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Economic Regulation of Urban and Regional Airports

Incentives, Efficiency and Benchmarking

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Chapter 1
Introduction

Peter Forsyth, Jürgen Müller, Hans-Martin Niemeier, and Eric Pels

This book discusses the current state of the art in the literature on, and the practice of economic regulation of, airports. This topic has received ample attention in the literature, but recent developments in aviation markets, policy and the literature concerning regulation and benchmarking necessitate a new overview.

1.1 Background

Forsyth et al. (2004), in their book "The Economic Regulation of Airports", stress that "most of the discussion in this book has taken as read that strong competition between airports is not feasible" (p. xxviii). They stress that sometimes, like in the UK, airport policy prevents competition as in the case of BAA's London airports (since then policy has changed). They argue further that competition between footloose low-cost carriers and full-service carriers might intensify and spread from secondary low-cost airports to the large regulated airports. Airports will then

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be forced to react and this will "raise the bigger question of whether, in more competitive circumstances, there is a continued need for formal price regulation". The last 15 years have proven that this conclusion was exactly right. BAA was broken up in 2009 and although this remained an exception to the rule that airports within close vicinity have been privatised as a group and have not been broken up, it made competition a more attractive option for policy. The success of footloose low-cost carriers increased pressure also on large airports. To what degree, and if sufficient to make competition work, are questions on which airlines and airports disagree. Airport Council International Europe conducted a number of studies, arguing that airports are no longer a natural monopoly, but a competitive industry. IATA argued the opposite. While acknowledging that some competition exists for small regional airports they argued that airports still have persistent market power. Competition Authorities found that Manchester and Stansted Airport were subject to competition, while London Heathrow, Dublin and Schiphol have persistent market power. Because airports are often seen as facilitators of regional economic growth, the issue of whether or not an airport has market power is important to consider, also when making regional policy. An airport may link the economy to the rest of the world, and thus facilitate business and tourism. When an airport is a poorly regulated, whether it is a natural or regional, monopolist, it will not deliver the connectivity the region aims at. Instead, it will exploit the local region by offering less connectivity for the business and too high travel costs for tourism, in order to generate monopoly rents. Establishing whether or not an airport has market power, and how to regulate market power, therefore is crucial to regional policy.

In the last 20 years regulation also changed. In 2004 light-handed regulation was brand new. The Australian regulator switched from tight price caps to a form of monitoring which termed it light-handed regulation—a term very attractive as the UK style of price capping had become increasingly bureaucratic. Light-handed regulation had in the beginning a relatively easy field. Major capacity extensions like Terminal 5 at Heathrow were not necessary and some of the capacity extensions were more straight-forward than in the UK. Regulating investment became an important issue not only at LHR, but also in Dublin and at the Paris Airports and other European Airports. UK style of price capping has been copied by other European states—sometimes not perfectly well, but sometimes very well. The idea of incentive regulation has been adopted step by step. The EU Commission also tried to establish an independent regulator in each member state. After long fights, it succeeded in some countries like Italy, France and Portugal, but failed in Germany and Spain. The idea of designing good institutions and good incentive has gained momentum and has changed regulatory practices, at least in some countries. These changes in policy give academics a rich field for research and like the practitioners they come to different results and draw different recommendations. This book tries to provide an overview about these debates.

The debates about airport regulation are complicated by the Covid-19 crisis. The top 10 busiest airports from 2019 lost 60.2% on average of their traffic in the first half of 2020 (ACI 2020). In Europe, non-EU airports, while hit hard, were less impacted than EU-airports, due to differences in the severity of the outbreak and national travel restrictions, and also due to the scope of the geographical networks served. Airports with a relatively high share of domestic passengers were hit, relatively speaking, less hard (Aviation24.be 2020). In other words, airports serving international and intercontinental trunk routes have been hit hard due to the current crisis, while under normal circumstances these airports are congested and oftentimes seeking to expand capacity in order to remain competitive. The increased pressure of low-cost carriers on large airports, as mentioned above, did not prevent these airports falling out of the list of the busiest airports.

Some airlines, often major airlines, flying international and intercontinental routes, received support. The common rationale is that hubs and hub airlines contribute to the local and national economies. Other airlines survive on their own, or fail, and these often are low-cost or regional airlines. This book will not address state support or economic effects, but from the perspective of competition policy it is interesting to see how the Covid-19 crisis exposes how a decline in the intercontinental market seems to hit (some) airports relatively hard, indicating a lot of traffic is only channelled through major airports under “normal” conditions. While this is not evidence for the abuse of market power, it does indicate traffic on trunk routes is channelled via a relatively small number of airports. At the same time, traffic on national/local markets allowed smaller airports to recover faster, while competition levels in such markets may be comparatively small. While we do not take a stance in the debate between IATA and ACI mentioned above, the developments we have seen since 2019 seem to suggest that under normal circumstances airports potentially may have some market power, even though this is not evidence for market power *abuse*. This observation, combined with the policy changes discussed above, necessitates an overview of the sources and practice of airport regulation.

This book provides this overview, and it does so in three parts. Part I provides a theoretical background on the need for regulation and systems of regulation. Airport competition is discussed, as well as common forms of regulation, and potential pitfalls. Part II discusses benchmarking, because benchmarking is often applied as an input to the regulatory process. Although benchmarking is necessary, reviews of how benchmarking is applied in the literature and in practice show improvements are possible. Part III provides examples from practice. Further details on the various parts are given below.

1.2 Part I: The Need for Economic Regulation

Chapter 2 focusses on airport competition. If an airport is subject to strong competition, it will not have much market power, and regulation will not be needed to keep prices down. But significant economies of scale and scope can lead to a natural monopoly situation in the airport’s catchment area. In addition, the large amounts of land needed for airports means that cities often have space for only one major airport. Connectivity is also better at larger airports, adding to their attractiveness. There is an advantage for regions of being served by only airport. But there are several factors that can give rise to competition, high population density being the most potent. Passengers can choose between airports (and destinations served from the airports), but airlines face significant switching costs and often do not have much countervailing power, unless they are very well politically connected, and/or when they dominate the airport.

Given that high population density is perhaps the key driver of airport competition, one would expect that regulation would be unnecessary for airports, large or small, in high population density countries, such as the UK, but necessary in low population density countries. One might expect that regulation would be observed with large and small airports in these countries. However, the actual patterns of regulation only partly conform to this expectation (see the table below for Europe). In the UK, the larger airports, such as London Heathrow, are the regulated airports, while in Australia only large airports are subject to (light-handed) regulation. Thus, it appears that the size, not proximity to competition, is a critical factor in determining whether an airport is regulated. Chapter 2 explores why this is the case and also discusses why airlines with potential market power may not have an incentive to abuse market power.

Chapter 3 explores competition caused by the overlap between destinations in origin-destination and transfer markets. The results of this chapter show the majority of hub airports in Europe have a dominant position, both in the origin-destination and in the transfer market. But market concentration in transfer markets has been decreasing steadily. Based on these results, a straight-forward conjecture would be that airports have market power and should be regulated. Chapter 4 argues airport regulation is necessary, but neoclassical policy prescriptions, focusing on the deadweight losses of monopolies are inconsistent with the patterns of regulatory decisions and processes we observe in practice. In recent years an alternative rationale of regulation has emerged, based on transaction cost economics. This form of regulation focuses on the need to protect and promote the sunk investments of consumers—airlines—of the monopoly facility, rather than the deadweight loss.

1.3 Part I: Systems of Regulation

Following this discussion on the need for regulation, Chaps. 5–10 analyse systems of regulation. Chapters 2–4 already discussed "incentives" to abuse market power, and the following chapters discuss this issue in a more theoretical setting. Chapters 5 and 6 provide further detail on why "standard" policy, focusing on the deadweight loss, may fail. Chapter 5 argues that low-powered airport regulation reduces the airport's ability to gain rents, but potentially leaves the rents to airlines when airlines have market power. After all, the companies involved (the regulated airport and the airlines) still have the incentive to maximise profits. High-powered regulation leaves the rents with the local airport rather than with the airlines, which may be politically convenient. In conclusion, different forms of regulation will have a different welfare impact, not always to the benefit of the final consumer. Chapter 6 examines airport privatisation and various forms of airport regulation, taking into account the behaviour of public administration and non-aeronautical services of an airport. This chapter concludes that price-cap regulation on aeronautical services could reduce airport charges, but also introduce an underinvestment in airport capacity that could lower social welfare, again because the company still has the incentive to maximise profits and there is no "penalty" to the company if the regulator's objectives are not reached. Chapters 5 and 6 thus provide some theoretical background to the argument put forward in Chap. 4: common policy prescriptions are inconsistent with what we observe in practice, because such prescriptions create (additional) inefficiencies, such as underinvestment. Chapters 7 and 8 therefore discuss a light-handed approach (LHR) to regulation (price monitoring, Chap. 7) and investment regulation (Chap. 8). Traditional regulation of firms with market power, be it cost plus regulation or incentive regulation, is recognised as having several drawbacks. As a result, some countries have replaced this regulation with LHR. Chapter 7 seeks to evaluate LHR in the context of airports. LHR is not a well-defined concept, but the elements which make up LHR can be identified. The potential positive features of LHR can be sketched out, and as can be the way it works. This leads on to a discussion of actual performance under LHR, and especially given the Australian experience. There is evidence that LHR works well in several respects, though its performance in some other respects, particularly in terms of its impact on productive efficiency, has not been much tested in a rigorous way. The chapter includes a discussion of how LHR might work if applied to other airports. It concludes with a review of the key findings and questions which remain to be settled.

Chapter 8 discusses regulation of investment in airports. Simple regulatory formulae, such as price caps, seem to work, but problems develop when major investments are required. Then it is difficult to ensure adequate investments in capacity and quality are made. One of the reasons for this problem is that regulators rely heavily on prices, but regulated prices are used to address several conflicting tasks, such as optimising capacity use, cost recovery, and incentives for investment. Additional instruments are therefore necessary, such as rewards for quality, and slots and trigger mechanisms for investment.

Chapter 9 discusses the difficult European airport (regulatory) environment. It adopts a political economy perspective. Many airports operate close to capacity and have high charges. In spite of this they perform quite well operationally. Slots create large rents which can be used to enable poor efficiency and enable the airlines and airports to create implicit contracts to underinvest and share the rents. This rent sharing is a possible explanation of why reform of regulation in Europe has been very slow and imperfect.

1.4 Part II: Benchmarking

One key issue in airport regulation is the application of benchmarking. Benchmarking is applied to determine the relative efficiency of the regulated airport, measured against its peers (comparable airports, performing just as well or better). After all, an airport that manages to increase its efficiency should also be able to reduce its prices. Benchmarking thus provides very important information to regulators and airport operators, but it is not a straight-forward exercise.

Chapter 10 discusses the three main methods for estimating airport performance, and the literature assessing the impact of regulation on airport performance. Regulation impacts airport efficiency, but this effect depends on the impact of governance form and competition levels on technical and cost efficiency. The chapter also provides a comprehensive review on the effects of regulation on economic efficiency. Of policy relevance in particular is whether incentive regulation is more conducive to cost efficiency more than cost-based regulation. Price-cap regulation in the UK had positive effects so strong that the regulated airports outperformed the competing airports. The chapter also outlines limitations of these studies and argues for more research to quantify the effects of regulation on cost and also allocative efficiency.

Chapter 11 discusses the many ways in which benchmarking has been used in the airport industry. It also examined some of the key issues associated with benchmarking. It takes a critical view of the actual practice of benchmarking and stresses the main pitfalls and dangers of benchmarking, such as lack of good data and misinterpretations in airport policy and regulation.

Chapter 12 provides an overview of practical issues facing a regulatory office seeking to use benchmarking to set a price cap at an airport. It uses the specific experience of Dublin airport price-cap regulation, where many different approaches to benchmarking have been investigated over the years. Because of the application to Dublin Airport, this chapter is on the border between Part II (on benchmarking) and Part III (practice), but due to the strong focus on benchmarking, it is included in part II of this book.

1.5 Part III: Regulation in Practice: Facts and Systems of Regulation

Following the discussions of benchmarking in regulation, Chaps. 13–18 provide country case studies to see how airports are regulated and benchmarking is applied in individual countries (see below table for the main results). While airport regulation is relevant all over the world, this book focusses on Europe and Latin America.[1]

[1] North America has adopted two models of airport regulation which are distinct from the rest of the world. Most US airports are operated either directly as public organizations or by port authorities.

Europe makes for an interesting case because EU airlines are allowed to fly within EU countries. For example, easyJet (easyJet Europe after Brexit) can offer flights within France. Airport regulation, on the other hand, often still is a local (national) issue. Airports may compete for services offered by airlines from other EU countries (and competition may have increased), while they are regulated by local regulators. Furthermore, regulation has been reformed in some European countries like Italy, France, Portugal, while other countries are still regulating airport in the traditional cost-based approach. Table 1.1 summarises the regulatory situation in the European countries discussed in Chaps. 13–17. The situation in Latin American countries is rather different and difficult to compare. Overall, the conclusion is that there is strong market power in most cases studied. But the regulator is not independent in quite a few of the countries studied.

Chapter 13 describes the development of airport economic regulation in the UK, comparing the system which was in force between 1987 and 2014 with the current regime. The chapter concludes the new system is more fit for purpose for today's UK airport industry. The first indications at Gatwick show the innovative and more light-handed approach has brought improvements. This finding is in line with the more theoretical expectations from Chaps. 2–6.

Chapter 14 discusses the French case. The competitive environment and the institutional and regulatory framework for airports in France have undergone major changes over the past three decades. While competition and carrier consolidation, and the growing importance of low-cost airlines, can be observed in the countries we have studied in this book, the institutional changes in France are more unique. The 2005 Law changed the rules on airport ownership and opened it up to private investors, leading to a different ownership structure of the larger French airports today, even though the planned privatisation of the Paris airports had to be postponed. The regulatory framework of airports has therefore also undergone major changes with the creation of a sectoral regulatory agency ASI, whose powers have been transferred in 2019 to the ART (Transport Regulatory Authority). Both single-till and dual-till regulation are being used. There are differences between the regulation of the large airports and the regulation of state-owned small regional airports. They are under the supervision of the DGAC, and for local airports (below 100,000 pax/p.a.) under the supervision of the Prefect, an administrator in charge of a local region.

Chapter 15 concludes that the large main German airports have persistent market power. All public airports have been corporatised and some of the large airports have

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The vast majority of activities are outsourced by long-term contracts with the airlines. Investments are supported by the government. Airport charges are regulated through the full cost recovery principle so that the charges rose in the Covid-19 crisis as the decrease in output led to higher average costs. A similar reaction happened at Canadian airports. Canadian airport are not-for-profit corporations at the local level. The US and the Canadian governance models have not changed much. The US model has been well analyzed by Graham (1992, 2018) and the Canadian model by Tretheway and Andriulaitis (2008). Regulations in Africa and Asia which we do not cover in this book are analyzed in Winston and Rus (2008).

Table 1.1 Summary table of regulation in different European countries

Country/airport	Ownership	Market power	Independent regulator	Regulation
Austria				
Vienna	Minority private	High	Yes	Incentive
Denmark				
Copenhagen	Majority private	High	No	Light Handed
France				
CDG & Orly	Minority private	High	Yes	Incentive
Nice	Majority private	High	Yes	Incentive
Lyon	Majority private	High	Yes	Incentive
Marseille	Public	High	Yes	Incentive
Germany				
Düsseldorf	Minority private	High	No	Cost based
Frankfurt	Minority private	High	No	Cost based
Hamburg	Minority private	High	No	Cost based
Munich	Public	High	No	Cost based
Stuttgart	Public	High	No	Cost based
Hungary				
Budapest	Fully private	High	No	Incentive
Italy				
Milan Bergamo	Minority private	High	Yes	Incentive
Milan Linate	Minority private	High	Yes	Incentive
Milan Malpensa	Minority private	High	Yes	Incentive
Rome Ciampino	Majority private	High	Yes	Incentive
Rome Fiumicino	Majority private	High	Yes	Incentive
Venice	Majority private	Low	Yes	Incentive
Netherlands				
Amsterdam	Public	High	Yes	Cost based
Portugal				
Lisbon	Fully private	High	Yes	Incentive
Porto	Fully private	High	Yes	Incentive
Spain				
Barcelona	Minority private	High	No	Incentive
Madrid	Minority private	High	No	Incentive
Malaga	Minority private	High	No	Incentive
United Kingdom				
Heathrow	Fully private	High	Yes	Incentive
Gatwick	Fully private	High	Yes	Light Handed
Stansted	Minority private	Low	Yes	Deregulated
Manchester	Minority private	Low	Yes	Deregulated

been partially privatised with a minority share for the private investors. Ownership and regulation have not been separated, although this has been demanded by airlines as well as the German competition commission. Traditionally German airports have been cost plus regulated. Attempts to reform this system have worked at some airports for some time, but in the end failed.

Chapter 16 evaluates changes in the market position of Schiphol airport in Amsterdam over the last decade. Examining the key developments, the chapter suggests the airport has probably strengthened its position in the markets for provision of infrastructure for both origin-and-destination and transfer passengers. However, through Schiphol Group's partial ownership of nearby operating airports (Eindhoven and Rotterdam) it has attracted services of some of the key LCCs, which have previously served the area via alternative gateways for the airlines serving O&D passengers. At the same time, several recent studies have documented increasing competition between the airports in the European context. The authors suggest therefore that a new investigation of market power of Schiphol airport is in order.

Chapter 17 compares privatisation, competition and of regulation for airports in Austria, Denmark, Italy, Hungary, Portugal and Spain. It shows that privatisation has set out mixed incentives for efficiency. Competition has increased for some airports, but the major airports still have persistent market power, because market structure has not changed with privatisation. This puts a heavy importance on the incentives from regulation, as we have seen in earlier (more theoretical) chapters (4–6). Even though we might expect competition levels to be higher in cities, regions or countries with high population density, this is very often not the case as they have been jointly privatised. Instead, these airports in these countries should be regulated for reasons discussed in Chap. 2. This chapter analyses how effective regulation is and how strong the incentives for efficiency are. For example, although Spain has adopted incentive regulation, the effects are not so strong as the regulator is not independent and the Spanish state still holds the majority share in the airports. Italy, Portugal and Hungary have reformed ownership and regulation in a much more consistent way, with clearer incentive for efficiency.

Chapter 18 describes the state of private participation and economic regulation of one hundred and eighteen airports in six major countries in Latin America. These countries in some cases have populations exceeding those of many European countries, and projections, by, e.g., Goldman Sachs, show the economies of, e.g., Mexico and Brazil are expected to be amongst the largest 10 economies in the future. Attention to these countries therefore is needed. The chapter concludes that concession contracts, regional companies, system of airports, and revenue-sharing clauses with the government are common features among airports. Under the body of rules needed to enforce regulation, regulatory agencies exhibit low levels of governance and weak economic regulation, as might be expected from the discussion in Chaps. 2 to 6.

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Part I
Theoretical Background: Market Power and Regulation

Chapter 2
How Strong Is Airport Competition: Is There a Case for Regulation?

Peter Forsyth, Jürgen Müller, Hans-Martin Niemeier, and Eric Pels

Abstract Given the natural monopoly properties and higher levels of connectivity of large airports, workable airport competition may not be possible, requiring regulation. This simple rule becomes more complicated, when looking also at the product range of airports, difference in consumer preferences and their price elasticity or competition from other transportation modes like high-speed rail on short-haul routes, thereby also affecting the catchment area. Control of access to aviation-related services, like ground handling, can also matter. Private versus public ownership of airports complicates the picture, as do airport capacity constraint. Transaction costs and opportunistic behaviour can also lead to regulation.

After covering the literature concerning airport regulation, the chapter goes on to look at a number of actual cases involving market power and its regulation. It also looks at airports charging behaviour and price discrimination, depending on the level of congestion at an airport. A number of studies of airport competition and its implications for regulation are summarized, especially for the UK, the Netherlands [Schiphol] and Australia. The studies commissioned by the ACI, which suggest that airports should be just subject to competition law and regulation should be the exception are also discussed.

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2.1 Introduction

The intensity of the discussion about airport competition accelerated in 2012 with the study by Copenhagen Economics (2012) for Airport Council International (ACI) Europe. This study and the continuous stream of studies from ACI have put competition at the forefront of airport policy discussion, but the issue goes back even to the times when airports were in the public hands and were regarded as public utilities. Starkie and Thompson (1985) envisaged a competitive airport market for the London metropolitan area and recommended breaking up BAA first and selling the airports separately. The Thatcher government did not follow this recommendation and privatized BAA as group of regulated airports. In spite of this the idea of airport competition continued to be explored (Starkie 2002; Forsyth et al. 2010). The critical question is whether competition can be relied upon to limit the use of market power at airports or whether regulation needs to be used to do this.

This chapter addresses this question by first discussing the case for regulation. Thereafter we provide a brief overview of airport competition (Sect. 2.2) and then look at the factors determining the substitutability of airports (Sect. 2.3). In Sect. 2.4 we discuss the concept of countervailing power and apply it to the airport-airline relationship. In Sect. 2.5 we assess some evidence of the use of market power and then, before drawing some conclusions, we review studies of competition and market power.

2.2 Competition and the Case for Regulation

2.2.1 Market Power and the Classic Case for Regulation

Our interest here in airport competition is in that it can render regulation concerning market power unnecessary. If an airport is subject to strong competition, it will not have much market power, and regulation will not be needed to keep prices down (there may be other reasons for regulation however). In addition, connectivity is also greater at larger airports, adding to their attractiveness. As a consequence, there are definite advantages for regions for being served by only airport.

On the other hand, several factors can give rise to competition. The most potent of these is high population density, which may lead to a number of airports being close by in the same region. Hence there has been much interest in measuring the catchment areas of airports. Passengers can choose between airports if they are in the same region/catchment area, but it is not easy for airlines to choose which airports they will fly to and from. There are switching costs in the short run, and in both the short and long run, airlines need to fly to and from the places which the passengers wish to fly from. Airlines do not usually have much countervailing power, unless they are very well politically connected, and/or when there are few airlines willing or able to serve an airport (and perhaps the airport or city is keen to ensure air service—see Sect. 2.5.1).

Given that high population density, which leads to the likelihood that there may be several airports in the same catchment area, is perhaps the key driver of airport competition, one would expect that regulation would be unnecessary for airports, large or small, in high population density countries, such as the UK, and necessary in low population density countries, such as Australia and Canada. One might expect that regulation would be observed with large and small airports in these countries. There are many countries in between, such as France, Germany and the USA. However, the actual patterns of regulation only partly conform to this expectation. In the UK, most airports are not regulated, but the larger ones, such as London Heathrow, are regulated, in some cases, quite tightly. On the other hand, in Australia, only large airports are subject to (light-handed) regulation, while medium sized airports, such as Adelaide's (800 km, away from the nearest airport capable of handling a medium/large sized aircraft, such as the Airbus A330 or Boeing 777), are not regulated at all. It appears that the size, not proximity to competition, is a critical factor in determining whether an airport is regulated.

There are some good reasons why this is so. For a start, there are not many airports which are close to a large airport which can serve all of the traffic which it does. London Heathrow may be quite close to many airports, all of which can handle a Boeing 737 or an Airbus A320, but not many which can handle medium to long distance aircraft, such as Boeing 747 s and Airbus A380s.[1] The large airport may have considerable market power over part of its product range. The large airport, in a large city, will have an advantage over smaller airports outside the city taking into account the cost of access and the time cost. (Heathrow slot prices are very much higher than Gatwick slot prices—for many travellers to or from London. Heathrow has the advantage over Gatwick even though Gatwick is significantly cheaper, suggesting that Heathrow and Gatwick are not strong substitutes).

At the other end of the scale, there are small airports which are quite distant from the nearest competitor—this is especially true for countries like Canada and Australia. This suggests that they have significant market power, but nonetheless these airports are not regulated. These airports' market power may be limited by competition between destinations, in the case of airports serving leisure destinations, or by ample competition from other modes, such as road or rail (Productivity Commission 2002).[2] Some of these airports are operated by not-for-profit enterprises

[1] But see Maertens (2010) who showed that many airports have extended capacity for intercontinental flights in Europe but have never received such flights.

[2] The development of surface transportation infrastructure, as a factor increasing substitutability between the airports and modes of transportation, will be a factor limiting the airport's market power. However, for practical purposes, a more precise evaluation will be necessary.

or municipal authorities—these may not be exercising the market power they possess. For the medium sized airports which are privately owned, local communities may have some say over the pricing policies of the airport—they will be expected to be good corporate citizens and to not make use of their market power. This would involve keeping prices close to cost. It is also possible that such airports may be using their market power to allow costs to be higher than the minimum possible (in the way that cost-plus regulated firms do). Market power may be being used in a way which is not apparent (such as over capitalizing the airport). Small airports often have difficulty in covering costs, even at relatively high prices, and for these the risk of abusing market power is small.

There may be good reasons why it is the large airports which are regulated, and the small to medium sized airports are not regulated. But it is also feasible that authorities have not been making good choices when it comes to airport regulating. Some airports which do face sufficient competition may be being regulated, at a cost in terms of efficiency and administration, and some airports which face very little competition may be not regulated, and which are able to exercise their market power, at a cost in terms of efficiency. There is a need to scrutinize the decisions about which airports should and which airports should not be regulated.

A standard argument for market failure, and thus the need to regulate, is usually found in scale economies, potentially making the airport a natural monopoly. Intuitively, smaller airports (measured in the number of passengers or flight movements) will have strong scale economies, while large airports have had more opportunity to exploit scale economies. If the bigger airports are regulated, this is then because the expectation is the market power they have comes from other sources, for example a locational monopoly. Small airports need to set the price above marginal cost in order to survive (without subsidies). So, while there may be good reasons to regulate large airports, we must be certain about the nature of the source of market failure and the need to regulate.

2.2.2 *The Allocative Efficiency Argument*

If an airport is privately owned, and has a monopoly, it will have the incentive and ability to charge high prices. This has an impact on allocative efficiency—it will produce too little of its services at too high a price. This is the classic argument in favour of regulation, and it is used in a wide variety of cases of utility regulation (Armstrong et al. 1994). With airports, the allocative efficiency gain from regulation is not likely to be great. For most monopoly airports, the elasticity of demand will be very low.[3] In theory, this would enable the airport to price at a substantial multiple of

[3] This is the case when there are no good substitutes because airport charges are only a small proportion of air travel demand which is also not very elastic. For an alternative view, see Starkie and Yarrow (2013). Note we do not refer to a point elasticity here, but to the general shape of the

cost. In practice, airports are not likely to make full use of the market power they have—they may set prices above costs, but there may not be an enormous margin (the reasons for this behaviour may be several—the influence of commercial revenues is often mentioned). In this case, there will be an allocative efficiency loss, though it is quite small due to the nature of (some) airport assets—some necessary inputs may not be readily changed in the short run.[4] The classic allocative efficiency argument for regulation is not strong.

If there were strong competition for the airport, it would not be able to charge high prices for its services, and this source of allocative inefficiency would be eliminated. However, there is also the possibility that the airport faces some competition, perhaps from one or two (perhaps less convenient) airports. In this case, the main airport would be partially constrained by the prices set by the competing airports. It is quite likely that the main airport has adequate capacity to serve all of the traffic to and from the region. The efficient solution to the airport allocation problem is that only that traffic which prefers the less convenient airports will use them—the main airport will set its prices such that they are sufficiently low such that this occurs, in other words, the airport will have a higher capacity utilization. However, there is also a distinct possibility that the main airport will set relatively high prices, inducing some of the traffic which it could handle efficiently to travel to the higher cost alternatives, requiring allocative inefficient expansion at less favourable airports.[5]

This type of situation can also occur with other services provided by the airport, most notably car parking. It is possible that the airport has ample space to provide car parking spaces, and that this parking may be the most efficient supply. However, if the airport has high parking charges, many users may be attracted to other, less convenient, car parks which are cheaper. The result will be a less efficient allocation of cars to car parks than can be achieved. In principle, regulation of car park charges, can achieve a more efficient outcome in terms of the lower overall costs and lower parking charges.

This inefficient allocation of traffic between airports, or cars to spaces, need not come about. If the airports were pure profit maximizers, and if they have highly accurate estimates of their market power, they would price their services and the amount of capacity they provide. The potential operators of less convenient airports will see that the customers with the highest willingness-to-pay choose the most convenient airports, even though the price may be high. The less convenient airports may then face the choice of investing in capacity or quality, without certainty that they will attract enough passengers (with a high willingness-to-pay) to make good on their investment.

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demand function. Also, on an inelastic demand curve will the monopolist look for price– output combinations which yield positive marginal revenues and a point elasticity larger than one in absolute value.

[4] But see Basso and Ross (2010) and Basso (2013).

[5] This could be particularly true if the main airport finds it difficult to price discriminate between users. It is also quite possible that the privately owned main airport is not a pure profit maximizer. In this situation, there can be a prima-facie case for regulation to keep prices closer to cost.

In reality, airport operators have imperfect information about their market power (and thus do not have the required knowledge to set optimal prices) and do not always act as profit maximizers (possibly decades of experience as public enterprises have conditioned their behaviour). Regulation may be able to avoid these sources of allocative inefficiency. A little competition may lead to results less efficient than monopoly. This also suggests that if there are two or more airports, it can be more efficient for them to have the same owners rather than different owners. If the one owner allocates traffic efficiently, single ownership does have at least one advantage (though this needs to be set against the costs of the owner using its market power). After all, in an industry which relies heavily on fixed assets, price competition may eventually result in prices falling below the level of fixed costs. The deregulation of the airline industry and rail industry in the USA caused many potential competitors to merge in order to reduce competition, but also to reduce fixed costs and over capacity. One of the reasons for regulation of airline markets in the USA prior to 1978 was to reduce the effect of excess capacity and destructive competition.

2.2.3 Regulation, Competition and Public Airports

One should not assume that there is a case for regulation of an airport only if it is privately owned. There can be a case for regulation of publicly owned airports. Some major public airports such as Amsterdam and Munich Airport have been regulated. The UK regulator regulated publicly owned Manchester Airport and the private London BAA airports irrespective of their ownership. Currently, Manchester airport is not regulated, since competition from other nearby airports, such as Liverpool’s, has been judged sufficient to moderate its behaviour. The fact that Manchester has a minority private investor since 2013 has no effect on this decision. A number of European airports, in particular those of Germany (e.g. Hamburg, Frankfurt, Dusseldorf), and French airports such as Paris Charles de Gaulle, or airports in Spain are partly privatized, though still majority owned by the state. The charges and prices of all of these are regulated.

Most public airports will not seek to maximize profits, thereby creating a deadweight loss in efficiency terms. However, they can use their market power, if they have it, and reduce efficiency in other ways. One way in which they can do this is by producing inefficiently—if the airport is subject to competition, its ability to do this is reduced. Another possibility is where an airport raises its charges and invests excessively—the more the airport faces competition, the less scope it has to do this. A publicly owned airport can also seek to provide an excessively high level of quality. It will be less likely to do this is it faces competition (low-cost carriers have switched to lower cost, albeit less convenient airports when the major airport has been offering too high a level of service quality).

There are several ways in which an airport can use its market power, resulting in less efficient pricing and operation. If competition is effective (but see the previous subsection), these ways will be cut off, and there is no need for regulation. However, if the public airport does have strong market power, it will often use it in a way detrimental to economic efficiency. In this case, regulation may help lessen this source of inefficiency.

2.2.4 Alternative Arguments for Regulation: Transaction Costs and Opportunistic Behaviour

The standard approach that regulation should correct the welfare losses form persistent market power has been questioned from the perspective of transaction cost theory (see chapter by Biggar in the volume). Biggar (Chap. 4) and other authors like Wolf (2003)[6] argue that in practice regulation is not done to avoid the deadweight loss of monopoly pricing, but to protect investors and users which make sunk investments from being expropriated. Both sides, the airport investors as well as the users make investments in long-lived physical investments. The airport builds runways and terminals. The airlines also make long-term investments to equip these facilities with. Airlines built their base and station aircraft. They invest in lounges and marketing campaigns. Hub carrier built up their network. Both parties face the danger of opportunistic behaviour which could make the relation specific investment unprofitable. The airport might face the problem that the users could force charges down to marginal costs which do not cover the average costs. Likewise, once the airline has made the investment, the airport could take advantage of this and raise its charges so that it extracts all the profits and the airline just receives the marginal costs of its sunk investment. In theory, perfect contracts could offer a solution, but in world of risks and radical uncertainty contracts cannot be complete and need also discretionary power. Such discretionary power could be provided by regulatory contracts. For example, the regulatory asset base (RAB) approach of UK style price caps offers the commitment of the regulator that airport charges do not fall to marginal costs, but will be sufficiently high to cover average costs (Helm 2010).

2.2.5 Distribution, Regulation and Competition

The distribution of producer and consumer surplus can be affected by regulation, and this means that the relative merits of competition and regulation can vary as a result of regulation. Typically, regulation can result in customers gaining from regulation, at the expense of producers (though this may not always be the case, where regulation is systematically designed to help producers at the expense of customers).

[6] Dieter Helm (2009, 2010) without explicitly referring to transaction cost theory calls this the “time inconsistency” problem of infrastructure investment, that is the danger stemming from opportunistic behaviour to charge only marginal costs for a sunk investment.

In the airport context, in the absence of competition, prices can be lower as a result of regulation. It is not clear that there are any obvious disadvantages from lower or higher prices. If producers and customers have equal weights, whether a price is higher or lower is immaterial. Sometimes regulators express a preference for consumers over producers—in such a case if regulation keeps prices down, this will be a benefit from regulation. On the other hand, if the airport is publicly owned, and the government has a high marginal welfare cost of raising taxation, additional profits earnt by the airport achieved by higher prices would be welfare increasing.

Thus far, we have used the term "customers" of the airport advisedly. Airlines and their passengers are different and are affected differently. It does not necessarily follow that the final incidence of higher or lower airport prices falls entirely on the passengers, and/or that they are unaffected. One possibility, which is relevant for many, particularly larger, airports is that their capacity is slot constrained. If this is the case, an increase in airport charges will be paid for entirely by the airlines—in a competitive market they are unable to increase their own fares and suffer a reduction in slot rents (Forsyth and Niemeier 2008). If the airline markets are very competitive, an increase in airport charges will be passed on in full to the passengers. However, airline markets are very often likely to be less than perfectly competitive—very many airline markets have one, two, or three independent airlines competing. In such a case, they can be more accurately characterized as oligopoly rather than competitive. If this is the case, an increase in airport charges will be paid for by both the airline and its passengers (Forsyth 2017).

To sum up, there is no general case on distributional grounds for or against regulation of airport charges. However, regulation has implications for airport charges and the distribution of traffic between the airport, the airlines and their passengers. Depending on the context there can be a case for or against regulation as a result of its effects.

2.3 Airport Competition: A Brief Overview

2.3.1 Privatization and Incentives for Profit

For many years, airports were regarded as quintessential public utilities. They were publicly owned and managed and were normally priced to cover costs. They were regarded as natural locational monopolies, though there was not much analysis of the natural monopoly assumption. The question of competition did not really arise. For most cities there was only one major airport, and the closest airport was assumed to be quite distant. Such an airport would have a monopoly of access by air. While there were exceptions to this rule—for example, some cities had two or more airports—public ownership and cost-plus pricing rendered the question of competition irrelevant.

From the 1980s, airports began to be privatized. Initially, the three London and four Scottish airports of BAA were privatized, and later on, other airports were privatized. The privatization move has still a way to go—countries are gradually privatizing their airports, though many still exist in public hands. When the three London airports of BAA were privatized, they were privatized as a group, though the issue of whether it might be better to privatize them individually, to foster competition, was raised (Starkie and Thompson 1985)—recently the airports have been de-merged. More recently, the Spanish airports have been privatized as a group, precluding the development of airport competition.

Privatization would affect the incentives of the airports—an airport with market power would seek to use this to put up its prices, so gaining higher profits with low output. As a result, most larger airports were regulated at the time of privatization. In recent years, there has been less of an assumption that competition is infeasible for most airports, and more willingness to analyse whether competition could come about. This has happened in the UK, which has removed or lessened the regulation of Manchester, then Stansted, and more recently London Gatwick airports. In short, airport competition is now recognized as a possibility, and the question being posed is whether it is sufficiently strong for regulation to be lessened or removed. For a survey of different aspects of airport competition, see Forsyth et al. (2010).

2.3.2 Types of Airports and Sources of Competition

There are several ways in which airport competition can come about (Tretheway and Kinkaid 2010).

One of these is where there are several airports in the same city. This can be the case in large cities such as London, Paris, New York, Tokyo, Shanghai and Los Angeles. Competition can exist if the airports are independently operated, as in the case of London now. One consideration which determines how strong competition concerns how close the two or more airports are. In the case of Tokyo, Haneda airport is close to the city centre, but Narita is quite remote—68 km away from Tokyo Station. In London, Heathrow and Gatwick do compete, though they are not perfect substitutes for one another—charges are significantly lower at Gatwick, and the prices of slots at Heathrow are much greater than at Gatwick.

Another source of competition can come about if airports are not in the same city, but in close by cities. There are many situations in which it can come about. Two large cities, such as Manchester and Liverpool, are quite close, and their airports compete. Low-cost carriers (LCCs) have been quite adept in seeking out airports which serve a city and also a broader region. These may be hitherto secondary airports, former military airports or, occasionally, new entrant airports. Many of these smaller airports are only able to serve some of the product range of airports—for example, they may have short runways which cannot cater for long-haul flights. Nevertheless, they are capable of providing strong completion for part of the range of services offered by the primary airport.

With both of these sources of competition, the strength of the competition will depend on how close the airports are, i.e. how easily they can be reached. As a result, the distance between potential competitors drives a lot of the analysis of whether an airport has market power. One way of assessing competition is to measure the distance between airports or the travel time necessary to access them (see Sect. 2.4.2). Another way, which is related, is to survey passenger preferences and measure whether they are prepared to travel to further away airports. This will be related to the passenger's values of time—typically, business travellers will have a higher value of time and will be more likely to opt for the closer airport than leisure and visiting friends and relatives (VFR) travellers.

For two types of airports, hubs and cargo airports, proximity is less important as a determinant of competition. Some airports are primarily hubs for transfer traffic (e.g. Dubai, Abu Dhabi) while others have a strong role as an origin-destination airport as well as a hub (London Heathrow, Amsterdam Airport Schiphol). The business of a hub airport is to serve connecting traffic. As a result, the competitor of a hub airport need not be close. Frankfurt may be a strong competitor for London, and Dubai for Istanbul (see chapter on hub competition in this book). Hub airports are actively seeking to gain business from other hubs. Furthermore, hubs are now seen as very desirable by governments, since they are seen as the source of wider economic benefits (WEB) of air travel. The recent London Airports Commission (2014, 2015) put a very high weight on the perceived hub benefits of Heathrow airport.

Finally, airports compete for cargo traffic. There are some airports which are virtually all cargo airports or some which have large cargo businesses. These may be located close to large industrial areas (Hong Kong) or may be hubs (Memphis). Cargo is less time sensitive than passengers, and the catchment area of a cargo airport may be larger as a consequence. Cargo airports, especially those which are hubs, may be competing with others some distance away.

Competition between airports can be constrained. One obvious way is that not all airports can serve the whole range of potential traffic. Only the very large ones can serve long distance flights using large aircraft, such as the Airbus A380. However, one of the more important constraints is that of capacity. Many airports, in Europe, in North America and some parts of Asia are capacity constrained. These airports are subject to excess demand—they would like to serve more flights than they are currently able to. Capacity constraints do not preclude competition, but they do blunt its effectiveness. This will be particularly the case of the limited capacity is not efficiently rationed—which is often the case. Airports rarely use prices to ration demand (Heathrow, Gatwick and Brisbane are exceptions), though slot markets are sometimes tolerably efficient (as in London). Airports which rely on opaque slot markets (most of Europe) or delays (most of the US airports) ration scarce capacity inefficiently.

Competition between two airports, one of which is capacity constrained, can be consistent with moderate efficiency if the capacity is efficiently rationed, but it will not bring down prices (the airport with adequate capacity will be able to increase its prices to take advantage of its competitor's higher prices). Competition is desirable, but it is not as effective as when both the airports are unconstrained. The UK CAA's decision to use a form of light-handed regulation for Gatwick, given that its competitor Heathrow is very capacity constrained, is understandable—total deregulation might not be a prudent choice.

Thus far we have discussed airports which have targeted traffic in general. As LCCs have developed, they have made extensive use of airports which have limited facilities and which are often quite distant from population centres or tourist destinations. Quite often there are only one or two airlines which make use of these "LCC" airports. The introduction of these new airports has increased the effective competition for the established airports. These "LCC" airports may not have much market power, since LCCs often are readily able to switch airports. Destinations and airports may seek to subsidize airlines to come and offer services (Sect. 2.5.3).

2.4 Substitutability of Airports

Passengers and/or airlines (or other companies) may perceive different airports as substitutes if these airports offer services in line with the customer's expectations. The airports must not only have overlapping geographical catchment areas, but also the service offered must be similar. This is discussed in more detail in the following subsections.

2.4.1 Demand Side and Supply Side Substitution

From the demand side, the passengers' willingness to switch between airports depends on their sensitivity to various factors, such as price of flight, schedule convenience, airport proximity, airport convenience, etc. If airports are perceived as close substitutes, this puts pressure on airlines serving a particular airport to adjust their business strategies and potentially curtail their services. Secondly, on some (especially longer haul) markets, airports competing for O&D traffic may be located outside of what is conventionally considered an airport's catchment area.[7]

Airport customers include different types of companies (airlines, logistics service providers, etc.) using airport capacity as an input into their production process. Airport market power then becomes relevant if supply substitution is limited, because, as discussed above (Sect. 2.2.4) and below (Chap. 4), airport users make sunk investments in order to benefit from the airport to produce their output.

[7] This appears to be the case, for instance, for European traffic to North Africa, where Paris area airports have a traditionally strong position on EU–North Africa market.

2.4.2 Provision of Infrastructure for O&D and Transfer Passengers and for Cargo: The Definition of Catchment Areas

An airport attracts passengers within a certain geographical area around the airport, which is called the catchment area of the airport. The relevant geographic market in the downstream markets for air transportation services is defined by these catchment areas. Since the demand for the provision of infrastructure for landing and take-off of different types of aircraft is derived from demand downstream, the geographic market definition for the upstream markets has to take the catchment areas of the downstream markets into account.

The European Commission's approach towards the definition of the geographic market in the airline industry is a two-step approach. The first step is to take a certain circle area around the airport as a starting point. The distance from the airport and the travel time needed for access is of great relevance. With reference to passenger transportation, the circle tends to be wider for long-haul or intercontinental flights and smaller for regional or short-haul flights.[8]

In the second step it is necessary to determine the exact catchment area (see former merger cases by the European Commission). In the KLM/Martinair merger case, the Commission conducted a passenger survey at Schiphol airport to investigate if Dusseldorf and Brussels airports belong to the catchment area for time-insensitive long-haul flights to Caribbean destinations. Tour operators considered Schiphol airport's catchment area of 200 km and 2 h drive as relevant, so Dusseldorf and Brussels airport belong to the catchment area of Schiphol airport for long-haul flights.[9]

If these catchment areas do not overlap with that of another airport capable of providing access to the same kind of infrastructure, we can say that the airport is indeed a local monopolist. However, the catchment area for O&D passengers is different from that for transfer passengers and cargo, so the same analysis must be done with respect to transfer passengers and cargo transport.

Transfer traffic emerges because many airport-pair markets worldwide lack non-stop air services, or airlines offer indirect alternatives to compete with the direct services offered by other airlines. Passengers travelling on those routes will be required to change planes and sometimes carriers along the way. These transfer passengers have a choice among airports hosting airlines that offer such transfer services. The "need" for airlines to accept transfer passengers largely depends on the size of the home markets. If the airline desires to serve a worldwide network with relatively high frequencies, while demand from its home airport is relatively low,

[8] As a starting point for the definition of the catchment area, the Commission considers distances of 100 km and one-hour travel time for short-haul flights and distances of about 300 km for international airports. For a hub airport, the Commission considers the main European hub-airports as belonging to the same catchment area, which can be reached within a 2 h flight.

[9] See Mueller et al., p.61ff.

transfer passengers are essential to keep the load factor at acceptable levels. Since most airlines flying long distance routes rely on transfer passengers to some extent to keep the load factor at acceptable levels, competition in these markets is quite tough, both for airlines and airports. The geographic catchment area is quite broad, with Middle Eastern airports competing for transfer traffic with European airports in some long-haul markets.

Cargo transportation is not time-sensitive, contracts are of short duration and airlines have a greater flexibility to adjust their networks as a reaction to price changes compared to passenger airlines. This works in favour of the broad geographic catchment area. Within Europe there are strong indications that the relevant geographic market for air cargo is EU-wide.

Markets are separate from each other if substitution between different services is low, which restricts competitive pressure, but this does not seem to be the case for cargo.

2.4.3 High-Speed Rail Competition

High-speed rail (HSR) affects airports in two ways. First, there is substitutability towards rail services on the short-haul routes. Second, high-speed rail can increase the airport's catchment area. For example, the opening of the Channel Tunnel caused some airlines to exit the London-Paris market, while at the same time Air France could use the link to feed its intercontinental network. But this effect is not only limited to the London-Paris market. On a number of routes, development of high-speed rail has led to reduction or elimination of air services. The most vivid examples in the EU are Paris-Brussels, Paris-Lyon and Madrid-Seville markets, where share of high-speed rail exceeds 75%. At the same time, high-speed rail can enlarge the airport's catchment area and bring more O&D passengers to the airport.

In general, it is difficult for the airlines to compete with HSR on routes where travel time by rail is 4 h or less, meaning that the airline is likely to expect a significant competitive effect. This of course depends on the pricing strategy of the HSR operator, with HSR often being the more expensive alternative. If low-cost carriers compete in the market, they often offer the lowest fares.

Gonzales-Savignat (2004) conducts a survey of travellers on Barcelona-Madrid HSR line to evaluate responsiveness of business and leisure travellers to price and non-price characteristics of rail services. In addition to discovering the obvious fact that leisure travellers are more price sensitive, the author finds that business travellers are found to be more sensitive to travel time changes than leisure travellers. Greengauge (2006) investigates the effects of the introduction of high-speed rail at Heathrow and finds that such a development will likely bring a transformation in general rail access to the airport from such geographical regions as North England and Scotland, as well as the near-continent (France, Belgium, the Netherlands and parts of Germany).

2.4.4 Bundling: Aviation-Related Services and Market Power

An airline requires certain aviation-related services while its aircraft is at the airport, including refuelling as necessary, cabin servicing and/or luggage handling. These ground handling services cannot be performed outside of the airport's premises. The relevant issue is whether the airport itself will be interested in getting involved into provision of such services, and if it will have incentives to restrict entry of other providers. The airline can provide ground handling internally (in this case, it can also sell its ground handling services to other carriers at the airport) or purchase it at the airport. In the latter case, ground handling can be provided by the airport itself, or by a specialized company operating at the airport. It is obvious that an airline with substantial presence at the airport will be less likely to outsource ground handling and instead take advantage of economies of scale associated with organizing the activity internally. The degree of airports' involvement in provision of ground handling services varies across the world, and its determinants are not as of yet well understood. For instance, while in the USA only the smaller airports have recently started testing the water in this area, Fraport—a company managing Frankfurt International Airport—has been offering ground handling and other services not only at its home base, but also at twelve other airports worldwide.

From the point of view of economics, the main issue with the airports' involvement in aviation-related services is their control over essential inputs in the process. Airports operating their own ground handling services might restrict competitors' access to those inputs (these include apron, luggage belt, fuel facilities, etc.), with detrimental consequences for competition. Such issues are within the realm of regular competition policy—firms which are denied access to essential inputs can refer the matter to the relevant competition agency. The regulator has to however understand that the airport, being in control of the essential inputs, may have an incentive to engage in exclusionary practices. On the other hand, if the airport faces competition (in origin-destination or transfer markets), margins in general will be relatively low. Promoting competition between service providers may then lead to wasteful competition and/or low wages may lead to a shortage in staff, as currently witnessed at some European airports.

2.5 Countervailing Power

2.5.1 Are There Alternative Airports Available?

What if the airlines have countervailing power—would this mean that the negative effects of market power at the airport level would be eliminated or reduced? There are several sources of countervailing power, but they can be grouped into two. The first of comes about as a result of political power—the airline or airlines may have more political power than the airport, and they may be able to induce the government to tilt the balance in their favour. This may be done informally, or quite formally—for example, they may be able to induce the government to regulate the airport. The second source of countervailing power is market based—the airline(s) may be sufficiently strong as a buyer of the airport's product to influence the terms of sale. Essentially this is the bilateral monopoly case.

In this case, the airport has a monopoly over landings at the airport, and the airline is the sole buyer of its services (it is possible that there are several airlines but that they collude in dealing with the airport). The results also depend on the market structure in the airline's product market, though in this case, it is implausible that the airline will be anything other than a monopoly. There are several possibilities with bilateral monopoly, and it can be less inefficient than pure one-sided monopoly. The two firms will share the monopoly profits, and the traveller will be worse off than under competition. If the airline and airport collude, joint profit maximization will lead to greater output and greater passenger welfare, but passengers will be still worse off than under competition, see, for example, Zhang and Zhang (2006) for an extensive analysis and discussion.

The genuine bilateral monopoly situation is feasible, but it is likely to be rather rare. There are several cases where there is a monopoly of airport services but there are likely to be few cases where these are matched by monopsony and monopoly with airlines. A possible example could be one where there is a remote airport and one airline which serves it, and there are no alternative airlines which are capable of serving it (perhaps because specialist aircraft are required). In this situation, while the result is better than pure monopoly, there may still be a case for regulation.

There are some specific cases in which the airport may have relatively little market power. One of these is that of hub airports with little origin and destination traffic. Of course, most hubs do have very significant non-transfer traffic (which is why they have grown large). However, some airports mainly serve hub traffic—some airports in the USA are (or were) cases of this, and the Gulf airports (such as Abu Dhabi) also are. The airlines which use them can threaten to switch their operations (over the medium to long term) and have strong bargaining power.

2.5.2 Are Airline Markets Competitive, Contestable or Concentrated?

Other than these sorts of situations, monopsony power on the part of the airline will depend on the airline having monopoly power in its product markets—and this is rather unlikely. Airline markets tend to be quite competitive in the main. While they are not purely competitive or contestable, airlines typically do not have much market power (if they did they would be much more profitable than they are now). Even though the number of competitors in a route market tends to be small in all but the largest markets, they do not behave as small group oligopolists. While empirical tests showed that they are not highly contestable, they still are somewhat contestable.

If fares are high, new airlines will quickly bring them down. If a market gap emerges, new airlines will swiftly close it—(as happened when the dominant carrier at Budapest, Malev, exited, see Bilotkach et al. 2014). This means that it is difficult for an airline or airlines to gain sufficient monopoly power to exercise countervailing power.

It is important not to assume that size or apparent market dominance gives countervailing power. Some airlines are very large, but this does not mean that they are able to exercise countervailing power over airports which have some market power. Large airlines complain about the largely deregulated Auckland Airport, which has high fees and is very profitable. Airlines may threaten withholding of fees, but in the end they pay up. Sometimes large airlines have some political power—but by the same token, local airports have the ear of local politicians and are seen as local champions. This is discussed in some country studies in later chapters.

An apparently strong position at an airport need not convey countervailing power. An airline may have a high percentage of flights from an airport, but this will not translate as market power. If the airport puts up prices, what can the airline do? It cannot switch to an alternative airport if there are none to go to. If it refuses to pay, it will vacate the market, and another airline will enter, and pay the price which the airport insists on.

2.5.3 Countervailing Power and Subsidies

Subsidies paid to airlines have become a significant issue in recent years. These subsidies may be paid by regional or national governments, or they can be paid by the airports themselves. The existence of a subsidy suggests that the market power of airports is not absolute—monopolies do not usually pay their customers to use their facilities. Airports nowadays often price discriminate—this does not necessarily mean that they provide subsidies. However, sometimes airports provide unambiguous subsidies. This could come about if a region considers that air services create wider economic benefits (WEBs), or the airport may be too small to be profitable. The Airports Commission for London put a high weight on connectivity benefits in its recommendations even though London is already very well connected (Airports Commission 2015). The net effect of this is that even with monopoly airports, the airlines can some market power. This is an aspect which has yet to be researched thoroughly.

2.5.4 Countervailing Power and Passenger Interests

Suppose that an airport faces little competition, but that the airlines which fly to it have countervailing power—the extreme case would be a bilateral monopoly. The airport will not be able to act as a monopolist, but will be needed to share its market power with the airline. This will influence the price-output choice of the airport and airline, and the outcome may be a more efficient choice than the pure monopoly airport situation.

However, this does not imply that the passengers gain from the presence of countervailing power. The passengers will pay a high price, as the airline and airport share the monopoly rents (Zhang and Zhang 2006). If the objective is to keep prices low to the ultimate consumer, the passenger, countervailing power of the airline does not help—to keep prices down, regulation will still be necessary.

2.5.5 Competition and Countervailing Power: A Summary

In the sections above, there has been a range of factors which will determine whether an airport has market power and is subject to countervailing power—these will influence the case for regulation. These are summarized in Table 2.1. Four types of airports are considered—these are Major Hubs (e.g., London Heathrow, Amsterdam Schiphol), Large city airports (e.g. Düsseldorf, Melbourne), Low-Cost Carrier Oriented airports (e.g. Hahn, Charleroi) and small regional airports (e.g. Inverness).

This table is modelled on a simpler table set out in the 2002 Productivity Commission Report (Productivity Commission 2002, p 133—see Sect. 2.7.2). The catchment area is an important determinant of competition, as are the type of traffic served (business or leisure) and the presence of alternative modes for access. The presence of countervailing power by airlines affects the case for regulation, and the willingness of the airport to subsidize airlines to provide services is an indicator of the relative market power of the airlines and airport. Whether an airport faces competition from alternative hubs is relevant, as is whether it is capacity constrained (constrained airports may have market power).

Table 2.1 enables one to check the different factors which affect the case for regulation. Some typical examples are given. Thus, London Heathrow faces competition in its catchment area, and hub competition, but it is capacity constrained. Düsseldorf is not a hub, but it too is constrained. It is unlikely to be subsidizing airlines though it may price discriminate. Hahn Airport faces less competition from other modes, and it may face countervailing power from the few airlines which fly to it. Finally, Inverness Airport is relatively remote in the UK and faces relatively little competition.

2.6 Some Evidence of the Use of Market Power

2.6.1 Airport Charging Behaviour

There is no “one-size-fits-all” recipe that will allow understanding airport charges in airports dominated by a single airline of few carriers. To begin with, there are two

Table 2.1 Factors determining market power and countervailing power at airports

Factor	Catchment area	Type of traffic	Competition from other modes	Countervailing power	Subsidies	Hub competition	Capacity constraints
Major Hub Heathrow	High	Business	Strong	Low	No	Yes	Yes
Large City Düsseldorf	High	Business	Strong	Low	No	No	Yes
LCC Oriented Hahn	Moderate	Leisure	Moderate	High	Possible	No	No
Regional Cen-tre Inverness	Small	Business	Low	Moderate	Possible	NA	No

types of dominated or concentrated airports. Large concentrated airports are typically dominated by a hub operator, whereas high concentration at the small airports may be driven by economies of scale. Such airports need their captive customers as much as the customers need the airports. With London Heathrow being probably the only exception, most currently large airports in Europe will lose a significant share of their traffic if the hub operator leaves or is forced into bankruptcy. Such a setup will necessitate some sort of bargaining between the concentrated airports and corresponding airlines. How to evaluate the likely relative strength of the parties' bargaining positions, and possible outcomes of such bargaining? Current literature has addressed relationship between airport dominance and airfares (Borenstein 1989; Bilotkach 2007), as well as between the airport concentration and air traffic delays (Brueckner 2002; Mayer and Sinai 2003). The apparent consensus from the above studies is that airlines with the dominant positions at airports will charge higher airfares. This increases the potential surplus that can be shared between the airlines and the airport. Also, empirical evidence indicates that the dominant airlines internalize some of the self-imposed congestion externalities.

In the light of the above-stated, it is not obvious whether the airport or the airline will have a better bargaining position. This is especially true in case of an airline running a single-hub network. An air carrier with several hub airports in its network can utilize this network structure to its advantage, using a credible threat of routing some of the transfer traffic through another hub to negotiate lower aeronautical charges. It is not very difficult for an airline with multi-hub network to dismantle one of the smaller hubs—we have witnessed a number of such moves in the US airline industry over the last decades. For instance, when Delta Air Lines decided to stop using Dallas-Fort Worth airport as one of its hubs, it has decreased the number of destinations served out of that gateway from over 70 to just six over a year. Few airlines within the EU, however, currently operate a dual-hub system. In addition to the obvious consideration of the scale of operation required for the two- or multi-hub network to become a viable option, nationality clauses still present in bilateral agreements with some countries also get in the way.

Take the case of KLM Royal Dutch airlines. For this carrier, locating a potential second hub within the Netherlands will probably not make sense, as hub airports require substantial O&D traffic to be viable. And KLM will not be able to use that second hub airport to channel traffic to or from destinations located in countries that include a nationality clause in their air services agreement with the Netherlands. While there has been some progress towards removing this clause (e.g. US-EU Open Aviation Area agreement allows EU carriers to fly to the USA from other EU countries than their home state), it will take a number of years (if not decades) before nationality clauses become history. On the other hand, if KLM dismantles its hub at Amsterdam Airport Schiphol,[10] no other Dutch carrier will be able to replace it in the foreseeable future. In either case, it appears that the larger the carrier, the better its position in the airport-airline bargaining relationships. Size of the carrier's

[10]The KLM/Air France merger included dual-hub guarantees, which expired in 2011.

home country also matters, given the regulatory regime in international aviation. An important point to make here is that the latter consideration will remain important until a nationality clause is eradicated from bilateral air service agreements pretty much worldwide.

2.6.2 The Presence of Price Discrimination

Facing different customers and no restrictions on pricing, an airport could potentially price discriminate. Moreover, as it should not be too difficult for the airport to obtain information about the airlines' business and ultimately their demand for the airport's services, we are most likely to see third-degree price discrimination.[11] Recall that price discrimination involves different price-cost margins (not just prices) for selling the same product to different customers. The following factors are likely to affect the nature and extent of price discrimination by the airports. First, the extent of the airline substitutability between the nearby airports will affect elasticity of the airlines' demand with respect to aeronautical charges. Second, location of an airport in question will matter. Third, and perhaps most importantly, the airport's ability to price discriminate will depend on the traffic mix, both within and across the airlines. These factors will be compounded with other characteristics, such as capacity constraints and demand variability.

To visualize how the factors we listed above can affect the feasibility and extent of price discrimination by an unregulated airport, consider the following example. Suppose an airport decides whether to price passenger Boeing 737 take-offs or landings differently for different airlines. The question is: "When will a rational airport price discriminate?", holding all other things equal. The traffic mix will clearly play a role. An airline using our hypothetical Boeing-737 to haul vacation travellers to a holiday destination will clearly be more sensitive to higher charges than a carrier using an identical aircraft to shuttle business travellers, especially if we analyse an airport well connected to a major metropolitan area, and therefore considered convenient by business travellers. In the same way, similar price discrimination is less feasible for a more remote airport. Overall, substitutability between nearby airports will, other things equal, limit the extent of price discrimination. We expect traffic mix and airport location to be the primary determinants of feasibility of discriminatory treatment of airlines. Capacity constraints will probably limit price discrimination, as the constrained airports will focus on the most profitable market segment, subject to this constraint. Thus, a capacity constrained airport in our example will not offer discounted charges aimed at the customers specializing in leisure passengers and will instead price them out to either more remote airports or

[11] Some volume-based discounts that airports may offer to some of their customers purchasing a lot of services may be due to a decrease of average variable costs of the airport via economies of scale, so volume-based discounts that might be offered to such an airline may simply reflect this.

off-peak departure/arrival times. This is very well in line with a discriminating monopolist pricing out relatively few customers with low valuation, as accommodating them will limit the profit it can get from the less price sensitive market segments. Capacity constraints might contribute to the fact that such airports as Amsterdam, Madrid and Munich set lower charges for transfer passengers as compared to the O&D traffic, whereas London Heathrow does not offer such a differentiation in charges. Offering the air-lines discounts on transfer passenger charges could exacerbate the congestion problem at Heathrow and make the airport less attractive for air travellers, and ultimately for airlines. At the same time, we can expect congested airports to price discriminate in time dimension, setting higher charges at the expected peak travel times. This is somewhat contrary to the current practice of higher night-time charges observed at some major airports. The regulators will most probably have to keep imposing these noise-based night-time charges on the otherwise unrestricted airports. A rational airport will have an incentive to lower its night-time charges, to attract and raise revenue from less departure-time conscious leisure, charter and cargo traffic. Here we have a classical negative externality problem requiring regulator's intervention.

In conclusion, looking at the hypothetical unregulated airports, we can expect the highest degree of price discrimination across different services by relatively uncongested airports, conveniently located for business travellers.[12] Congested airports will most probably practice departure or arrival-time based price discrimination. Higher substitutability between the current and the nearby airports will reduce the extent of such discrimination.

2.7 Studies of Competition and Market Power: A Brief Review

There have been a number of studies[13] of airport competition and its implications for regulation, completed in recent years. There has been considerable attention given to airport competition in the UK, and regulators have factored it in to the design of regulation (see Sect. 2.7.1). In Europe there have been studies in countries such as Germany (Malina 2010; Strobach 2010) and Greece (Papatheodorou 2010), and Maertens (2012) has studied airport market power for the whole of Europe. The Australian Productivity Commission examined airport competition in detail when recommending regulation in Australia (see Sect. 2.7.2). Other general studies include the Copenhagen Economics Study (see Sect. 2.7.3).

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[12] Note that this discrimination might be taking place both within and across the airlines. Some airline's services to London and Heraklion might be subject to different charges, keeping other things constant.

[13] One of the first studies for Europe is the study by Air Transport Group (2002).

2.7.1 Airport Competition in the UK Market

One of the earliest writers to discuss the possibility of airports being in competition with one another was Starkie (Starkie and Thompson 1985;[14] Starkie 2002, 2009). If the market for airline services is dense, which it is in the UK, airports tend to be located close to one another. Many though not all of the UK's airports are privately owned and not subsidized. This means that, in geographical terms, their catchment areas will overlap. In turn, passengers will tend to regard airports as substitutes for one another. Starkie quotes evidence from the UK CAA on how catchment areas overlap from the UK CAA and from the UK Competition Commission on passenger preferences. He observes that there is a wide dispersion of airports in the UK in terms of size, and that small to medium sized airports are mostly profitable. He also argues that there is not much evidence that airports are natural monopolies, and questions the need for regulation.

Some of the UK's airports are regional airports, a number cater mainly for LCCs, and some are major hubs, such as London Heathrow and Manchester. Currently, only Heathrow is subjected to detailed price regulation, and London Gatwick is subjected to a form of light-handed regulation (which differs substantially from Australian monitoring). Over time, the number of airports subjected to regulation has been falling; in the past, London Stansted, Manchester and some Scottish airports were regulated. Airports such as Manchester and Stansted have been able to make the case that they are exposed to sufficient competition as to render regulation unnecessary.

The studies of the UK CAA on de-designation of Manchester and Stansted and from the UK Competition Commission (CC) (now the Competition and Markets Authority, CMA) on the break-up of BAA have raised some controversial issues. Both have in common that they define the relevant market by the same method. They both follow the Competition Commission guidelines and define the market for airport services as derived demand for air transport with a product market and a geographic dimension. They also agree on the criteria to assess the market power, namely catchment overlaps, route overlaps, switching costs, airport cost structures and incentives and capacity availability. In spite of this, they differ on the instrument used to assess the market power and on the degree of market power of Stansted airport.

The CAA assesses the monopoly of Manchester and Stansted with the SNIP test.[15] The CAA (2007) estimates that a five per cent increase in charges at

[14] Starkie and Thompson criticized the plan of the Thatcher government to privatize the four London airports and the three Scottish airports in 1985 because this would prevent competition. Starkie and Thompson recommended breaking up BAA and regulate the airports separately as at least for a certain period of time to restrict their market power.

[15] SSNIP is the abbreviation for "Small but Significant Non-transitory Increase in Prices". The SSNIP test is a tool which is used for market definition. It addresses the question if several imperfect substitutes belong to the same product market or not.

Manchester Airport would lead to a reduction of more than 4% of traffic and a five per cent increase in charges at Stansted Airport would lead to a reduction of more than 3.73% of traffic. These changes would not be profitable as the airport also loses commercial revenues. Hence both airports are constrained by competition from other airports. The CC criticizes the CAA approach and argues that the competitive level of charges is difficult to calculate and price caps have distorted the market so that an SSNIP test is not necessary and or too difficult to pursue (CC 2009, p. 36). The CC finds that besides Gatwick and Heathrow also Stansted faces "very limited competition from non BAA airports" (ibid., p10) and hence the monopoly should be broken up by the divesture of Gatwick and Stansted. The CC recommended, for the Scottish BAA airports, the divesture of either Edinburgh or Glasgow.

BAA sold Gatwick in 2009, Edinburgh in 2012 and Stansted in 2013. In 2016 Competition and Markets Authority (2016) assessed whether the divesture has intensified competition as hoped. The rationale for breaking up was the view that in the short run competition among the London airports would result in better price structure and capacity utilization as well as quality competition. In this regard Competition and Markets Authority (2016) found evidence that Gatwick and Stansted have improved their price structures and attracted more traffic. Quality has improved at all airports, in particular also at Heathrow which was criticized for its poor quality—a factor which leads to the break-up initiative. The Competition and Markets Authority also used a consultant to quantify the gains. This was difficult as many changes happened in parallel, in particular the reform of regulation.[16] The Competition and Markets Authority claims that at the divesture of Gatwick, Edinburgh and Stansted led 9–12% increase in passengers and to an annual increase of consumer benefits of £62 million which outweighs the costs of £95 million born by BAA and the CC.

The issue of price competition and quantity competition was controversial as Heathrow and Gatwick were capacity constrained and price competition would imply that it was in the hands of the airports to decide how and when to provide capacity so that airlines can switch from one airport to another. Although this obviously was not in the hand of the airport, but in the hand of policy, the CC had criticized BAA for its reluctance to press policy for new capacity. In the decision of third runway both Heathrow and Gatwick tried to persuade the Airport Commission to build to extend their airport and the Competition and Markets Authority interprets this as a gain from divesture.[17]

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[16] Competition and Markets Authority (2016, p. 3) stresses the combined effects of regulatory and ownership change: "Benefits arising from the separate ownership of airports and those resulting from the new regulatory framework, which took effect alongside divestments, have interacted and reinforced each other".

[17] Competition and Markets Authority (2016, p. 5) puts it this way: "The CC considered that BAA's common ownership of the three major airports in the London area appeared to have exacerbated delays in the delivery of runway capacity and noted BAA's reluctance to press for more runway capacity. Under separate ownership competition for the allocation of new runway capacity has

The evaluation of the Competition and Markets Authority has its limits as it relies on qualitative judgement and the econometrically analysis has problems identifying casual effects, as they themselves acknowledge. Surprisingly there are hardly any rigorous academic assessments.[18] In some respect Graham and Pagliari are an exception. They analysed the Scottish case. Graham and Pagliari (2018) found some evidence[19] for Edinburgh and Glasgow Airports that passenger numbers and routes have increased, charges have risen but also discounting, cost efficiency and service quality. Prestwick has become less competitive (Graham and Pagliari 2020).

2.7.2 The Productivity Commission Inquiries

If the UK represents one extreme in respect of population density, Australia is at the other extreme—Australia has a relatively low population spread out over a large area, and airports away from the coastal fringe are distant from one another. When it first privatized its major airports, Australia chose to regulate them using price caps, in much the same way as the UK had done. In 2001–2002 the Government's main microeconomic adviser, the Productivity Commission, was asked to review airport regulation. After a detailed review the Commission recommended that only seven airports be regulated, but in a light-handed way (Littlechild 2012; Arblaster 2014). Since then there have been three reviews (Productivity Commission 2006; Productivity Commission 2011, 2019), and only Sydney, Melbourne, Brisbane and Perth are still subjected to light-handed regulation.

The Commission saw a choice between the costs of regulation (weaker incentives for efficiency, etc.) and the costs of the use of market power. It noted that the elasticity of demand for airports is often low, and that even if prices are high the efficiency cost of the airports using some market power is not necessarily large. The Commission evaluated twelve airports in terms of their market power (Productivity Commission 2002, p. 133). It considered that there was not much substitutability between most airports—in other words, their catchment areas did not overlap. However, it also looked at modal substitution and destination substitution. Thus, it considered that there was moderate to high possibility of modal substitution in all but one airport, and the fact that many of the airports served holiday destinations meant that destination substitution was high in many cases. (The criteria for catchment areas are very different from that used in Europe—it considers that Alice Springs

increased considerably. Information on expansion options provided to ministers has been comprehensive with detailed bids from Heathrow and Gatwick."

[18] Botasso et al. (2017) have found for the UK that competition within the airport's catchment area, the countervailing power of airlines and the degree of competition in the downstream airlines market determine airport charges. As the break-up increases competition among airports the study supports the decision of the CC, but as the study covers the period from to 1996–2008 only indirectly.

[19] Graham and Pagliari acknowledge that they have not econometrically tested their findings.

high potential for substitution from Yulara, some 5 h 30 min drive away). In summary, the Commission considered that only four airports (Sydney, Melbourne, Brisbane and Perth) had high market power, and all the rest had low or moderate market power. It recommended that these airports, along with Adelaide Canberra and Darwin be subjected to light-handed regulation—more recently it has recommended that only the four "high" market power airports be regulated (the government accepted this recommendation). Apart from the expansive view of what constitutes a catchment area in Australia, the Commission's recognition of modal and destination competition is of interest.

The recommendation by the Commission to exclude Adelaide airport from light-handed regulation in 2011 (Productivity Commission 2011) is also of interest. Adelaide Airport is over 8 hour's drive from the nearest major airport, Melbourne airport. At the time of the ending of light-handed regulation it was the second most expensive of the five largest airports (Sydney was the most expensive). The Commission accepted that the arguments of the airport that it was facing countervailing power of the airlines had entered into contracts with them and that it had contracted away the market power which it might have had. With strong influence of the State government, the airport may have been acting not as a profit maximizing airport might it, it might avoid direct regulation.

2.7.3 Assessing Market Power at Amsterdam Airport

The market power of Schiphol airport has been assessed in two studies. The first study by Frontier Economics (2000) of the market power of Schiphol discusses methodological issues and provides a good review of the literature on the concepts of market power and how to measure them. It gave the antitrust authorities [NMa] a good conceptual overview of how to work on assessing the market power of Amsterdam airport. The NMA concluded that Schiphol airport has persistent market power which needed to be regulated.

A follow-up study assessing the market power at Amsterdam Airport Schiphol (Mueller et al. 2010) for the Netherlands Competition Authority provides for a detailed assessment of the factors for market power.[20] The relevant markets are broadly divided into two categories, which are the markets for the provision of infrastructure to airlines, and the markets for the access to the airport infrastructure for the provision of ground handling services by third parties. Both categories are further subdivided into several sub-markets. The study defines four markets for the provision of infrastructure to the airlines at the airport. First, it discusses the proposed separation of the market for the provision of infrastructure to the airlines serving passengers from the market for the provision of infrastructure to the airlines offering cargo transportation. The price structure of the airport differs for both types

[20] It refers to aviation related activities; non-aviation operations of the airport were beyond its scope.

of flights, the take-off and landing charges for cargo flights are roughly half of the fee for a corresponding passenger flight.

Downstream passenger and cargo markets function differently, which translates into the ability of the airport to price-discriminate upstream due to a lack of substitutability.[21] Cargo is less time-sensitive than passenger transportation, the ability to offer direct connections is of less importance in cargo, and the cargo business is more flexible as compared to passenger transportation due to shorter contractual bindings vis-a-vis airports. Moreover, passenger and cargo airlines operate different business models, which indicates that the airlines do not have the ability to easily switch between the provision of these services. The study found that Schiphol has market power on the market for the provision of infrastructure to airlines offering cargo transportation.

The Amsterdam airport study provides evidence to further subdivide the market for the provision of infrastructure to airlines serving passengers into sub-markets for the provision of infrastructure to airlines serving O&D passengers, and the provision of infrastructure to airlines serving transfer passengers. The price structure the airport charges depends on the fraction of O&D and transfer passengers an aircraft carries. The ability of the airlines to react to a change of the airport's relative price structure is rather limited. The introduction of the "Air Passenger Tax" in 2008, which was abandoned again a year later, helps as a natural experiment in this context. The tax was imposed on O&D passengers, leaving transfer passengers exempt. Data indicate that the introduction of the tax led to a decline in O&D traffic at Amsterdam Airport Schiphol, while no substantial change in transfer passenger numbers was detected. Substantial substitution between these two types of services does not exist, which gives evidence that O&D and transfer passengers represent separate markets from an airport's point of view.[22] The analysis found that Schiphol has market power on the market for the provision of infrastructure to airlines serving O&D passengers, but also for the provision of infrastructure to airlines serving transfer passengers.

With respect to aircraft parking, the study concludes that aircraft parking is a secondary product, demand for which fully depends on take-off and landing activities. Hence, aircraft parking is not a separate market at Amsterdam Airport Schiphol and belongs to the respective markets for the provision of infrastructure to the airlines.[23] Amsterdam Airport Schiphol provides access to the airport for third parties which offer ground handling services to the airlines.

Unlike many other airports, Schiphol does not itself offer ground handling services. The airport implements an open access system free of charge. The study

[21] Rather, cargo is to some extent a complement to passenger transportation. Passenger aircraft carry cargo in their bellies to optimize the load factor.

[22] The study also indicates that there is a separate market for the provision of infrastructure for local & instruction flights, and that a further subdivision according to the type of aircraft, flight times, or the type of handling is not necessary for the purposes of the study.

[23] The conclusion might be different if airlines target an airport mainly for the reason of aircraft parking, which is not the case at Amsterdam Airport Schiphol.

separates five sub-markets with respect to the provision of access to the airport infrastructure, grouped around the usual bundles offered by ground handlers to the airlines. The study finds that Schiphol has monopoly on the market for the access of infrastructure to ground handlers and others,[24] also with respect to rental of operationally required spaces to airlines, ground handlers and government.

Geographic markets are broadly defined, with the provision of infrastructure to airlines offering cargo transportation being EU-wide, and smaller geographic markets for the provision of infrastructure to airlines offering transfer and O&D passenger flights. This definition is in line with the analysis of the catchment areas of the airport. With respect to the markets for the provision of infrastructure to third parties offering ground services at the airport, the geographic markets cover the airport's area including nearby locations. For instance, ground handling companies regard storage capacities at locations close to the airport as imperfect substitutes to the facilities located on the airport. Despite increased competition the study still found market power for airport operator of Schiphol on the defined relevant markets for aviation and aviation-related services.

2.7.4 The Two ACI Studies by Copenhagen Economics Studies and OXERA

ACI has conducted two studies on airport competition—the first one by Copenhagen Economics (CE 2012) and the second by OXERA (2017). Both studies were built largely on the work of David Starkie (2002, 2009) who peer-reviewed the first study.

The studies argue that liberalization of airlines in the early 1990s transformed the airport sector from an industry where airlines were regulated and airports "used to be considered as something akin to natural monopolies" (p. 3) to a world in which footloose airlines compete for price sensitive and better informed passengers with the choice between or more airports in fierce competition so that "airports now have to compete with one another to retain and attract traffic they need" (ibid). Airports should be just subject to competition law and regulation should be the exception and "justified case by case" (ibid.)

CE (2012) analysed the period 2002–2012 and found that passengers undertake more discretionary trips are more price elastic and time inelastic. The internet has reduced switching costs and more tourist destinations have emerged. Airlines have become footloose, because airlines business models have changed. LCCs have gained market shares leading to more point to point traffic. An increasing degree of opening of routes and closures of routes/route churn) and competition for base and hubs puts pressure on airports. Airports have reacted competitively with new entry and existing airports have increased capacity. OXERA (2017) follows this narrative

[24] It also indicates that alternative sub-divisions may appear reasonable. This question is left open in the study because it was not considered as crucial for the purpose of the investigation.

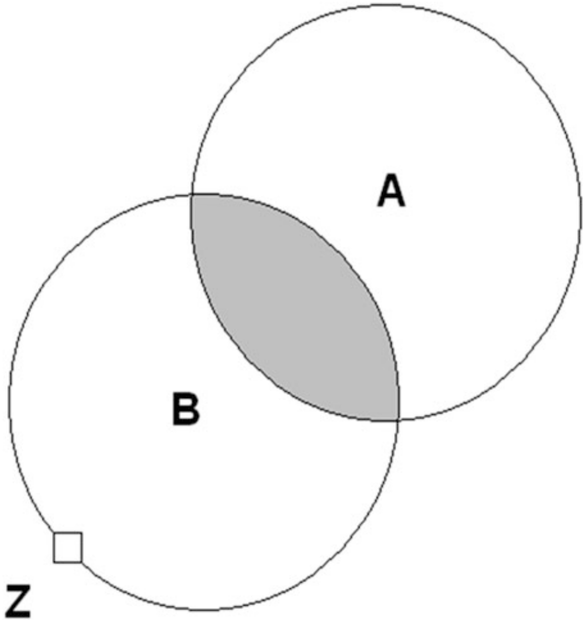

Fig. 2.1 Competition and catchment areas

and provides an update for the period of up to 2016. OXERA argues that competitive pressure has changed from smaller airports to larger airports in the size of 10–25 million passengers as these airports face more route churn. Self-connecting passengers have emerged and competition from Middle East and Turkish airports has intensified so that also large airports are increasingly under competitive pressures.

The theoretical backbone of the ACI is that airports are seen as a business with large fixed costs and slowly rising operating costs. The complementary nature of commercial revenues sets incentives for airports to attract new traffic. "While their geographical position may confer some advantage relative to consumers who live nearest the airport, most airports cannot achieve the desired scale of passengers by attracting only those very close to the airport" argued CE. From this empirical assumption they argue that airports have to compete for passengers which can choose among airports. Catchment areas overlap.

It is important to note that the ACI studies argue that the two airports are not only competing about the passenger in the overlapping catchment area (Shaded area in Fig. 2.1), but that in competing for these passengers the competitive pressure on airport charges extends to the whole catchment. "Since airports are unable to price discriminate within the overlap area, the competition in the overlap . . . is potent for the whole of the 100% as pointed out by Starkie (2002), argued CE (2012, p. 57). The ACI study then takes a 2 h driving time to delineate the catchment areas and argues that because "63% of European citizens are within 2 h driving of at least two airports" there is "significant scope for airports to compete for passengers" (page 8).

This approach was criticized by Wiltshire (2018). He argues isochrone map isochrones are merely circles drawn on a map showing surface access travel times

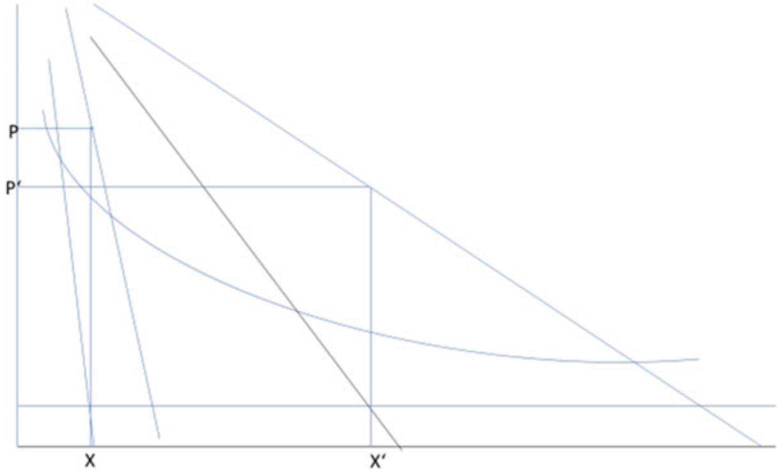

Fig. 2.2 Airport in 2000 and 2016

around a given airport. If the drive time is assumed to be sufficient long enough, it appears that there is plenty of competition. In reality the isochrones provide a false picture of actual consumer behaviour as shown by Frontier Economics (2007) for the case of the de-designation of Stansted airport. Using actual data from easyJet Frontier Economics showed that catchment areas are much tighter than isochrones because passengers have a very strong preference to use their local airport.

What the Starkie/ACI model of overlapping catchment areas does not provide an answer is the question if two or more airports which have separated catchment areas and hence hold a monopoly why should each airport try to extend their catchment and then lose their market power. The size and contour of the catchment area are not given and airports often have a strategy to expand and shape their catchment. Is it profit maximizing to extend catchment areas so that they overlap? This seems implausible.

ACI interprets these changes as evidence that airports have lost their natural monopoly and have become a competitive industry which should not be regulated, but only be subject to competition law. However, this argument is not persuasive. To illustrate this let us assume that the airport has the characteristic of a natural monopoly, namely that it has a subadditive production function with long run decreasing average costs of up to 40 million. Suppose we compare the same airport in 2000 with ten million passengers served mainly by the former flag carrier, its full service competitors and some charter airlines with an airport in 2016 with 25 million passengers serving now footloose LCC and FSC (see Fig. 2.2).

Such an airport experiences changes two kinds of changes. The first stems from rising income which in turn shifts the demand curve D to the right. The second are the factors ACI indicates as drivers for competition. For each of the factors we discuss how it qualitatively affects the functions.

- Intensified competition for airline services new and existing routes. These are factors which make the demand for airport services more price elastic. The airport might have experienced that an airline opens a base, closes its and the airport managers achieves to persuade another airline to station aircraft. Similarly, the airport marketing department has won finally at a routes conference after many attempts an airline to serve a new destination. In all these cases the number of substitutes increases and the demand becomes less steep.
- Intensified competition from connecting passengers. In 2000 the airport had a number of FSA to connect the airport via there hubs. It had a few long-haul connecting flights with relative few transfer passengers. Now it has lost some of these routes to the Gulf carriers, but it has still kept a relatively small share of transfer passengers. As the number of substitutes for connecting passengers has increased and some alternatives become more attractive the job of the airline marketing department becomes harder. It affects the demand curve so that it becomes less steep.
- Intensified competition for passengers in the local area. Passengers are willing to travel longer to get a cheap flight, better train services have shortened travel times and made other airports with their services more attractive. The airport has reacted and won passengers from other airports to fly from its airports. Again the number of substitutes has increased and the demand curve becomes less steeper.

The ACI factors all have in common that airport managers feel being under increasing pressure and feel like competing stronger, but is this incompatible with a natural monopoly? Not really, because also a monopolist is not completely unrestricted and is constrained demand. It also does marketing and fights with the airlines over prices and services in order to balance the marginal revenues and marginal costs.

Comparing the two equilibria it becomes obvious that the airport has still a natural monopoly. The profit maximizing airport charges have decreased from p to p′ because the demand curve has become less steep, output has increased from x to x ′, but the welfare loss has increased. The latter point is important as it runs against the argument, that airports should not be regulated because the welfare loss is small.

Admittingly, this is not the only way to interpret the results of ACI. The results of ACI could also lead to a change in the market structure from a monopoly to a duopoly or other forms of oligopoly, but the ACI studies are not even trying to analyse this. This points to another weakness of the ACI studies. It is the supply side. The ACI studies depict the airport industry as a competitive industry, but for such an industry entry should occur in those markets with excess demand or high profits so that the monopoly becomes eroded.

On the supply side ACI/Copenhagen Economics (2012) argues that airports have "responded strategically to the challenging market conditions". Incumbents have extended capacity and newcomers have entered the market. ACI lists then 14 airports which have built a new runway or terminal among them Barcelona, Madrid, Copenhagen, Frankfurt, Heathrow, Dublin, Malaga which according to Maertens (2010) have substantial market power. ACI/OXERA (2017) continues in this vein and argues "substantial increases in capacity at the largest airports in Europe" and refers to Barcelona, Madrid, Frankfurt, Vienna and Dublin. These airports have also high market power. On market entry ACI/Copenhagen Economics (2012) claims that "new airports have also entered the market. There were 81 more airports in Europe with commercial jet services in 2008 than in 1996". (p. 6). However, this widely overstates the effects of market entry, because airports at which airlines substitute jets for turbo prop are counted as market entry. OXERA does not repeat this mistake, but overall the trend of market entry has been that airports did not enter markets with excess demand, but with excess supply (Muller-Rostin et al. 2010). Thus, the evidence brought forward by ACI points in the direction that some incumbent airports have expanded capacity and thereby also increased their market share in the local market and newcomers found it difficult to enter markets with excess demand.[25] The supply side reacted consistently with a natural monopoly as new entrants found it difficult to enter markets where the incumbent had a cost advantage and relation-specific investment is needed.

In summary, the ACI factors show that the liberalization of the downstream market has increased pressure of the upstream monopoly. This is a familiar story from other public utilities. For airports, this could mean that the airports have lost their monopoly or that the demand has just become more elastic, so that the rationale for regulation becomes stronger.

2.8 Conclusions

While in years gone by, airports were seen as natural or locational monopolies, it has become evident that in many cases, airports are selling their products into competitive markets. In this situation, there is no strong reason why these airports need to be regulated to limit their use of market power. Typically, only medium to large airports are regulated, and small airports tend not to be regulated. Some medium to large airports have substantial monopoly power, while others are clearly competitive. In between these, there is a grey area of airports which may warrant regulation, but may not.

These are the airports which pose questions for competition authorities. Ideally, competition authorities should assess the degree of competition an airport is faced with. The ways of assessing competition are discussed in this chapter. In addition, the possible role of countervailing power has been canvassed, though the results of this assessment have not been as clear as the measures of competition (there are few classic airport-airline bilateral monopolies except where airports are very small). There has been mounting research into these determinants of competition. A number

[25] There are a few exceptions in which new entrants gained a small share of the local market. These are the examples of Weetze near Düsseldorf, Memmingen near Muni and Doncaster near Manchester. Weetze and Memminger are former military airfields.

of competition authorities have undertaken empirical studies and used the results in guiding their decisions as to whether to regulate or not, and how to regulate. In spite of this, there is still wide room for judgement.

This scientific approach of assessing competition for an airport has been used in several countries, including the United Kingdom, the Netherlands and Australia. However, it must be noted that in many cases, governments have simply decided to regulate, without any scientific assessment. These governments are used to regulation, so they do it, from habit rather than from conviction. These cases will lead to unnecessary regulation, and also probably, poor regulation.

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Chapter 3
European Hub Airport Competition: An Assessment of Market Concentration in the Local Catchment and in the Transfer Market

Annika Paul, Hans-Martin Niemeier, and Peter Forsyth

Abstract The airport market is considered to exhibit significant market power and has therefore been subject to different types of economic regulation. Multiple studies have been investigating the degree of market power in order to implement regulation accordingly. Different approaches are pursued in regard to market power assessment, including the switching potential of passengers and airlines, or the implications of airports as two-sided markets, enabling a comprehensive insight whether an airport has a dominant position on a particular market segment.

The analysis in this chapter contributes to the discussion of hub airport competition by assessing the destination overlap both in the origin and destination and in the transfer market. For this purpose, the market concentration of European hub airports is analysed using the Herfindahl Hirschman Index, for each destination offered at the selected hub airports and the respective development over time. This analysis shows that the majority of European hub airports has a dominant position in both the origin-destination and transfer market. However, it can be observed that the level of market concentration has been decreasing over time, thus implying a higher overlap between destinations offered at hub airports and their competitive counterparts, and potentially more choice for passengers.

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Keywords Market power · Relevant market · Concentration · HHI · Hub and spoke

3.1 Introduction

With both the liberalisation of the European aviation market and strong growth in the overall demand for air travel in the past decades new airline business models emerged, stimulating traffic growth and imposing competition on the existing carriers in the market (Morrison 2001; Dobruszkes et al. 2017). Some of these new carriers, such as Ryanair, have been focusing their operations mainly on secondary airports, which have hence been experiencing an increase in passenger volume and aircraft movements. Providing a greater array of possibilities for European passengers in terms of airports and destinations they can choose from, this development has been raising the question whether European hub airports are nowadays subject to a more competitive environment than a couple of decades ago.

Different studies have been looking into this question, fuelling the discussion on the extent of competition between (hub) airports and the resulting implications for economic regulation. There is no simple and straightforward answer, considering the complexity of the airport sector and the different players involved. The assessment of airport market power focuses on different factors, including airline switching (Thelle et al. 2012; Maertens 2012; Polk and Bilotkach 2013; Müller et al. 2010) or the availability of passenger choice in terms of airports within a particular catchment (Starkie 2010; Redondi et al. 2011; Wiltshire 2013; Burghouwt and Redondi 2013; Malina 2010; Mandel 1998). More recent studies such as Thelle et al. (2012), Oxera Consulting (2017) or Bilotkach and Bush (2020) point out that airports in Europe are facing increasing competitive pressure due to competition for airline services as well as passengers in the local catchment and in the transfer market.

The research presented in this chapter focuses on a particular aspect of airport competition, i.e. the overlap between destinations in the origin-destination and transfer market at European hub airports. Considering passenger switching as one factor that can potentially limit airport market power, the passengers' preferred destinations need to be available at the different airports of choice. The analysis focuses on the degree of overlap European hub airports face in terms of destinations offered in the origin-destination and transfer market.

Section 3.2 describes the European hub airports under consideration, and Sect. 3.3 outlines and discusses various aspects and elements that are applied in order to assess whether airports exhibit market power. In order to determine the degree of overlap in destinations offered between airports in the two markets, the Herfindahl Hirschman Index is applied using scheduled traffic data at the considered 36 European (hub) airports. Section 3.4 provides the evaluation of the origin-destination market and Sect. 3.5 focuses on the transfer market. Section 3.6 concludes the analysis.

3.2 European Hub Airport Market Development

A hub is an airport at which an airline and its potential alliance partners offer connecting flights between different destinations. Hub airports also offer origin-destination services in their local catchments. The airports outlined in Table 3.1 are considered throughout this chapter. For the purpose of obtaining a detailed overview of the development of the European hub airport market and potential competitive constraints, a set of 36 hub airports and their respective secondary airports in the catchment are defined.

The identification of European hub airports is based on several sources and assumptions. First, since a hub airport is the node of an airline operating a hub-and-spoke network, all these European airlines are identified and the respective airports included in the database. Further, the Connectivity Report by the Airports Council International Europe (2016a), which defines different categories of hub airports according to their level of connectivity in 2016, is analysed and respective airports included. In addition to this, a range of different studies investigating airport competition and the connectivity of hub airports have been evaluated to complement the above sample of European hub airports. These include Burghouwt (2007), with an outline of European network carriers which are all included in the analysis here, and also Burghouwt et al. (2015), Lieshout and Burghouwt (2013), Veldhuis (1997), Malighetti et al. (2008), Grosche and Klophaus (2015), Grosche et al. (2015), Dennis (1994, 1999). Airports which are considered as hubs and investigated within these studies include Basel/Mulhouse (BSL), Clermont-Ferrand (CFE), Nice (NCE), Luxembourg (LUX), Cologne-Bonn (CGN), Malaga (AGP). These are, however, not considered here due to their size and current non-hub focus. Having analysed this market and identified feasible hub airports, a dataset of 36 airports results, which includes both the largest airports in Europe in terms of passenger volume in 2016 (Airports Council International Europe 2016b) and those airports which classify as hub airports.

Table 3.1 depicts the chosen airport sample in descending order of 2016s passenger volume. The motivation for including large and small hub airports in the dataset is to analyse potential differences in the level of market concentration these various airport types are facing.

3.3 Review of Hub Airport Competition

There are different approaches regarding the assessment of market power in the airport industry. Competition within this sector may be imposed by airline and passenger choice between multiple airports either in the local catchment or in the transfer market, studies show that this choice has been increasing over time (Morrell 2010; Tretheway and Kincaid 2010; Thelle et al. 2012). Table 3.2 highlights the

Table 3.1 Passenger volume at European hub airports

Rank	Airport	2000	2004	2008	2012	2016
1	London Heathrow Airport (LHR)	64.28	67.11	67.06	70.04	75.71
2	Paris Charles de Gaulle (CDG)	48.25	50.95	60.87	61.61	65.94
3	Amsterdam Schiphol Airport(AMS)	39.27	42.43	47.43	51.04	63.62
4	Frankfurt Airport (FRA)	48.96	50.70	53.47	57.52	60.79
5	Istanbul Atatürk Airport (IST)	14.7	15.6	28.63	45.12	60.01
6	Madrid Barajas International Airport (MAD)	32.71	38.16	50.82	45.18	50.40
7	Barcelona Airport—El Prat (BCN)	19.44	24.35	30.20	35.13	44.13
8	London Gatwick Airport (LGW)	31.95	31.39	34.21	34.24	43.14
9	Munich Airport (MUC)	22.87	26.60	34.53	38.36	42.26
10	Rome Fiumicino (FCO)	n/a	27.16	35.13	36.98	41.74
11	Moscow Sheremetyevo International Airport (SVO)	n/a	n/a	15.21	26.19	34.03
12	Paris Orly Airport (ORY)	25.40	24.05	26.21	27.23	31.24
13	Istanbul Sabiha Gökcen (SAW)	n/a	0.25	4.36	14.84	29.65
14	Copenhagen Airport (CPH)	18.40	18.89	21.48	23.29	28.99
15	Moscow Domodedovo Airport (DME)	n/a	n/a	20.45	28.25	28.50
16	Dublin Airport (DUB)	13.66	17.03	23.47	19.10	27.92
17	Zurich Airport (ZRH)	22.68	17.72	22.04	24.75	27.62
18	Palma de Mallorca Airport (PMI)	19.26	20.63	22.83	22.67	26.25
19	Manchester Airport (MAN)	18.32	20.97	21.41	19.85	25.70
20	Oslo Airport (OSL)	n/a	13.18	19.34	22.08	25.57
21	Stockholm Arlanda Airport (ARN)	n/a	16.47	18.18	19.66	24.72
22	London Stansted Airport (STN)	11.86	20.91	22.36	17.46	24.29
23	Düsseldorf Airport (DUS)	15.91	15.09	18.15	20.83	23.52
24	Vienna International Airport (VIE)	5.92	14.71	19.75	22.17	23.35
25	Lisbon Airport (LIS)	9.21	10.39	13.60	15.30	22.45
26	Brussels Airport (BRU)	21.60	15.45	18.48	18.94	21.79
27	Berlin Tegel Airport (TXL)	10.24	10.98	14.49	18.16	21.25
28	Athens International Airport (ATH)	13.35	13.66	16.45	12.86	19.99
29	Milan Malpensa Airport (MXP)	n/a	18.42	19.22	18.52	19.41
30	Antalya Airport (AYT)	n/a	n/a	18.85	25.27	18.91
31	Helsinki (HEL)	10.00	10.73	13.43	16.42	17.18
32	Vaclav Havel Airport Prague (PRG)	n/a	9.57	12.59	10.77	13.07
33	Warsaw (WAW)	n/a	n/a	9.46	9.59	12.80
34	Budapest (BUD)	n/a	6.38	8.43	8.43	11.44
35	Lyons Airport (LYS)	5.92	6.12	7.80	8.36	9.50
36	Keflavik (KEF)	1.46	1.89	2.24	2.74	6.82

Sources: Airports Council International Europe (2016a, b), Groupe ADP (2017), Ataturk Airport (2017), Istanbul Sabiha Gokcen International Airport (2017), Copenhagen Airports AS (n.d.), Zurich Airport (2000, 2004), Eurostat (2016), Helsinki Airport (2016), Keflavik Airport (2017), Budapest Airport (n.d.), Warsaw Chopin Airport (2016), VINCI Airports (2017), Vaclac Havel Airport Prague (2016)

Table 3.2 Different forms of competition between airports

Type of Type competition	Explanation	Approaches	Selected references
1. Competition for airline services	• Airlines switching operations between airports (countervailing power)	• Analysis of route churn rates, i.e. opening and closing of routes • Contractual agreements between airport and airline, leaving airlines with sunk investment and thus less incentive to switch	Oxera Consulting (2017), Thelle et al. (2012), Button (2010), Starkie (2002), Malina (2010)
2. Competition for passengers in the local catchment	• Passengers are switching between airports in the local catchment • Availability of substitute transport modes such as rail services	• Definition of the relevant market using SSNIP test • Analysis of number of airports offering the same route • Analysis of market concentration on the route level, applying the Herfindahl Hirschman Index • Analysis of the effect of (high-speed) rail services on the routes offered at an airport	Adler (2008), Adler and Nash (2004), Thelle et al. (2012), Starkie (2002), Maertens et al. (2016), Oum and Fu (2008), Albalate et al. (2015), Behrens and Pels (2009), Adler (2008), Müller et al. (2010), Polk and Bilotkach (2013), Bilotkach et al. (2013)
3. Competition for passengers on the transfer market	• Passengers are switching between hub airports, which offer the same transfer connections	• Analysis of overlap in transfer connections at hub airports • Assessment of overlap between transfer connections and direct connections • Calculation of market concentration on the transfer market using the Herfindahl Hirschman Index • Analysis of self-hubbing, i.e. transfer flights are not offered by the same airline or within an alliance	Oxera Consulting (2017), Malighetti et al. (2008), Maertens et al. (2016), Allroggen and Malina (2010), Lieshout and Burghouwt (2013), Fichert and Klophaus (2016), Redondi and Burghouwt (2010), Fageda et al. (2015), Burghouwt and Veldhuis (2006)
4. Airports as two-sided markets	• Complementarity between aviation and non-aviation business to limit monopolistic price-setting	• Theoretical modelling to test assumptions of two-sided platforms in the airport context	Gillen (2009), Fröhlich (2010), Gillen and Mantin (2013), Bracaglia et al. (2014)

Source: Paul (2018)

different forms of competition airports may engage in, the different approaches taken to measure these, and selected studies investigating these aspects.

One aspect which is being discussed in the context of constraining potential airport market power is airline countervailing power. This denotes the constraint airlines may impose by being able to switch their operations from one airport to another (Button 2010), with research showing that more airlines are able to do so (Starkie 2012; Thelle et al. 2012). This is especially true for low-cost carriers since their assets are more mobile than those of a network carrier (Starkie 2002; Button 2010; Thelle et al. 2012).

The substitution coefficient defined by Malina (2010) calculates the degree to which an airline is willing to switch its operations from a particular base airport to another substitute airport. The coefficient can take on values between zero and one, with the latter denoting the case where the substitute airport exhibits the same or a better quality level, and hence imposes competitive pressure on the base airport. The application to the German market shows that the large hub or international airports such as Frankfurt Airport (FRA), Munich Airport (MUC) or Hamburg Airport (HAM) have a coefficient of zero, and hence it is assumed that airlines have no feasible substitutes available to satisfy the demand for O&D traffic.

Competition in the local catchment of airports can be imposed by other airports in the surrounding, or by other transport modes, such as high-speed rail, but is usually constrained to short-haul traffic. The impact of (high-speed) rail services on air transport is investigated in several studies. Albalate et al. (2015), for example, analyse the effect of available rail services on routes offered at airports in four European countries. The findings show that air services on a route are reduced if high-speed rail services are available on this city pair. Behrens and Pels (2009) confirm this result for the market between London and Paris, stating that airlines are observed to retreat from this market by no longer offering this route. This substitution may also be taking place since rail services are acting as a complement for air services by providing feeder services to airports, thus replacing short-haul flights, and enlarging an airport's catchment area (Dobruszkes et al. 2011; Polk and Bilotkach 2013). Another reason for this development may also be the accessibility of rail stations within city centres as well as the perceived comfort during rail travel.

The transfer market is often investigated by determining the overlap in transfer connections offered at an airport. Since transfer connections are a specific feature of an airline operating a hub-and-spoke network, this type of potential competition is mainly imposed on hub airports. The degree to which transfer connections at hub airports are also offered via other hub airports is calculated using airports' market shares, indices to display the degree of market concentration on a particular route, or by assessing the level of demand on a connection, and thus making it possible to derive conclusions as to the level of competition (Lieshout and Burghouwt 2013; Grosche et al. 2015; Malighetti et al. 2008).

The notion of airports as a business with two distinct, but interrelated markets, the one for aviation services and that for non-aviation services, provides a further strand of discussion regarding the constraint of airport market power (Gillen and Mantin 2013). Since airports generate an increasing share of total revenues from non-aviation businesses such as retail or parking, ensuring the continuity of this source of income is of high importance. In 2015, the share of these business activities accounted for almost 40% of total revenues across European airports (Airports Council International Europe 2015). Therefore, it is argued that airports have an incentive to attract an increasing customer base using non-aviation facilities and services at the airport, and thus passengers are becoming direct customers of the airport. In regard to the different business areas at an airport, Starkie (2002) and Gillen (2009) raise the argument whether the complementarity between aviation and non-aviation revenues incentivises airports to set lower charges on the aeronautical side, since the additional demand attracted by this will generate ancillary revenues on the non-aviation side, e.g. airport parking, shops, restaurants or real estate. Research on this particular topic is still rather limited, though. This particular aspect will not be subject of the analysis in the following sections, however, and therefore not elaborated in more detail here.

Within the following analysis, the focus is placed on the potential competition within both the local catchment and in the transfer market by assessing the overlap in offered connections available to passengers.

3.4 Competition in the Local Catchment

This section focuses on hub airports and their secondary counterparts in the local catchment, and the impact of an increased offer of flights at the latter on the market position of European hub airports. For this purpose, the traffic development at all hub and secondary airports under consideration is measured for the period from 2000 to 2016. Following that, as proposed by Polk and Bilotkach (2013), one main line of airport market power assessment focuses on the degree of overlap of destinations between hub and secondary airports within a catchment. The Herfindahl Hirschman Index serves as a measure to determine the degree of overlap, or the level of market concentration, in a hub airport's catchment.

In starting with the assessment of airport market power in the local catchment, the relevant market is often defined using the SSNIP[1] test (Müller et al. 2010; Polk and Bilotkach 2013; Competition Commission 2009). Assessing the market power of UK airports, and whether common ownership should be prohibited, the Competition Commission (2009) states that there is "... no advantage in defining rigid geographic markets for airports" (p. 36). Relying on passenger surveys for these particular airports, the Commission defines district share thresholds in order to assess how willing or likely passengers are to switch between different airports. First, if the number of passengers from a certain districts exceeds a specific threshold, e.g. 30% of all passengers from that district, this district is considered to be in the catchment of the considered airport. Second, the same is done for all airports which are potential

[1] SSNIP = Small but Significant Non-transitory Increase in Prices.

competitors for the airport in question. If these draw their passengers from the same districts as the airport being investigated, an overlap is assumed which may impose constraints on market power. This approach relies on detailed passenger data and is therefore often difficult to reproduce. In its definition of the local catchment area of Amsterdam Schiphol Airport (AMS), Müller et al. (2010) focus on an area of 200 km as well as a 2-h drive time around the airport. Relying, inter alia, on the analysis of the substitution potential between AMS and other airports within its catchment, this study finds that AMS has a dominant position in its catchment, thus only facing limited competition on the market for O&D passengers.

A differentiated approach towards overlapping catchment areas is introduced by Wiltshire (2013) and Thelle et al. (2012), for example. The latter report finds, by means of a passenger choice model, that the share of European destinations which have an overlap at different airports within 2-h drive has increased in the period from 2002 to 2011. At Frankfurt Airport (FRA), for example, the share of destinations which are also offered at other airports has increased from 35% to 54%. For airports to exhibit equally ranked substitutes for passengers, the price, availability and frequency of flights have to be incorporated as well. The findings of Wiltshire (2013) suggest that a 1% increase in distance decreases passengers' likelihood to travel to a particular airport by 4%. However, a 1% decrease in ticket price would provide the necessary incentive to use the further away airport.

Table 3.3 provides an overview of different studies that discuss airport competition and relevant catchment areas. The current discussion shows that there is no exact threshold, which is being applied in terms of determining relevant catchment areas. It strongly depends on the type of passengers, for example. To conduct a comprehensive analysis for the 36 airports in this paper, their potential substitutes within a 1-h as well as 2-h driving radius are included (see Fig. 3.1). These assumptions are in line with similar studies on airport competition and are selected to ensure a degree of comparability.

Those airports within the local catchment of an airport have been selected that have scheduled passenger traffic according to the OAG database.[2] No explicit differentiation is made between passenger types and time of day. However, considering a one and a 2-h catchment might provide a proxy for different passenger groups' willingness to drive to the airport. Furthermore, especially for short-haul connections, passengers have the possibility to switch to other transport modes such as (high-speed) rail in order to get from A to B.

To analyse the overlap in routes, the Herfindahl Hirschman Index (HHI_{route}) for each individual route offered at an airport is calculated. The intention of this detailed approach is to determine the degree of overlap between routes that are offered at a

[2] Not within the scope of the analysis within this chapter, but an indication for future research, is the consideration of catchment areas at each arrival airport. This means that in the determination of overlap between routes not only flights from the catchment area of Frankfurt Airport (FRA) to particularly London Heathrow Airport (LHR), for example, are considered but also flights to all airports within the catchment of LHR.

Table 3.3 Overview definition airport catchment area

Study	Definition catchment area
Airports Council International Europe (2013)	Passenger point of view: considering the drive time (2 h) and the potential amount of airports to be reached within this time
Boonekamp and Zuidberg (2016)	Airport catchment area: assignment of population on NUTS-2 level within 100 km radius around selected airports
Competition Commission (2009)	Hypothetical monopoly test (SSNIP) employed to determine airport-specific catchment area
Civil Aviation Authority (2010)	Airport catchment area: (1) isochrones approach considering different driving times (congestion-free) and transport modes; depending on passenger willing to travel (e.g. depending on route and passenger type); rather used as "benchmarks"; overlapping between catchments, and (2) historical usage patterns (using passenger survey data or airline booking patterns)
Civil Aviation Authority (2016)	Estimating the geographic area from which a large proportion of an airport's outbound passengers originate; catchment areas do not incorporate passenger price sensitivity and hence may overestimate competitive constraint Hypothetical monopoly test (SSNIP) employed to determine airport-specific catchment area
Fuellhart (2007)	Airport catchment defined as the radius of 75 miles surrounding the specific airports
Lieshout (2012)	Consideration of dynamic airport catchment areas: size determined by access time, flight frequency and/or air fares
Maertens (2012)	Airport catchment area: NUTS-3 level regions located within 100 km by car from the relevant airport; presence of low-cost carriers can increase catchment
Mandel (2014)	Airport catchment area variation according to passenger segment, trip purpose and routes; overlap with other airports determines the level of competition
Marcucci and Gatta (2011)	Airport catchment area: consideration of people within a 2-h-driving radius around the airport
Postorino (2010)	Airport catchment area: all users and passengers of an airport, application of accessibility indices to determine size of catchment; consideration of prefixed time value such as 2 h for European airports; differentiation of primary and secondary catchment area (affected by e.g. income, population, employment)
Staub (2014)	Airport catchment area: differentiation by passenger type and route choice, static value cannot be assumed
Starkie (2010)	Airport attractiveness determined by its relation to market demand (population density, income level, business activity, international trade links, tourism potential, quality of transport links—airport access time); differentiation of access time by passenger type; overlap of catchment areas: geographical segmentation of customer not possible
Thelle et al. (2012)	Airport catchment area: assuming "normal transport time": at least either 100 km or 1 h drive time (airports argue that catchment areas exceed this limit), differentiation by passenger segment; overlap of routes as important factor
Wiltshire (2013)	Assuming isochrones of 120 km or 2 h drive time, overlapping isochrones indicate potential competition between airports

Source: Paul (2018)

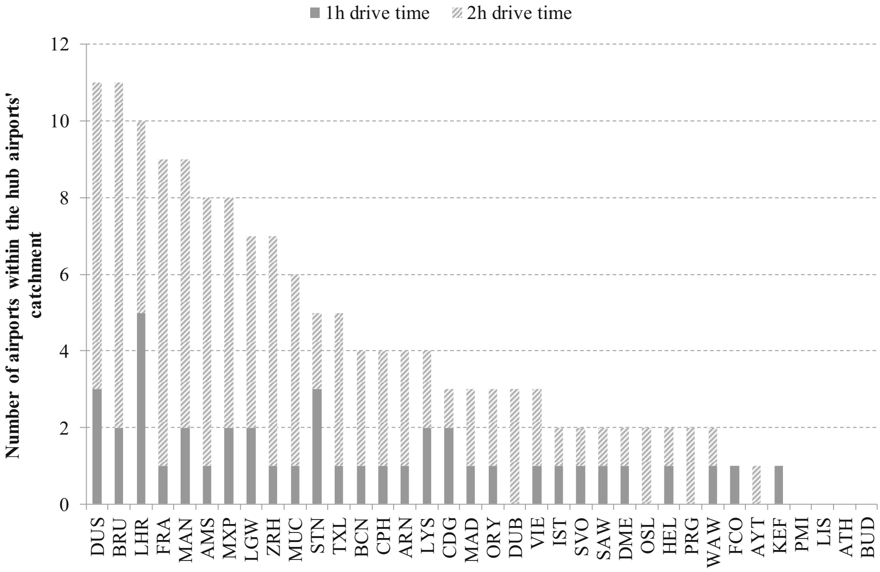

Fig. 3.1 Secondary airports within catchment of European hub airports. Source: Paul (2018), based on OAG (2000, 2004, 2008, 2012, 2016)

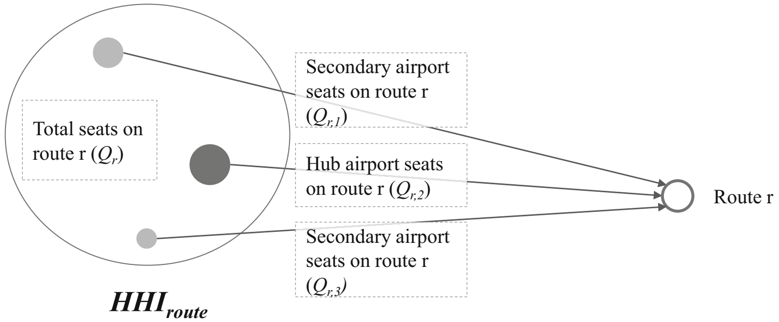

Fig. 3.2 Calculation of $\text{HHI}_{\text{route}}$ for European hub airports. Source: Paul (2018)

hub airport and its secondary airports within the catchment. Figure 3.2 illustrates this approach in more detail.

The left-hand side of the figure comprises all airports in a hub airport's catchment (i, with $i = 1, \ldots, N$), which all offer seats on a particular route r (or to a destination), with $r = 1, \ldots, M$. Therefore, the total seats offered on route r (Q_r) per year are the sum of seats by all airports i in the catchment ($Q_{r,\ i}$) in this year. The disaggregated Herfindahl Hirschman Index ($\text{HHI}_{\text{route}}$) is thus calculated as follows:

$$\mathrm{HHI}_{\mathrm{route,r}} = \sum_{i=1}^{N} s_{r,i}^{2} \tag{3.1}$$

where $s_{r,\ i} = Q_{r,\ i}/Q_r$ represents the share of airport i's output $Q_{r,\ i}$ in total output in the catchment (Q_r) on route r. Calculating the $\mathrm{HHI}_{\mathrm{route}}$ therefore yields a single value for each route offered at the hub airport. The subsequent analysis of the $\mathrm{HHI}_{\mathrm{route}}$ focuses on (1) the change of this index over time for different routes and by hub airport, as well as (2) the level across airports and the potential implications.

In order to observe the change of the $\mathrm{HHI}_{\mathrm{route}}$ for all European hub airports in the dataset, each route is analysed individually in terms of changes in its $\mathrm{HHI}_{\mathrm{route}}$ value over time. The mean $\mathrm{HHI}_{\mathrm{route}}$ (Table 3.4) implies a rather high market concentration in the catchment, or alternatively, a low degree of overlap between airports in terms of routes offered.

In terms of low-cost carriers potentially exposing hub airports to an increased level of competition by offering the same routes at secondary airports, and thus providing a substitute for passengers, two main findings can be derived from the analysis in this chapter. First, low-cost carrier growth has been rather evenly distributed across hub airports and secondary airports, therefore casting doubt on the argument that low-cost carriers often focus only on secondary, smaller airports (Paul 2018). A current example of this development can be observed with the low-cost carrier Ryanair and the hub airport Frankfurt (FRA). From summer 2017 onwards, Ryanair started to offer flights on routes which are mostly considered as holiday destinations (Frankfurt Airport n.d.). Flights between Munich Airport (MUC) and Dublin Airport (DUB) were also initiated by this carrier in 2017 (Munich Airport n.d.). Low-cost carriers have been, however, the drivers of growth at both hub and secondary airports, compared to full service carriers. The further growth of low-cost carrier operations at hub airports strongly depends on available capacities at these in the future.

Regarding the level of market concentration for most of these airports a rather high Herfindahl Hirschman Index can be observed. If firms in a market are of equal size, the minimum value this index can take is the inverse of the number of firms. Thus, assuming that there are two equally sized firms in a market, the lowest attainable value will be 0.50, and more firms imply a lower minimum attainable value. Comparing the route-level Herfindahl Hirschman Index at European hub airports against this 0.50 threshold reveals that most airports face a rather high degree of market concentration (Fig. 3.3). The figure also shows those airports which experienced a decrease in market concentration in the local catchment. However, as depicted in Table 3.5 in the Appendix, this decrease is rather small for most airports in the sample.

Bringing together these two interpretations of the Herfindahl Hirschman Index, a high-level indication in regard to market concentration for each hub airport can be obtained. Brussels Airport and Dusseldorf Airport, for example, both face a relatively low degree of market concentration in their catchment, which has also been decreasing over time. On the other side of the scale are Madrid Airport and Helsinki

Table 3.4 Development of mean HHI_{route} for all European hub airports (all years)

Hub airport	Mean	Minimum	Maximum	Standard deviation
DUS	0.42	0.11	1.00	0.22
BRU	0.51	0.14	1.00	0.25
LGW	0.65	0.18	1.00	0.27
MAN	0.66	0.17	1.00	0.29
AMS	0.67	0.16	1.00	0.27
STN	0.70	0.22	1.00	0.26
LHR	0.71	0.15	1.00	0.29
FRA	0.71	0.17	1.00	0.29
LYS	0.72	0.28	1.00	0.21
SAW	0.73	0.48	1.00	0.19
SVO	0.74	0.33	1.00	0.25
DME	0.74	0.33	1.00	0.24
ZRH	0.74	0.26	1.00	0.26
TXL	0.76	0.23	1.00	0.26
MUC	0.77	0.20	1.00	0.25
ORY	0.78	0.34	1.00	0.20
MXP	0.80	0.21	1.00	0.26
DUB	0.87	0.35	1.00	0.21
CDG	0.88	0.34	1.00	0.18
IST	0.92	0.48	1.00	0.16
VIE	0.92	0.29	1.00	0.16
ARN	0.93	0.39	1.00	0.16
PRG	0.93	0.50	1.00	0.15
BCN	0.94	0.31	1.00	0.16
OSL	0.94	0.33	1.00	0.15
WAW	0.95	0.34	1.00	0.15
FCO	0.96	0.50	1.00	0.11
CPH	0.97	0.33	1.00	0.11
HEL	0.99	0.52	1.00	0.06
AYT	1.00	0.57	1.00	0.02
MAD	1.00	0.96	1.00	0.00
KEF	1.00	1.00	1.00	0.00
ATH	1.00	1.00	1.00	0.00
BUD	1.00	1.00	1.00	0.00
LIS	1.00	1.00	1.00	0.00
PMI	1.00	1.00	1.00	0.00

Source: Paul (2018), based on OAG (2000, 2004, 2008, 2012, 2016)
The mean HHI_{route} for each hub airport and each year is included in the Appendix.

Airport with hardly any overlap in regard to their routes as offered, and no observed decrease in this market concentration over time. Other major European hubs, including Amsterdam Airport, Frankfurt Airport, and London Heathrow Airport, all exhibit a mean route-level Herfindahl Hirschman Index between 0.60 and 0.70 in

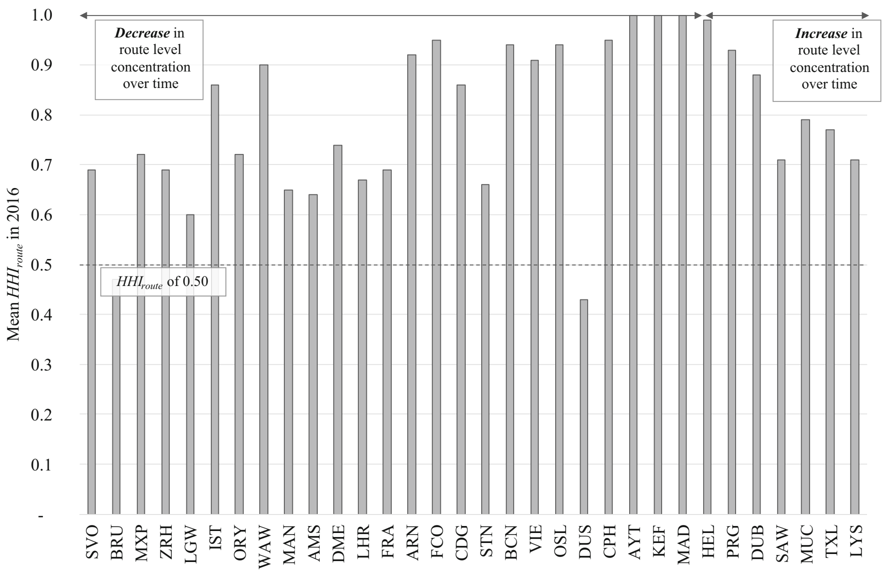

Fig. 3.3 Development of market concentration in the local catchment. Source: Paul (2018), based on OAG (2000, 2004, 2008, 2012, 2016)

2016, but with an observed decrease in this value over time. The market position of Paris Charles de Gaulle in its catchment is even more pronounced with a mean HHI_{route} value of almost 0.90. Potential competitors within this airport's catchment are scarce and seem to focus on different market segments. Paris Orly Airport, for example, is within this catchment and also exhibits a relatively high degree of market concentration. Potential overlap in routes between these two is on routes with high demand, apart from that the airports are focusing on distinct segments. In addition, both airports are under common ownership which makes the Paris market a highly concentrated monopoly market.

3.5 Competition in the Transfer Market

Regarding the discussion on airport competition, supporting arguments highlight the increasing competition especially in the transfer market, and that this is restraining large hub airports from abusing their market power (Thelle et al. 2012; Lieshout and Burghouwt 2013; Pavlyuk 2012; Bruinsma et al. 2000; Forsyth 2010). This section therefore focuses on this particular market segment at European hub airports.[3] The market segment of transfer traffic is not typical of every airport, but mostly of hub airports. The latter's distinct characteristic is that an airline designs its network in a

[3]Within this section the same sample of European airports as outlined in Table 3.1 is considered.

Table 3.5 Development of mean HHI_{route} for European hub airports over time

Hub airport	2000	2004	2008	2012	2016
DUS	0.44	0.44	0.41	0.40	0.43
BRU	0.57	0.53	0.51	0.48	0.47
LGW	0.70	0.68	0.68	0.63	0.60
AMS	0.69	0.71	0.68	0.66	0.64
MAN	0.72	0.67	0.68	0.63	0.65
STN	0.69	0.73	0.73	0.67	0.66
LHR	0.71	0.74	0.70	0.72	0.67
FRA	0.73	0.72	0.70	0.70	0.69
SVO	0.90	0.78	0.70	0.64	0.69
ZRH	0.81	0.79	0.73	0.71	0.69
SAW	n/a	0.68	0.78	0.74	0.71
LYS	0.66	0.72	0.73	0.75	0.71
MXP	0.85	0.87	0.82	0.76	0.72
ORY	0.80	0.81	0.80	0.80	0.72
DME	0.79	0.78	0.75	0.71	0.74
TXL	0.72	0.72	0.77	0.78	0.77
MUC	0.75	0.78	0.75	0.75	0.79
IST	1.00	0.99	0.95	0.89	0.86
CDG	0.90	0.90	0.89	0.88	0.86
DUB	0.87	0.88	0.86	0.87	0.88
WAW	1.00	1.00	0.97	0.89	0.90
VIE	0.94	0.92	0.91	0.93	0.91
ARN	0.97	0.96	0.93	0.89	0.92
PRG	0.92	0.96	0.94	0.92	0.93
OSL	0.97	0.98	0.94	0.88	0.94
BCN	0.98	0.94	0.92	0.92	0.94
FCO	1.00	0.97	0.97	0.95	0.95
CPH	0.97	0.98	0.97	0.96	0.95
HEL	0.98	0.99	0.99	0.99	0.99
AYT	1.00	1.00	1.00	1.00	1.00
MAD	1.00	1.00	1.00	1.00	1.00
KEF	1.00	1.00	1.00	1.00	1.00
ATH	1.00	1.00	1.00	1.00	1.00
BUD	1.00	1.00	1.00	1.00	1.00
PMI	1.00	1.00	1.00	1.00	1.00
LIS	1.00	1.00	1.00	1.00	1.00

way that flights are both temporally and spatially concentrated at these airports. This allows airlines to bundle traffic on different flights, hence to offer a larger network of destinations to its passengers and to exhaust economies of density (Burghouwt 2007). Dennis (1994) defines a hub as "an integrated interchange point where one or two specific airlines operate waves of flights" (p. 211). Within the following analysis, the existing assessments of transfer market competition are extended to the

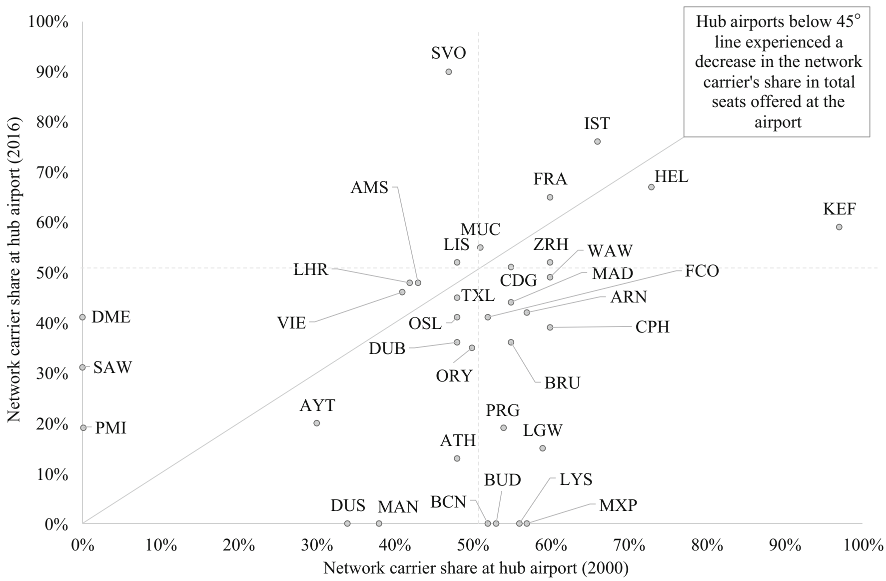

Fig. 3.4 Share of network carrier in total seats offered at European hub airports. Source: Paul (2018), based on OAG (2000, 2004, 2008, 2012, 2016)

set of 36 European (hub) airports as considered in analysing the overlap in transfer connections that are offered via these hubs.

These definitions already highlight the close relationship between the network airline and its hub airport. Since airlines are customers of airports, the competition imposed on these airlines also affects the airport. Within the analysis in this section, the flights of network carriers as well as their respective alliance partners are considered. Addressing the degree of competition on this market is hence referring to the competition between network carriers, and airline alliance partners, via their respective hub airports.

The share of these airlines at their relevant hub airports, in terms of their share in total seats offered at the respective airports, is determined and shown in Fig. 3.4. Here the development of these shares from 2000 to 2016 can be observed, with some hub airports experiencing major changes in terms of their network carrier relationship. Figure 3.4 only shows the years 2000 and 2016 in order to observe the change over the entire period. The 45° line separates the hub airports into those which saw an increase in their network carrier's share and those that did not. Most hub airports in the dataset experienced a decreasing share of network carrier operations.[4] One reason for this might be the steep low-cost carrier growth in the period between 2000 and 2016, as previously outlined. These particular carriers have been picking up

[4]This figure only includes the network carrier and not its potential alliance partners; the latter may have been taking up some of the traffic of the network carrier which is not considered here.

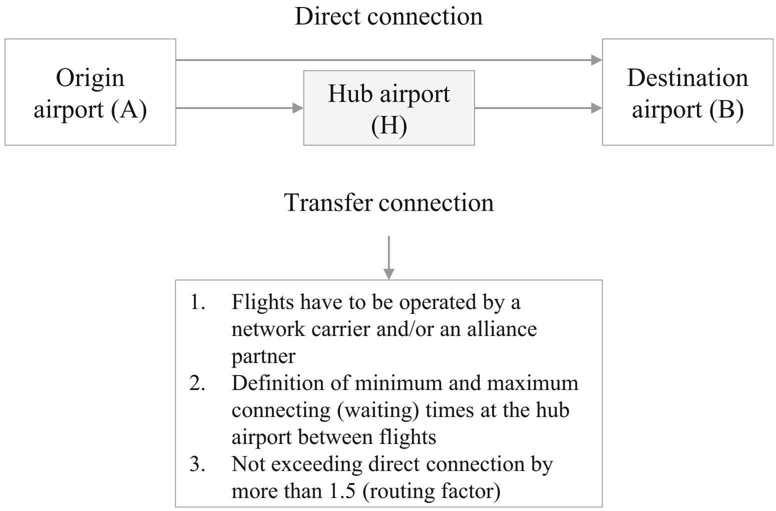

Fig. 3.5 Underlying assumptions to determine feasible transfer connections. Source: Paul (2018)

operations at European hub airports, and therefore increasing their shares of total seats being offered. The observed decrease in network carrier operations thus does not necessarily have to be due to the network carrier cutting back on operations.

Hub airports which saw an increase in the network carrier's share include some of the largest airports in Europe, in terms of total passenger numbers. At Frankfurt Airport (FRA), for example, the share of its network carrier Lufthansa in total aircraft seats offered has increased from 60% in 2000 to about 65% in 2016. Next to this increase, the share is rather high, which implies that the hub airport strongly depends on the continuation of the network carrier's operations, since replacing these amount of seats by other carriers would probably take several years, if even possible at all. At Istanbul Airport (IST), the network carrier Turkish Airlines (TK) also increased its share in total seats offered from 2000 to 2016, from less than 70% to about 75%. Another strong increase in carrier dominance took place at Moscow Sheremetyevo (SVO), with the share of Aeroflot (SU) rising from less than 50% in 2000 to about 90% in 2016. These developments play an important role when determining the amount of transfer connections offered at each hub airport in the time period under consideration.

In order to identify viable flight connections at each of the considered hub airports, a set of assumptions is applied to the data (see also Fig. 3.5):

1. Only flights by network carriers and their respective alliance partners are considered.
2. Definition of maximum and minimum connecting times between flights, based on the criteria outlined in Burghouwt and Redondi (2013):

(a) Short-haul to short-haul connection: minimum waiting time of 60 min; maximum waiting time of 180 min
(b) Short-haul to long-haul connection: minimum waiting time of 60 min; maximum waiting time of 300 min
(c) Long-haul to long-haul connection: minimum waiting time of 60 min; maximum waiting time of 720 min

3. Application of a routing factor: direct travel time times a factor of 1.5, based on the assumptions discussed in Burghouwt and Redondi (2013).
4. Selection of a particular week during off-peak season during which transfer connections are considered (the last full week in September of each year); according to Redondi et al. (2011), using scheduled traffic data during peak periods may lead to biased results regarding the level of connectivity at a hub airport, since some flights are only scheduled during these peak periods; hence, the focus on a regular week during the off-peak season ensures consistency of flights throughout the year.[5]

First, for each hub airport, only those flights are considered which are offered either by the network carrier operating at that hub or by an airline which is a member of the same alliance as the network carrier. Furthermore, at least one leg of the connecting flights offered via the hub has to be by the airline which has its base at the hub airport. In the case of Frankfurt Airport (FRA), for example, at least one leg has to be operated by its network carrier Lufthansa. This requirement is imposed since transfer connections are often defined by a single ticket by one airline or its alliance partners as well as baggage check-through at the hub airport (Airports Council International Europe 2016a).

The second assumption concerns the minimum as well as maximum feasible connecting time, or waiting time, between flights at a hub airport. The thresholds applied in the following analysis are based on values mainly applied in the literature on airport connectivity analyses, including Malighetti et al. (2008), Burghouwt and Redondi (2013) and Redondi and Burghouwt (2010). Hence, for a transfer flight connecting two airports within Europe, i.e. a short-haul to short-haul connection, a minimum waiting time of 60 min and a maximum waiting time of 180 min are assumed. For a connecting flight between a European and an intercontinental destination, i.e. a short-haul to long-haul connection, a maximum transfer time of 300 min is assumed. In case the transfer connection is between two intercontinental destinations, a maximum connecting time of 720 min is considered. All connecting flights exceeding these thresholds are eliminated from the dataset.

In the third step, a routing factor is applied which is determined by multiplying the direct travel time between two destinations by 1.5. If the overall travel time of a connecting flight exceeds this time threshold, it is eliminated from the dataset.

[5] The following weeks are considered in each observed year: 18.–24.09.2000; 20.–26.09.2004; 22.–28.09.2008; 24.–30.09.2012; 19.–25.09.2016.

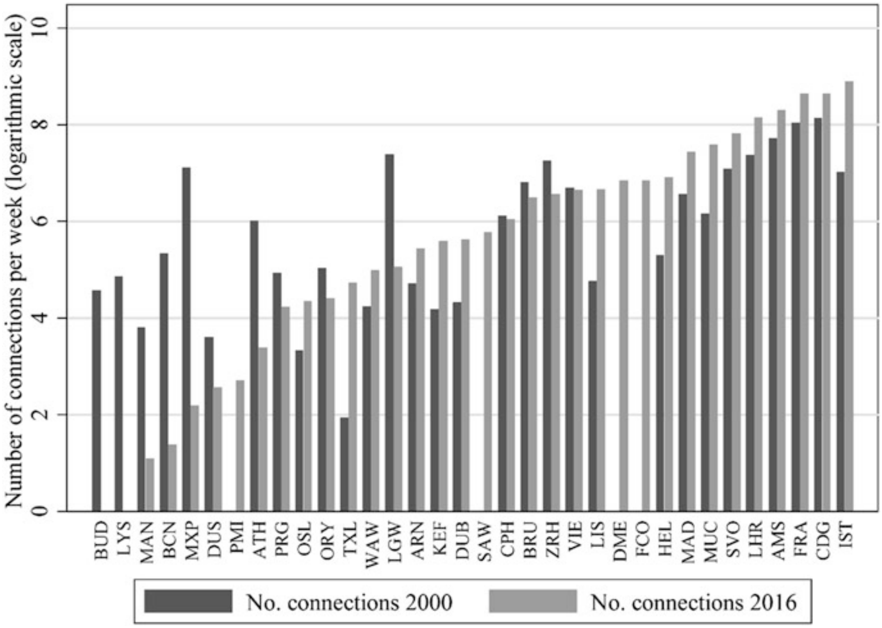

Fig. 3.6 Development of connectivity levels across European hub airports. Source: Paul (2018), based on OAG (2000, 2004, 2008, 2012, 2016)

Based on these assumptions, Fig. 3.6 shows the number of transfer connections for all European hub airports in the dataset for the respective weeks in September in 2000 and 2016. The airports are ranked in ascending order of the total number of transfer connections offered in 2016.

This initial analysis reveals the difference in the number of transfer connections offered at European hub airports and identifies those airports that have been either winning or losing in terms of number of transfer connections offered over the observed time period.

The potential level of competition the considered European hub airports face in regard to their transfer market is determined by calculating the degree of market concentration for each transfer connection offered at each of the hubs during the considered time period. Figure 3.7 illustrates this concept in more detail. As outlined before, a transfer connection is a connection from origin A to destination B via a hub airport H. In the example, the connection from A to B can be made by transferring via three different hub airports, with each of these airports offering a particular number of seats on this specific connection. Hence, in order to calculate the Herfindahl Hirschman Index for this connection, all possible transfer connections and the respective seats offered are taken into consideration.

The total seats offered on a transfer connection are depicted by Q_c, which is the sum of each hub airport's i seats on this transfer connection $Q_{c,\,i}$, with $i = 1, \ldots, N$, and $c = 1, \ldots, K$. The Herfindahl Hirschman Index for each transfer connection ($\mathrm{HHI}_{\mathrm{connect}}$) is thus calculated:

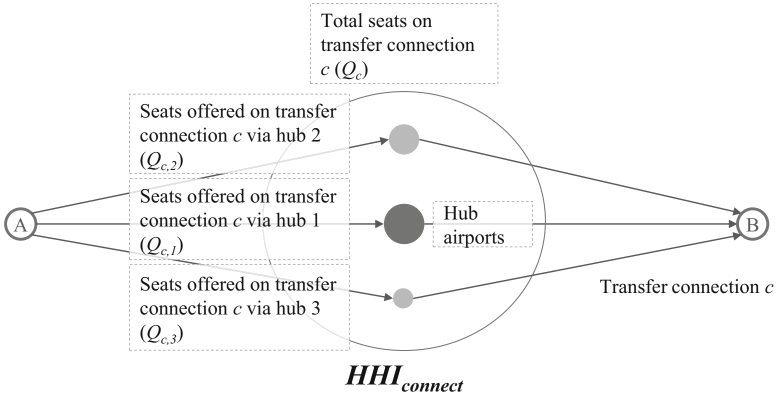

Fig. 3.7 Calculation of $HHI_{connect}$ for European hub airports. Source: Paul (2018)

$$\mathrm{HHI}_{\mathrm{connect},c} = \sum_{i=1}^{N} s_{c,i}^2 \tag{3.2}$$

where $s_{c,\,i} = Q_{c,\,i}/Q_c$ represents the share of hub airport i's seats $Q_{c,\,i}$ in total seats offered on a transfer connection (Q_c). Calculating the $HHI_{connect}$ therefore yields a single value for each transfer connection offered at the hub airport.

In Table 3.6 a detailed insight into the development of market concentration in the transfer market for European hub airports is obtained by looking at the yearly $HHI_{connect}$ values. Here, the hub airports are ranked in ascending order of their $HHI_{connect}$ value in 2016. Almost no hub airport exhibits an $HHI_{connect}$ value below 0.40 for either the year 2000 or 2016, with Milan Malpensa Airport (MXP) facing the lowest level of market concentration in 2016 with an $HHI_{connect}$ of 0.37. For the analysis of competition in the transfer market, not only the degree of market concentration for each hub airport is essential but also the development of this Herfindahl Hirschman Index over time.

By this, it can be observed whether potential competition imposed by overlapping transfer connections has been increasing over the course of the observed period for the individual airports in the dataset.

To summarise the interlinkage between hub airports and their respective network carriers, the latter have a share in total seats offered of about 40% or more at the majority of the European hub airports. The amount of transfer connections offered during the week investigated therefore provides a good indication of the role the transfer market is playing in the airport's total operations. The Herfindahl Hirschman Index shows that most airports in the sample face decreasing market concentration levels (Fig. 3.8). Considering the decrease in market concentration at the hub airports depicted, including most of the major hub airports in Europe, both in terms of total passengers numbers and regarding the amount of transfer connections offered per week, implies that these have seen an increasing overlap of their transfer connections. This suggests that passengers have more choice available when selecting their

Table 3.6 Development of mean $HHI_{connect}$ for European hub airports over time

Hub airport	2000	2004	2008	2012	2016
MXP	0.71	0.68	0.66	0.43	0.37
DUS	0.75	0.74	0.76	0.75	0.42
ZRH	0.64	0.62	0.55	0.53	0.53
LHR	0.71	0.74	0.63	0.64	0.66
WAW	0.81	0.81	0.82	0.75	0.66
CPH	0.80	0.70	0.71	0.71	0.68
MAN	0.75	0.79	0.71	0.71	0.68
FCO	n/a	0.68	0.70	0.68	0.68
PRG	0.74	0.77	0.79	0.80	0.72
FRA	0.74	0.75	0.75	0.73	0.72
MUC	0.75	0.77	0.74	0.76	0.73
BRU	0.77	0.89	0.85	0.76	0.74
KEF	0.75	0.72	0.79	0.81	0.75
AMS	0.75	0.77	0.76	0.73	0.75
HEL	0.88	0.76	0.74	0.71	0.75
DUB	0.74	0.68	0.72	0.84	0.75
ARN	0.84	0.89	0.82	0.79	0.75
CDG	0.79	0.84	0.80	0.79	0.75
VIE	0.74	0.79	0.81	0.82	0.77
MAD	0.83	0.86	0.80	0.80	0.80
TXL	0.92	n/a	0.98	0.84	0.81
OSL	0.88	0.95	0.93	0.90	0.81
IST	0.81	0.83	0.85	0.85	0.86
LGW	0.85	0.92	0.89	0.91	0.86
SVO	0.90	0.86	0.84	0.88	0.86
LIS	0.85	0.88	0.91	0.89	0.87
SAW	n/a	n/a	n/a	1.00	0.89
DME	n/a	0.95	0.97	0.97	0.96
ORY	0.99	0.99	1.00	1.00	0.97
PMI	n/a	0.86	0.98	0.97	0.97
ATH	0.85	0.90	0.90	1.00	1.00
BCN	0.91	0.93	0.96	0.88	1.00
AYT	n/a	n/a	1.00	1.00	n/a
BUD	0.61	0.79	0.82	n/a	n/a
LYS	0.91	0.93	0.93	0.96	n/a

Source: Paul (2018), based on OAG (2000, 2004, 2008, 2012, 2016)

most feasible connection, thus putting increasing competitive pressure on these hub airports.

Regarding the level of market concentration, however, for most of these airports this decrease is oftentimes rather small, and a rather high Herfindahl Hirschman Index can be observed. Applying the same threshold as in Sect. 3.4, most hub airports have a mean index of well above 0.50, implying that a high share of transfer connections offered at these hubs is relatively concentrated, i.e. only little or no

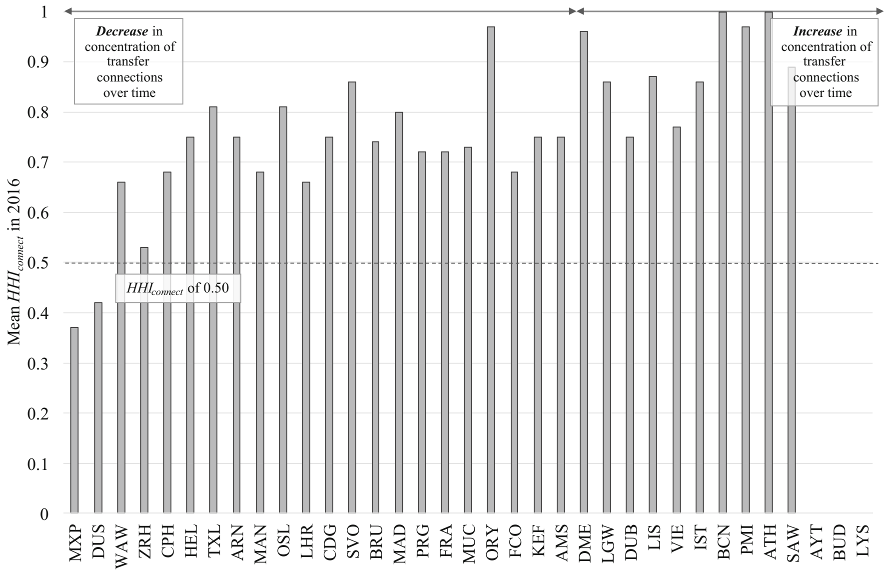

Fig. 3.8 Development of market concentration on the transfer market. Source: Paul (2018), based on OAG (2000, 2004, 2008, 2012, 2016)

competing transfer connections are provided. Comparing the four incumbent airports LHR, CDG, AMS and FRA shows that LHR faces the highest degree of overlap in terms of its transfer connections, and AMS the least.

3.6 Discussion and Implications for Economic Regulation

In order to attain a thorough understanding and evaluation whether an airport possesses substantial market power in one area or another, different aspects have to be considered. These include the potential of airline and passenger switching, or airports as two-sided markets, and the effects on market conduct in different markets. The analysis in this paper provides one element in the discussion of airport competition, namely the assessment of destination overlap both in the origin and destination and in the transfer market.

Bringing together the assessment of these two markets at European hub airports yields a high-level overview of the degree of market concentration each of these airports faces on both markets. Figure 3.9 depicts the mean values for the Herfindahl Hirschman Index in 2016 for both these markets as well as the number of transfer connections offered at each airport within this period. The latter is an indication to the importance of the transfer market when assessing the potential competition in this. In evaluating the extent of constraints of market power for an airport, it is important to consider the different markets in which an airport might be exposed to some degree of competition and investigate these in more detail. The transfer market

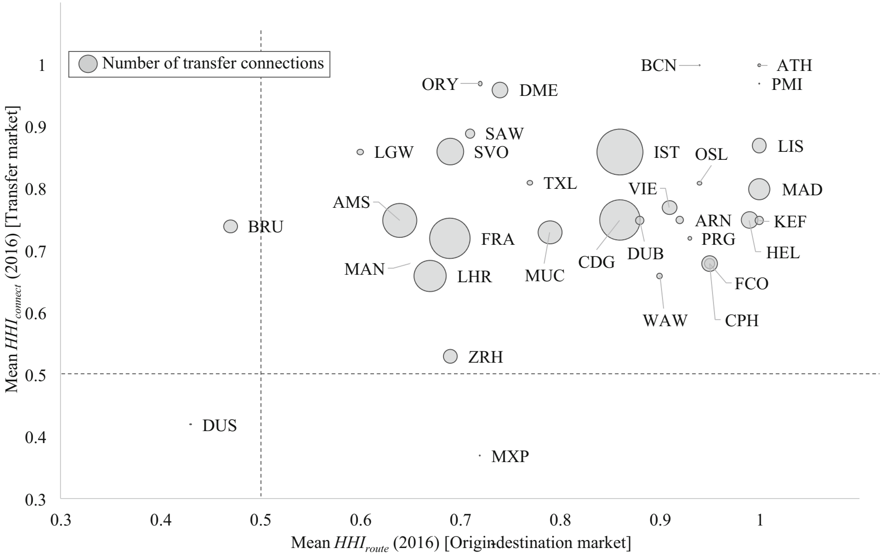

Fig. 3.9 Market concentration on the origin-destination and transfer market. Source: Paul (2018), based on OAG (2000, 2004, 2008, 2012, 2016)

hence plays only a minor role at those airports which offer a very small amount of transfer connections during the investigated period. For these airports, the degree of competition on the origin-destination market therefore has a higher impact on the airport's output decisions and pricing behaviour than the transfer market.

This overview shows that the majority of hub airports in Europe have a dominant position both on the origin-destination and on the transfer market. In general, this implies that the overlap in routes offered in these markets with other airports is rather limited. Using a Herfindahl Hirschman Index with a value of 0.50 as a rough threshold illustrates that all but three airports in the dataset exceed this limit on both the transfer and the origin-destination market. As the results of the empirical estimation have shown, an increase in the level of the Herfindahl Hirschman Index leads to a decrease in output offered on the respective origin-destination route or transfer connection. Having an airport with a high share of routes on both the origin-destination and transfer market with a high level of market concentration therefore implies that this airport has a dominant position. However, the second observation for these markets shows that market concentration has been decreasing steadily for the majority of European hub airports.

The analyses in Sects. 3.4 and 3.5 reveal that only Dublin Airport (DUB) and Sabiha Gökcen Airport (SAW) faced an increase in market concentration on both markets across the observed period from 2000 to 2016. In regard to Dublin Airport the Commission for Aviation Regulation has reiterated the price cap regulation in place and thus determines the maximum level of airport charges Dublin Airport may impose (Commission for Aviation Regulation 2019). However, in an interim review in 2020, the Commission for Aviation Regulation (2020) introduced amended price caps due to the impact of the COVID-19 pandemic on overall air transport and hence also Dublin Airport. Of the large hub airports in Europe in terms of total passenger volume, London Heathrow Airport (LHR) exhibits the lowest degree of market concentration on the transfer market and ranks in the second place in terms of low market concentration on the origin-destination market. Furthermore, for both markets a decrease of market concentration from 2000 to 2016 can be observed. The competitors on the origin-destination market in the local catchment of London Heathrow are strong in terms of offering similar destinations as the hub airport, thus providing a high degree of substitution potential for passengers. In addition to that, a high share of transfer connections via London Heathrow is to or from the North American market. Considering only these developments, London Heathrow can be considered as facing competition on a rather high share of routes and transfer connections, thus potentially limiting its ability to exert market power on its customers, the airlines and passengers. However, the value of the HHI with more than 0.6 still suggests that market concentration on both markets is still relatively high. This is in line with Civil Aviation Authority's (CAA) findings in their market power determination of Heathrow Airport: "The most likely source of any SMP [significant market power] that HAL [Heathrow Airport Limited] has stems from its position as the operator of the UK's only hub airport and the combined package that Heathrow offers of strong demand, including premium passengers, cargo and connecting passengers. This makes Heathrow attractive for both based and inbound airlines". (Civil Aviation 2014).

In terms of overall passenger volume per year, FRA has been in the third or fourth place in Europe between 2000 and 2016. In its local catchment area, defined as a 2-h driving radius, there are nine different secondary airports with scheduled airline traffic, which may impose some degree of competition on FRA in terms of the overlap in origin-destination routes. In this regard, market concentration in this local catchment decreased steadily over the observed period but is still relatively high compared to the threshold of 0.50 discussed above, with 0.73 in 2000 and 0.69 in 2016. However, the decreasing level of market concentration suggests that secondary airports in the catchment have been catching up and providing more routes, and respective total seats or frequencies, which are equivalent to the offer at FRA. Cologne Airport (CGN) has been a strong base of Germanwings as has Stuttgart Airport (STR), thus these airports can be considered as drivers of the increased overlap in destinations available to passengers. Furthermore, Ryanair opened a base at Frankfurt Hahn Airport (HHN) in 2002 and increased its offered capacities to various destinations over the considered period. Dusseldorf Airport (DUS), as being one of the other hub airports considered, also contributed to this development. Having strong counterparts in its local catchment therefore provides more choice available for passengers when selecting their arrival or departure airport. Frankfurt

Airport is also well connected to the rail network, with a high-speed rail connection being provided in close vicinity to the terminals. Since the main carrier at Frankfurt Airport, Lufthansa, has a close cooperation with the German rail provider, Deutsche Bahn, it can be assumed that the airline replaces some of its routes with rail services and feeding passengers into its node by rail (Lufthansa n.d.). The transfer market exhibits a similar development regarding the degree and development of market concentration. With a Herfindahl Hirschman Index of around 0.70 and a decrease of this over the observed time period, more transfer connections offered via this airport face an overlap with connections via other hub airports. Here, the North American and Asian markets face a lower degree of market concentration than on other regional markets, and it has also been decreasing over time. This finding suggests that these regional markets are exposed to competition from other hub airports and their respective network carriers. And since these contribute a large share of transfer traffic at this particular airport, it can be inferred that this market is exposed to competition.

As has been highlighted previously, the approach towards assessing airport market power, which has been presented in this chapter, may constitute one potential element contributing to the current discussion on the extent of economic regulation of airports and can therefore enhance the approaches currently applied. The hub airports considered in this sample exhibit very distinct characteristics in terms of their traffic structure and the potential competition within their catchments, which also needs to be considered when interpreting the results and possibly comparing airports with each other. The decision on regulation is a question of persistent market power which needs to be analysed case by case as done by the CAA and the Dutch Authorities. Persistent market power does not rule out that airlines and passengers have alternatives to choose from, but that these substitutes are rather imperfect. The high and only slightly and slowly falling concentration ratios in the O&D market as well as in the transfer market of European hubs are in line with the assessment of the studies on Heathrow, Gatwick and Amsterdam of having persistent market power. Manchester Airport with relative lower, but still significant concentration ratios was de-designated from regulation in 2009, but recently airlines have demanded a reversal of this decision. It remains to be seen how the CAA will decide and what role hub competition will play in its assessments.

In addition to this, the steep decline in air traffic caused by the COVID-19 pandemic (Airports Council International Europe 2021) has put airports under severe pressure to remain financially viable and to secure future operation. With still a high degree of uncertainty, this historical crisis may be a game changer for the current airport and airline structure, and consequently for the potential competitive constraints outlined in this chapter. Closely monitoring the recovery and development of the European airport landscape and assessing the implications for economic regulation will be a major task moving forward (Table 3.7).

Appendix

Table 3.7 Airport codes

Airport within the dataset (ICAO Code)
London Heathrow Airport (LHR)
Paris Charles de Gaulle (CDG)
Amsterdam Schiphol Airport(AMS)
Frankfurt Airport (FRA)
Istanbul Atatürk Airport (IST)
Madrid Barajas International Airport (MAD)
Barcelona Airport—El Prat (BCN)
London Gatwick Airport (LGW)
Munich Airport (MUC)
Rome Fiumicino (FCO)
Moscow Sheremetyevo International Airport (SVO)
Paris Orly Airport (ORY)
Istanbul Sabiha Gökcen (SAW)
Copenhagen Airport (CPH)
Moscow Domodedovo Airport (DME)
Dublin Airport (DUB)
Zurich Airport (ZRH)
Palma de Mallorca Airport (PMI)
Manchester Airport (MAN)
Oslo Airport (OSL)
Stockholm Arlanda Airport (ARN)
London Stansted Airport (STN)
Düsseldorf Airport (DUS)
Vienna International Airport (VIE)
Lisbon Airport (LIS)
Brussels Airport (BRU)
Berlin Tegel Airport (TXL)
Athens International Airport (ATH)
Milan Malpensa Airport (MXP)
Antalya Airport (AYT)
Helsinki (HEL)
Vaclav Havel Airport Prague (PRG)
Warsaw (WAW)
Budapest (BUD)
Lyons Airport (LYS)
Keflavik (KEF)

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Chapter 4
The Transactions Costs Foundation for Public Utility Regulation and Its Application to the Regulation of Airports

Darryl Biggar

Abstract Traditional theory asserts that a bottleneck or monopoly airport will seek to reduce the volume of services to raise the price, leading to economic harm known as a deadweight loss. But there is a problem: regulators and policymakers do not behave as though the deadweight loss is their primary concern. This chapter sets out an alternative foundation for economic regulation, based on the need to protect sunk investments from hold-up. In the case of airports, these sunk investments are made by both airlines and firms that rely on air transport services to provide services from a particular airport. When the airport has no close substitutes, such sunk investments are subject to the threat of hold-up. The economic harm is the resulting chilling effect on such investments. The threat of hold-up can be controlled through vertical integration or long-term contract. We show how government ownership and public utility regulation can be interpreted as a form of vertical integration and long-term contracting, respectively. We show how the features of airport regulation that are found around the world are consistent with this theory. We suggest that this theory provides a sound, coherent rationale for the analysis of airport regulation going forward.

Keywords Monopoly · Regulation · Deadweight loss · Sunk investment · Transaction cost approach · Ownership

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4.1 Introduction

Like other monopoly businesses, major airports around the world are routinely subject to a variety of government interventions. Major airports are often government owned, operated under a long-term lease or concession, jointly owned and/or operated by major customers such as airlines and often are subject to some form of independent or arms-length regulation. Although there is variation in the focus of these policies, it is common for these interventions to control the prices charged by airport services, to limit the profit or rate-of-return of the airport business, to limit the extent of price discrimination between different services, and, where the airport is slot-constrained, to ration scarce capacity with grandfathered slot rights.

Why, exactly? What can explain this pattern of regulatory interventions in the airport sector? What harms are these policies designed to address, and how do these actions help?

These questions are fundamental. Without a clear understanding of the economic rationale for airport regulation we are not in a position to understand whether to regulate, how to regulate airports or how to reform or improve existing airport regulation.

Traditional economic analysis, found in numerous textbooks and papers, asserts that the primary economic rationale for airport regulation is to maximise economic welfare by reducing or eliminating the economic harm known as deadweight loss.[1] Yet, as set out in Biggar (2012), the patterns of airport regulation that we observe around the world are not consistent with this hypothesis. Airport regulators do not behave as though the minimisation of deadweight loss is their primary concern. This problem is not unique to airport regulation. Across a wide range of industries and jurisdictions, the observed practices of regulation are not consistent with a single-minded focus on the minimisation of deadweight loss.[2] Regulators and policymakers do not seem to behave as though the minimisation of deadweight loss is their central consideration. As Crew and Kleindorfer (2006) point out: "[D]espite continuing statements by economists extolling its virtues",[3] the patterns of public utility regulation that we observe practiced around the world cannot be explained as the outworking of a desire to reduce or eliminate deadweight loss. "Objectives other than economic efficiency are clearly at work in determining prices in regulated industries . . .".[4]

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[1] For example, Crew and Kleindorfer (2006), page 63–64 write: "Elementary neoclassical economic theory shows that a monopoly left to its own devices will restrict output and maximize profit by equating marginal revenue and marginal cost. As a result it will earn monopoly profit, henceforth referred to as rents . . . The loss from the reduced output of monopoly is known as the deadweight loss or the welfare loss from monopoly".

[2] Biggar (2009), Faulhaber and Baumol (1988), Baumol (1986), Berg and Tschirhart (1995), Zajac (1995), Crew and Kleindorfer (2006).

[3] Crew and Kleindorfer (2006), page 66.

[4] Crew and Kleindorfer (2006), page 66.

In recent years an alternative hypothesis on the economic foundation of monopoly price regulation has emerged.[5] This alternative hypothesis has its roots in transaction cost economics. According to this approach, the primary rationale for monopoly price regulation is to protect, and thereby promote, the sunk relationship-specific investment of customers in reliance on the monopoly service provider. This approach can explain the range of government interventions in monopoly sectors around the world and the key features of airport regulation in particular. I suggest that this alternative approach offers material promise, both as a positive theory of government intervention in monopoly sectors and as a foundation for normative proposals for reform going forward.

This chapter seeks to introduce the transaction cost approach to public utility regulation and to explore its application to airport regulation. The chapter first briefly reviews the theory of transaction cost economics, introducing the concept of hold-up, and mechanisms for mitigating the hold-up problem. The next section applies this theory to the problem of monopoly. In a monopoly sector, *all* sunk investments by customers in reliance on the services of the monopoly facility are relationship-specific investments. These sunk investments are vulnerable to the problem of hold-up. The different approaches to government intervention in monopoly sectors can be understood as different governance mechanisms for addressing this hold-up problem. Section 4.3 applies this theory to airport regulation, showing how the range of public policy towards airports and the key features of airport regulation can be understood in this light. The chapter concludes with an assessment of the implications for the reform of airport regulation in the future.

4.2 Transaction Cost Economics and Competition Policy

4.2.1 Relationship-Specific Investment and Hold-Up

In order to extract the most value from a potential transaction it is common for trading partners to have to make sunk investments whose value depends on an on-going series of trades. Examples include investment in a customized manufacturing facility, investment in developing new software for an electronic device, or an investment in producing goods in advance of payment.

In many cases, such investments are not specific to a particular trading relationship. For example, a factory might invest in specialised equipment in the knowledge that there are a number of potential buyers for the products produced using that equipment. A manufacturer might choose a location in the knowledge that there are many different transport options for delivering key inputs to that location. However, circumstances sometimes arise where the value of the sunk investment depends on

[5] See Biggar (2009, 2011, 2012).

continuing trade with a particular trading partner. Such investments are known as relationship-specific investments or “specific assets”.[6] Examples include:

- *Location-specific investments* such as investment in a factory which relies on access to a monopoly gas transmission pipeline, or a householder choosing to build a house close to a monopoly commuter rail service
- *Customer-premises equipment*, such as investment in electrical wiring or electrical appliances in reliance on access to a supply of electricity through the local electricity network
- *Marketing investments*, such as the marketing by an airline of services to or from a major airport, in reliance on continued access to that airport; or
- *Human-capital investments*, such as investment in R&D to develop a new product or service in reliance on a complementary product or service sold by an independent firm.[7]

The presence of relationship-specific investments gives rise to a risk of what is known as **ex post contractual opportunism** or **hold-up**: Once one party has made a sunk relationship-specific investment, he or she is exposed to the risk that the other party will attempt to extract the value of that investment (known as “quasi-rents”) through a change in the terms and conditions of trade in its favour. For example, suppose a coal mine relies on a coal railway to transport its product to port. If the coal mine invests in new equipment which lowers its cost of extraction it may be exposed to the risk that the coal railway will raise its charges, expropriating the economic value created by that cost-reducing investment. Alternatively, a sugar beet farmer might be reliant on a local processing plant to convert the farmer’s sugar beet crop into sugar. Once the farmer plants the crop, the farmer is exposed to the risk that the processing facility will reduce the offered price, taking advantage of the farmer’s investment in her crop.

In the absence of mechanisms to control for the threat of hold-up, the investing party will be either reluctant to make sunk investments, will make inefficient investments, or will forego the benefits of exchange. Economic harm is the reduced or foregone benefits from trade.

Transactions cost economics asserts that, when faced with relationship-specific sunk investments, the trading partners will seek **governance mechanisms** to reduce the risk of hold-up and thereby facilitate socially valuable investments, increasing the value of trade and exchange. Transaction cost economics conventionally distinguishes two categories of governance mechanisms: **ownership mechanisms**, such as vertical integration, and **contractual mechanisms**. We will look briefly at each of these governance mechanisms in turn.

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[6]“Asset specificity takes a variety of forms—physical assets, human assets, site specificity, dedicated assets, brand name capital, and temporal specificity . . . It is the big locomotive to which transaction cost economics owes much of its predictive content”. Williamson (1998), page 36.

[7]There are further examples in Biggar (2009) and Gómez-Ibáñez (2003), page 9. Investments by customers are also discussed in Lyon and Huang (2002).

One approach to solve the hold-up problem is to combine the two parties in a single firm. Such vertical integration aligns the interest of the supplier and the customer. No longer does the supplier have any incentive to raise the price or lower the quality to the downstream customer. Any attempt to raise the price simply transfers rents around within the firm, with no effect on overall profitability.[8] Vertical integration is a common feature of economic activity, particularly (as discussed further below) in sectors featuring a bottleneck or monopoly.[9]

The alternative to some form of ownership solution to the hold-up problem is some form of contract. Contracts are, of course, a staple of normal commercial interaction. A contract is a mechanism that allows parties to enter into enforceable commitments. The investing party can rely on these commitments by its trading partner when making necessary sunk investments. Every contractual mechanism can be thought of as consisting of two components: a pre-recorded set of principles or promises, and a mechanism for resolving disputes and/or enforcing those principles or promises.

In some cases, the relationship-specific investments required are very long lived. This might include investment in the airport itself, or investment by an airline in terminals, in aircraft, or in marketing or branding. Where substantial long-term sunk relationship-specific investments are required, protecting the sunk investment of the trading partners will typically require a **long-term contract**. Starkie (2012) points to several examples of long-term contracts, between a coal-mine and a coal-fired power station, between dairy farmers and major grocery retailers, between shipping lines and port operators, and between aircraft manufacturers and airlines. In principle, a well-constructed long-term contract can mitigate the hold-up problem and give an assurance to the trading partners, on which they can rely when making needed investments.

However, long-term contracts introduce new issues. The longer the contract and the greater the uncertainty in the environment, the greater the range of future possible scenarios. For contracts with a duration measured in decades, it is not possible to identify and negotiate over every possible future contingency. No matter how well-intentioned or well-informed are the parties to the contract, inevitably a situation will arise *ex post* where the contract specifies an outcome that is not optimal for the parties in that circumstance—that is, an outcome which the parties would not have agreed if they had specifically negotiated over this contingency, possibility, or scenario at the outset.[10] The longer the duration of the contract, the greater the

[8] Crocker and Masten (1996) explain this as follows: "By allocating residual rights of control over the use and disposition of assets, ownership restricts the ability of non-owners to withhold assets from production and thus limits hold-up opportunities".

[9] The transaction cost literature also highlights problems that may arise in the internal organisation of firms. These bureaucratic inefficiencies ultimately undermine the benefits of internal organisation and thereby limit firm size. Vertical integration, like contracts, has both pros and cons.

[10] The literature on transaction costs asserts that a core problem with real-world contracts is that they are incomplete and this leads to costly ex-post renegotiation (see, for example, Williamson 1998, Stern 2009, Hviid 1999, Macher and Richman 2008). However, the term "incomplete" is rather

likelihood that the original contract (if interpreted narrowly or literally) would lead to sub-optimal or undesirable outcomes in some circumstances ex post. This reduces the value of the contract and reduces the incentive for investment.

This circle can be partially squared through careful design of the dispute resolution/enforcement mechanism. In the case of a short-term contract, where completely unexpected scenarios are, by definition, rare, the role of the dispute resolution/enforcement mechanism can be limited to interpreting and applying the terms and conditions of exchange as set out in the original contract.[11] However, in the case of a long-term contract, we can no longer presume that the parties were able to foresee and negotiate over every potential contingency. In this case it is at least possible that an attempt to renegotiate the contract ex post is not merely rent-shifting, but may result in better outcomes for both parties. In this case, the dispute resolution mechanism may be able to achieve a better outcome for both parties by exercising flexibility and discretion, substituting its own judgement as to the arrangements the parties would have agreed if they had specifically negotiated over the relevant scenario ex ante.

This ex post flexibility and discretion is a two-edged sword. Flexibility and discretion allow for a better outcome in unforeseen circumstances, but reduce the certainty and predictability of future outcomes under the contract. The contracting parties can no longer rely exclusively on the written contractual promises to protect their investments but must rely, at least in part, on the objectivity, knowledge, and skill of the dispute resolution body to promote their mutual interests. The longer the duration of the contract and the more the uncertainty in the environment, the greater the need for flexibility and discretion by the dispute resolution body and the greater the importance of designing the dispute resolution mechanism to ensure that it performs this role effectively.

Importantly, once a decision has been made to establish an independent dispute resolution body with the authority to vary the contract terms and conditions ex post, there is correspondingly less need to specify the original contract in detail. Instead, the contract may merely set out broad principles, with reliance placed on the dispute resolution mechanism to "fill in the blanks" in the contract in a manner that protects the investments of the parties and supports the overall objectives.[12] A loosely

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misleading. The underlying problem is not that it is costly to write a contract which specifies the action to be taken in every possible future contingency (after all the simple contract "X must do Y in every future scenario" is a trivial contract which specifies the action to be taken in every future scenario). Rather the problem is that the action specified by the contract may not be *optimal* when that scenario actually arises. Rather than the term incomplete it is preferable to use the term *improvable*. A contract is improvable if, ex post, there is a positive probability that in some future scenario the contract will specify a set of actions which the parties would not have agreed had they specifically negotiated over that scenario ex ante. The longer the duration of the contract and the greater the uncertainty in the environment, the greater the likelihood that a contract is improvable ex post.

[11] This is, essentially, the classical role of the courts in Anglo-Saxon countries in enforcing conventional commercial contracts.

[12] This point is emphasised by Stern (2009). See also Sidak and Spulber (1998).

specified long-term contract is sometimes described as a "relational" contract[13]—what Goldberg (1976) calls a "constitution governing a relationship".

Empirical studies confirm that the longer and the more complex the transaction, the more likely it is that the contract merely sets out broad obligations and mechanisms for resolving disputes, and the more likely it is that those dispute resolution mechanisms will be private arrangements such as arbitration or mediation rather than litigation.[14]

4.2.2 Transaction Cost Economics and Competition Policy

These concepts from transaction cost economics have a direct application to competition and monopoly policy. We will say that a market is competitive if the sunk investments are not relationship-specific and there are many possible alternative trading parties. In a competitive market, each participant can, in the event of a threat of hold-up, switch to another trading partner without any loss of value. It is this ability to switch trading partners which provides the primary protection for the sunk investments of the market participants in a competitive market. Contracts, where they are still required, can be relatively short in duration and prescriptive as to what is required. As noted earlier, contract enforcement is primarily a matter of interpreting and applying the contract as it was agreed.[15]

However, in the absence of effective competition, the situation is quite different. If there are no alternative trading partners, *any* sunk investment made in reliance on continued transactions with a particular firm is inevitably relationship specific. For example, a coal mine might make a sunk investment in developing a mine in reliance on access to a monopoly coal railway to transport the coal to a port. An aluminium producer might make a sunk investment in a smelting facility in reliance on access to the monopoly electricity transmission grid. A freight forwarder might make a sunk investment in a rail spur from its warehouse to the nearest main trunk line.

[13] So-called alliance contracts are an illustration of this principle. Alliance contracts are a form of commercial contracting which are designed to be used in situations of complexity, scope uncertainty, or complex operational constraints. Importantly, the parties to the contract enter into a commitment not to resolve disputes through the courts but, rather, to administer and adapt the contract through the decisions of an Alliance Board or Alliance Leadership Team. The Alliance Board, comprising representatives of the contracting parties, is an example of a permanent dispute resolution body empowered, in conditions of high uncertainty, to replace deferential dispute resolution by the courts (Department of Infrastructure and Transport 2011). The Alliance Board plays a role closely analogous to a public utility regulator in a conventional regulatory regime.

[14] See Lumineau and Oxley (2007).

[15] Contracts are often still required even in a competitive market for the simple reason that, except in the most basic market exchanges, there can arise slight timing differences between the creation of the good or service and the corresponding payment or exchange. These timing differences give rise to a hold-up problem, especially for the provision of (non-storable) services.

This need for sunk relationship-specific investment is not limited to large customers. Even small customers (small businesses or households) may be required to make a sunk investment, such as the investment by households in electrical wiring and electrical appliances in reliance on access to the monopoly electricity distribution network, or the investment in devices that rely on access to a monopoly broadband telecommunications network, or the investment in a location close to a monopoly commuter rail station.

These sunk, relationship-specific investments are exposed to the threat of hold-up. In the absence of some mechanism to protect against hold-up, market participants will be reluctant to invest in reliance on the monopoly, or will make imperfect investments, or will forego trade with the monopoly entirely. The transaction cost approach to public utility regulation asserts that this chilling effect on investment is the primary economic harm from monopoly. The public policy problem is the design of governance mechanisms that reduce the scope for this harm.

As noted above, there are two broad classes of solutions to the hold-up problem: ownership mechanisms and contractual mechanisms. Each of these has implications for resolving the basic monopoly problem.

4.2.2.1 Ownership Solutions to the Monopoly Problem

As emphasised above, one way to eliminate the hold-up problem is through **vertical integration**. In fact, vertical integration is very common (and, indeed, virtually standard practice) in monopoly industries. In the electricity sector, electricity generation, transmission, and distribution were for many decades combined into a single, highly vertically integrated firm. Vertical integration was also the historical norm in the natural gas industry.[16] Even today, coal mines are often integrated with neighbouring coal-fired electricity generators. Telecommunications companies were historically integrated into all aspects of the telephone business, including communications equipment manufacturing. In remote regions of Australia, large mining companies tend to be highly vertically integrated, owning their own mines, railways, ports, and airports.[17]

[16] See Makholm (2006).

[17] In Australia (as in other countries), the structural separation of natural monopoly sectors from related competitive sectors was a significant component of the pro-competitive reforms of the 1990s. Joskow (1991) makes the point that, to the extent that the original vertical integration was a transaction cost minimising response, it cannot be expected that structural separation in monopoly industries will be without costs. In the framework set out in this paper, structural separation represents a choice between two frameworks: The contractual control of an integrated firm and the promotion of sunk investment by downstream end-users, versus the contractual control of a separated monopoly facility and the promotion of sunk investment by both the intermediate services and the downstream end-users. The choice between these two approaches will depend on the facts in each case.

Vertical integration is most straightforward when there is a single upstream or downstream trading partner. But forms of vertical integration remain feasible when there are several trading partners. Many natural monopoly service providers are owned directly by their customers in a form of **co-operative or club ownership**. While investor-owned utilities dominate the electricity supply industry in the USA, rural customer electricity co-operatives remain common and are not usually subject to formal price regulation. In New Zealand, many local electricity distributors are member-owned and are subject to a lighter form of regulation.[18] Member-owned co-operatives are also a common way to handle local monopolies in the agricultural sector.[19] **Joint ventures** also often involve a degree of shared ownership. Joint venture arrangements are common in the mining industry in Australia. In each of these cases, the ownership arrangements provide an implicit assurance to the customers that the co-operative will exercise its control over the firm to protect the customers from the threat of hold-up.

Importantly, **government ownership** can also be viewed as a form of vertical integration. Government ownership can be viewed as a form of club or co-operative ownership, but with compulsory membership of the club or co-operative. According to this perspective, the benefits of government ownership arise from the implicit promise that the government will use its control over the firm to protect the broader public against hold-up, in the form of adverse price shocks. This provides customers an assurance on which they can rely to make the necessary sunk complementary investments.[20]

Government ownership, however, introduces a new set of problems. Experience shows that over time it is difficult to maintain incentives for productive efficiency in government-owned firms, and to insulate key pricing and investment decisions from political pressures.[21] The empirical literature on the relative efficiency of government-owned firms is mixed.[22] In any case, in recent decades there has been a substantial transformation of many monopoly sectors involving corporatisation, privatisation and the introduction of arms-length regulation (discussed further below).

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[18] See Meade (2005). Questions remain about whether some regulatory controls remain necessary on customer-owned utilities, perhaps to protect customers who do not share in ownership or to protect suppliers. See Biggar (2022).

[19] See, for example, Frank and Henderson (1992) and Cook (1995).

[20] Historically, government ownership of monopoly industries in Australia (as in many other countries) was a very stable regulatory arrangement, lasting many decades and covering a period of rapid expansion of and investment in the electricity and telecommunications networks. Indeed, it may be that government ownership is the transaction-cost minimizing governance arrangement precisely in circumstances where large amounts of new investment are required in an uncertain environment.

[21] Zeckhauser and Horn (1989): "The diffuseness and non-transferability of ownership, the absence of a share price, and indeed the generic difficulty residual claimants would have in expressing 'voice' (much less choosing 'exit') all tend to magnify the agency losses".

[22] See the discussion in Oum et al. (2006).

4.2.2.2 Contractual Solutions to the Monopoly Problem

Ownership solutions are not always feasible or desirable. As emphasised earlier, the other class of solutions to the hold-up problem involve long-term contracts. Consistent with this theory, long-term contractual arrangements are common in monopoly sectors.[23] For example, governments often procure monopoly services through long-term contracts referred to as concession contracts, franchise contracts, or public–private partnerships (PPPs).[24] Stern (2009) makes the case that looking across countries and over time, long-term contracts are, if anything, the predominant form of provision of monopoly services:

> In infrastructure industries, long-run contracts have always played a dominant role, with the sometimes exception of nationalised infrastructure industries. Going back 250 years in the UK and elsewhere, toll roads and then canals and then railways operated under the equivalent of concession contracts. Concession contracts are still hugely important in infrastructure industries in Continental Europe, Latin America and elsewhere—particularly in the water and sewerage industry. In addition, although current and recent UK infrastructure industry privatisations typically involved the use of regulatory licences . . . these licences are essentially contractual documents. They are, in many ways very similar to concession contracts in terms of their function and content.[25]

Such long-term contracts often include explicit reliance on a permanent institution to resolve disputes. For example, some PPP authorities envisage a role for a permanent institution in monitoring PPP contracts.[26] Shugart and Balance (2005) advocate for the establishment of 'Expert Panels' (a form of permanent dispute resolution) in the administration of water supply concession contracts.

An interesting example of a permanent institution associated with an explicit contractual approach to monopoly services is the London Underground Arbiter. As part of a reform of the operation of the London Underground Ltd., in 2002–2003 the UK Government entered into 30-year agreements for the maintenance and upgrade of the Tube infrastructure. However, it was recognised that prices could not remain fixed for the entire 30-year period. Instead, prices were fixed for four periods of 7.5 years each. The PPP Arbiter was created to oversee the process of price adjustment between each of these periods. It was explicitly recognised that the PPP Arbiter, although created in the context of a long-term contract, bore close resemblance to a conventional utility regulator.

> It was considered that achieving this balance required a depth of understanding of the PPP which would not be achievable under typical dispute resolution arrangements, but needed an industry specialist with a continuing monitoring role, more akin to a utility regulator.[27]

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[23] See, for example, Joskow (1987) and Crocker and Masten (1991) and the subsequent literature.

[24] For a recent study see Athias and Saussier (2010).

[25] Stern (2009), page 2.

[26] See, for example, World Bank documents on PPPs.

[27] Transport For London (2011), paragraph 24–25. See also Dassiou and Stern (2009). In the case of an alliance contract, the Alliance Board or Leadership Team is precisely a form of specialist,

Stern (2009) points out that the dispute resolution arrangements in other long-term contracts also resemble the actions of a regulator:

> In the resource industry, contracts between multi-national oil, gas and mining companies with national governments typically include binding arbitration in a neutral venue such as Geneva, London, or New York under international agreed arbitration rules and procedures. This is a weak form of 'regulation' in that it involves an external agency to resolve contractual disputes but does not allow for regulatory involvement beyond dispute resolution.
>
> However, for infrastructure concession contracts, one frequently finds—particularly in developing countries—that governments establish semi-independent or independent monitoring and enforcement agencies for concession contracts. Some of these agencies also have the power to review and, in particular, to modify these contracts following a review instituted by buyer or seller. At this point, the concession contract monitoring agency (or specialist court) is at least as much of a 'regulator' as the PPP Arbiter and arguably not very different in its core responsibilities from Ofwat or Ofgem" (emphasis added).[28]

Indeed, in the framework set out here, I suggest that the set of statutes, regulations and processes which collectively make up what we know as arms-length or public utility regulation can itself be viewed as a form of long-term contract. This **regulatory contract**, like other contracts, consists of both a set of rules and principles, on the one hand, coupled with a dispute resolution authority, on the other. In the case of public utility regulation, the dispute resolution role is usually played by the permanent, specialist institution, known as the public utility regulator.[29] The regulatory contract may not be written down in one document but (like the English constitution) may consist of a combination of laws, rules, licences, precedents, decisions, and

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permanently established dispute resolution mechanism which plays the role of a regulator in administering the alliance contract.

[28] Stern (2009), page 3.

[29] The notion that the fundamental role of a public utility regulator is to resolve disputes may seem, at first, foreign. After all, is not the fundamental role of a public utility regulator to set prices? Yet there is a large amount of evidence that public utility regulators routinely behave like a dispute resolution entity. Littlechild (2008, 2011) provide many examples where regulators have facilitated negotiations between customers and service providers. RAP (2011) mentions that it is common for US regulators to encourage negotiation between the parties. Many US and Canadian regulators provide dispute resolution services of various kinds including mediation and arbitration. In Germany, the Federal network regulator encourages a form of mediation between the customers and the monopoly service provider. Similarly, the Canadian Transportation Agency uses an explicit arbitration procedure when deciding disputed rates for rail shippers. The Australian Productivity Commission has rejected calls to allow the ACCC to arbitrate disputes between airports and airlines precisely because it sees this function as a form of price regulation. Furthermore, the processes followed by public utility regulators in rate hearings borrow substantially from dispute resolution in other fields, including adherence to the rules of natural justice and procedural fairness. The majority of the states in the USA try to bolster the participation of customers in these processes, through the support or encouragement of a customer advocacy body. These bodies seek to represent customer interests before regulatory authorities—in a very similar manner to how these interests would be represented before a court or other dispute resolution mechanism.

conventions, which collectively provide the monopoly service provider and its customers with some assurance as to the outcomes to expect in the future.[30]

Studies of the early history of monopoly price regulation support this view of public utility regulation as an administered long-term contract. Priest (1993) emphasises that public utility regulation in the USA was preceded by a period in which monopoly services were provided primarily by contractual arrangements (municipal franchises or concessions), enforced through the courts. Amongst other things, these contracts fixed maximum prices and mandated service quality and availability conditions. However, there were "persistent difficulties" adapting the franchise contracts to changing market conditions: "These various problems closely resemble now well appreciated problems in the execution of long-term contracts for the supply of a product or service". After a period of experimentation, municipalities settled on a form of franchise contract which was relatively flexible but which relied on council subcommittees or boards of arbitrators for its administration.

> Though implemented by means of contract, this method of control begins to resemble the operation of a regulatory commission. Indeed, . . . the adoption of regulation by commission cannot be claimed to differ qualitatively from the regulation by city council or, often, by specialized committee that preceded it in many jurisdictions. . . . [I]t is not clear that regulation by commission can be distinguished from an advanced stage in the evolution of municipal franchise contractual form.[31]

In other words, consistent with the transaction cost perspective, the history of public policy towards monopoly services in the USA can be seen as the evolution of mechanisms for the administration of a long-term contract. Conventional mechanisms for dispute resolution (such as the courts) are not suited for adjustment of the terms and conditions of a long-term contract. As problems with these traditional mechanisms emerged, there was an evolution towards oversight of these contracts by permanently established boards of administrators, which ultimately led to the form of public utility regulation by commission which is familiar today. Joskow (1991) summarises this perspective:

> The evolution of public utility rate-making and accounting rules bears little if any relationship to the traditional static second-best pricing problem that appears in the academic literature. Instead, the evolution of these accounting and rate-making rules is more closely related to the standard transaction cost economics problem of finding a set of contracting rules that will induce efficient levels of investment, guard against holdups to support these investments, and provide for efficient adaptation to changing economic conditions.[32]

Despite the recognition of the role of transactions cost in the foundation of monopoly price regulation almost 40 years ago, much of the subsequent literature focused on

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[30] The observation that public utility regulation can be viewed as a form of long-term contract can be traced back to Goldberg (1976) and Williamson (1976) and was reiterated by Crocker and Masten (1996).

[31] Priest (1993), 301–303.

[32] Joskow (1991), also see Crocker and Masten (1996) and, more recently, Sidak and Spulber (1998).

the importance of protecting the sunk investment of *the monopoly service provider* (as opposed to the customers).[33] That literature yields important insights, such as the importance of regulatory commitment and the importance of the independence of the regulatory authority from government and consumers. However, this focus on the sunk investment of the service provider cannot explain why some public policy intervention is required in the first place. Many monopoly service providers would have no problem recovering their sunk investment costs if the government would just leave them alone.[34] Protecting the sunk investment of a regulated firm is an important consideration once a decision has been made to impose regulatory controls. But it cannot explain why a decision is made to impose those regulatory controls in the first place. The transaction cost approach to public utility regulation asserts that the need to protect the sunk investments of the monopoly firm is a symptom rather than a cause of the need to intervene in the first place.

4.2.3 Public Policies Towards Natural Monopoly

To summarise the previous sections, the transactions cost perspective on public utility regulation, with its focus on sunk investment by customers, provides a natural and compelling explanation for the range of public policy approaches to the problem of natural monopoly that are regularly observed.

This is illustrated in Fig. 4.1. The range of policies includes, on the one hand, private vertical integration, club or co-operative ownership, and government ownership; and, on the other hand, contractual arrangements, such as private long-term contracts, joint venture arrangements, concession contracts, public-private partnerships, and public utility regulation.

Furthermore, the transaction cost perspective predicts that we should expect to find government intervention in monopoly industries where private arrangements (private vertical integration or private long-term contracts) are infeasible, such as where the number of downstream customers is large. This seems to reflect observed regulatory patterns.[35] Furthermore, this approach predicts that we should expect to see arms-length regulation through a publicly administered regulatory contract (i.e. conventional public utility regulation) where the institutional and legal processes allow the regulatory authority to exercise expertise and flexibility in adapting the regulatory contract to the changing needs of the environment and/or when political processes limit the efficiency and responsiveness of government-owned

[33] See, for example, Levy and Spiller (1994) and the subsequent literature which is surveyed in Armstrong and Sappington (2007).

[34] Or, if there was a threat of "destructive competition", through the granting of a statutory monopoly.

[35] See Spiller and Tommasi (2005) who highlight that public utility services are usually widely consumed.

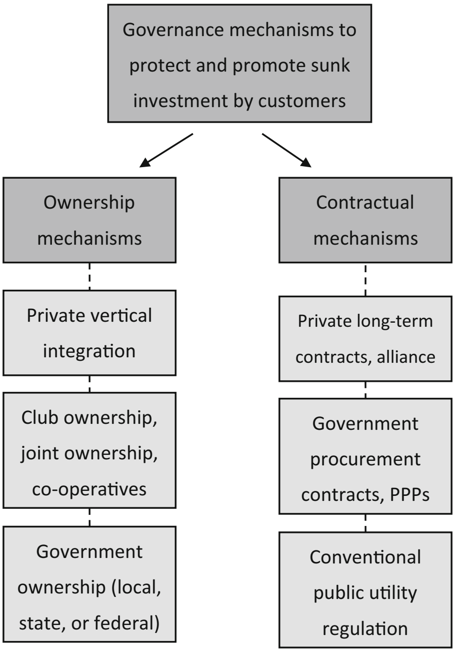

Fig. 4.1 Governance mechanisms to protect and promote sunk investment by customers

firms. In contrast, we might expect to see government ownership of monopoly firms in countries where government-owned firms are subject to good governance and accountability mechanisms, and where the legal structures governing independent regulatory authorities are weak or untested.[36]

4.3 Transaction Cost Economics and Airport Regulation

Let's now apply this framework to the regulation of airports.[37] The focus of this chapter is on major airports which possess market power (that is, major airports without close substitutes located close to major centres of economic activity).[38]

[36] Of course, combinations of these approaches are also possible. It is possible to envisage arms-length regulation of government-owned or partially privatised firms. However, these combinations often suffer from a lack of clarity over roles and responsibilities. In the case of arms-length regulation of a government-owned firm, who is responsible for maintaining a stable price path and maintaining productive efficiency: The government as owner, or the regulatory framework?

[37] The same principles apply to the regulation of air traffic control services, but for reasons which are not entirely clear the charges for air traffic control services have, to date, been less controversial and there appears to be less academic interest in the regulation of air traffic control services. For a survey on economic regulation of airports, with a focus on the UK, see Littlechild (2018).

[38] Starkie (2012) emphasises that for some smaller airports an individual airline may account for a large share of the airport's business. In addition there may be substitute airports or, as in the case of

Much of the academic literature on airport regulation has taken for granted the textbook perspective that the primary economic harm arising from airport market power is the ability to charge a price above marginal cost, resulting in a reduction in total economic welfare (measured as the sum of producers' surplus and consumers' surplus). According to this perspective, the primary economic objective of airport regulation is the minimisation of deadweight loss. This perspective can be found in numerous academic papers[39] and government reports.[40]

However, as in other regulated sectors, the patterns of airport regulation that we observe in practice are inconsistent with the hypothesis that the primary objective of airport regulation is the minimisation of deadweight loss.[41] For example, if the primary objective of airport regulation were the minimisation of deadweight loss, we should expect to see little or no regulation of airports where the elasticity of demand for airport services is low—i.e. those airports with strong demand and few substitutes.[42] But, this seems the opposite of what we observe—it tends to be those airports with the highest degree of market power that are most likely to be subject to price control regulation or government ownership.[43] In Australia, the Productivity Commission recommended that airports with the lowest elasticity of demand should be subject to a stricter form of monitoring.

Furthermore, if the primary objective of airport regulation were the minimisation of deadweight loss we should expect to see airport regulators pursuing marginal cost pricing, Ramsey pricing, peak-load pricing, and/or encouraging various forms of price discrimination.[44] Instead, as Biggar (2012) emphasises, we find that airport regulation routinely explicitly rules out forms of price discrimination, eschews Ramsey pricing, and tends to reject peak-load pricing in favour of quantity rationing.[45] Instead, airport regulation typically focuses primarily on eliminating

low-cost carriers (LCCs), the airline may retain flexibility to adjust its routes over time. If the airport is unlikely to easily make up for lost revenues if the airline takes its business elsewhere, it is the airline which holds the market power (or "buyer power"). In this case it is the airport which may fear to make sunk investments in reliance on the services of a particular airline.

[39] See for example, Forsyth (1997, 2001, 2008), Niemeier (2009), page 6,11, Czerny (2006), Czerny and Zhang (2011), Basso (2008), Basso and Zhang (2010). For a different perspective on the role of economics in airport regulation policy, see Niemeier (2021).

[40] See, for example, Productivity Commission (2002).

[41] See, for example, Niemeier (2009), page 9.

[42] In Australia, the Productivity Commission (2002, 2006) has argued that because the elasticity of demand for airport services is low, the deadweight loss arising from charging above marginal cost is small and therefore there is little need for conventional airport price control regulation.

[43] See Bel and Fageda (2010), Biggar (2012).

[44] On price discrimination see Forsyth (1997) and PC (2006). On Ramsey pricing of airports see Morrison (1982), Martin-Cejas (1997), Czerny (2006), and Hakimov and Scholz (2009). On congestion pricing, see Carlin and Park (1970), Brueckner (2002), Brueckner and Van Dender (2008), Czerny and Zhang (2011).

[45] On rules against price discrimination see Biggar (2012). On the tendency of tariffs to depart from the Ramsey ideal see Morrison (1982, 1987). On the rejection of price-based rationing of airport capacity see Starkie (2005) and Forsyth and Niemeier (2008).

monopoly rents—which has at best only a weak or tenuous association with the size of the deadweight loss—and on minimising the rate of change of airport charges.[46] To repeat the key point, despite its widespread uncritical adoption in the economics literature, the hypothesis that airport regulation is primarily intended to address deadweight loss simply does not fit the facts.

4.3.1 Protecting Sunk-Specific Investment in the Air Transport Sector

Fortunately, the transaction cost approach set out in the previous section provides an alternative framework. This alternative perspective focuses on the need for airport customers—airlines, freight forwarders, and their downstream customers—to make material sunk investments in reliance on continuing access to airport services at reasonable terms and conditions. These might include investments:[47]

- By an airline in marketing services to or from a particular airport, or in customising or constructing a new terminal at a particular airport, or in customising the facilities at the airport itself (e.g. widening or lengthening the runway)
- In training staff where special procedures are required or in acquiring or customising aircraft where special restrictions apply (such as noise level limitations)
- By a hub airline in organising its flight schedules around a particular airport, or in obtaining take-off and landing slots, or in negotiating alliances and arrangements for the provision of connecting services with other airlines which service the airport
- In facilities located on or near a particular airport, such as a maintenance base or a parcel-sorting facility

The extent to which these sunk investments are exposed to the threat of hold-up depends on the market power of the relevant airport. Some airports face relatively good substitutes for at least part of their business. The presence of substitutes limits the extent to which these airports can expropriate the value of the sunk investments mentioned above.[48] If two airports at a destination are essentially equivalent in the minds of the travelling public, an airline can use the threat of switching airports to

[46] ICAO policies state that "increases in charges should be introduced on a gradual basis".

[47] See Biggar (2012), Fuhr and Beckers (2006).

[48] For example, passenger routes from Australia to Europe require at least one refuelling stop in Asia or the Middle East. Airlines such as Qantas face a range of choices for such stops. If these choices are essentially equivalent in the mind of the travelling public, Qantas can, in principle, protect any sunk investment it makes in, say, marketing these European routes by switching to another stopover airport. At the same time, the airports in the Middle East may attempt to differentiate themselves in the eyes of the travelling public so as to limit the ability of the airports to switch in this way.

protect itself from the threat of expropriating its sunk investment.[49] Indeed, if an airline represents a large share of the business of an airport and the airport is unlikely to be able to easily replace that business, it is the airline that holds the market power and the sunk investments of the airport which are at risk.[50]

On the other hand, it is widely recognised that some airports have substantial market power. This is particularly the case for airports without close substitutes located close to major economic centres and particularly for airlines that operate as a hub from these airports.[51] For these airports, there is both a need for material sunk investment by customers and, in the absence of some governance mechanism, a material risk of hold-up. Without some form of mechanism to protect against hold-up there is a risk that airlines and air travel customers will fail to invest in reliance on the airport, reducing the value from trade.

The analysis above suggests that there are two different types of governance mechanisms to address this problem: ownership mechanisms and contractual mechanisms. Examples of both types of mechanisms can easily be found in the airline industry.[52]

4.3.1.1 Ownership Solutions to the Airport Monopoly Problem

Let us start with ownership mechanisms. Following the structure set out above, we will look at vertical integration, joint ownership, and government ownership, in turn.[53]

Vertical integration between airlines and airports is, in principle, a solution to the hold-up problem facing airlines. Direct vertical integration between airports and

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[49] Some sunk investment may still be required. Contractual arrangements may still be necessary to protect those investments, but those contracts will typically be shorter (say, 1–5 years) than in the case where the airport faces no good substitutes.

[50] This option is discussed further below. Starkie (2012) reports the deputy CEO of a regional airport expressing exactly this concern and the need for contractual arrangements to solve it: “The airport needs an operational commitment from the airline as to the number of aircraft and time period it will commit to operate from that airport as a base, so that the airport can then derive some comfort from the costs it may then incur in paying for improvements to infrastructure and other facilities at the airport”.

[51] Although airlines can, in principle, choose to relocate their hubs, “the intensity of hub competition is limited by the high switching costs for airlines due to specialised investment and non-tradable slots”. Niemeier (2009).

[52] Niemeier (2009), page 5: “Today airports are ... a heterogeneous group with ownership structures ranging from state-owned to partial and even full privatisation, with regulatory systems ranging from cost regulation to price cap and even to complete deregulation”.

[53] Here we are looking at vertical integration with the airport as a whole. Event at airports with limited market power, airlines may enter into ownership arrangements for particular assets. For example, airlines often own and operate terminals or maintenance facilities at key airports. Lufthansa has an ownership stake in Frankfurt’s terminal 2.

airlines raises concerns for competition.[54] In Australia and Mexico, statutory rules prohibit vertical integration between an airport operator and air transport companies.[55] Nevertheless, there are a few examples of partial airline-airport vertical integration around the world. Lufthansa, for example, owns a 9.1% stake in Frankfurt airport.[56] Frankfurt is a key hub airport for Lufthansa, which carries the majority of the passenger traffic at this airport. Fuhr and Beckers (2006) explicitly link this investment to the protection of sunk investment in the absence of a strong, independent regulator:

> In comparison with sophisticated regulatory regimes, such as those in the UK, price regulation for Frankfurt Airport and its supporting regulatory institutes must be considered weak . . . . We argue that the conflict of interests of the federal state of Hessen in its dual role as regulator and owner, combined with the lack of well-developed regulatory institutions has strengthened Lufthansa's incentive to seek an equity stake. As its hub-and-spoke network is fully developed and site-specific investments are large, Lufthansa aims to protect its accrued quasi-rents . . . . In contrast to a purely administered contract by an outside regulator, Lufthansa gains access to inside information as well as special enforcement mechanisms through its seat on the supervisory board.[57]

It is also possible to find joint venture or joint ownership arrangements between airports and airlines. Such arrangements are particularly common in the "slot coordination" role in European airports. OECD (2001) reports that, for many European countries, the slot coordination role is a joint venture of major airlines (often including the civil aviation authority).

In the USA, where airports remain government owned, airlines have not been able vertically integrate with airports. Nevertheless, airlines have routinely provided debt guarantees which, indirectly have provided a degree of control over airport operations. Oum et al. (2006) observe that this, also, can be seen as a form of vertical integration:

> "because most major capacity expansion projects are financed through revenue bonds guaranteed by the major tenant airlines, these airlines have substantial power over airports' decisions on capacity investment, user charges, and other key strategic decisions". In effect

[54] Although such vertical integration is theoretically possible for airports with close substitutes, in the case of airports with material market power, vertical integration is usually discouraged. The reason is straightforward: vertical integration raises the threat that the integrated airport-airline will deny or degrade access to rival airlines, reducing competition in air services, extending the monopoly problem from the airport segment to the entire range of air services. The policymaker seeking to address the monopoly problem is faced with a choice: Regulation of the entire range of end-user air services or regulation or the prices of airport services. Rather than regulating the prices of an integrated airline-airport providing a range of air services (or regulating access to an airport owned by an integrated airline-airport), it is usually easier to require structural separation, to regulate the prices of the separated airport and to allow competition between airlines to dictate the prices and range of air services.

[55] See, for example, Serebrisky (2003).

[56] CAPA, "The airline-airport battle intensifies. Lufthansa-Fraport link unravelling?", 24 July 2009.

[57] Fuhr and Beckers (2006), page 399.

> these US airports have been indirectly privatised and vertically integrated by being placed under the control of their major airline tenants.[58]

Even where an airport is technically under separate ownership, contractual arrangements with an airline may place that airline in a position very similar to an owner. Oum and Fu (2009) describe how a "signatory airline" may become the residual claimant over the cash-flow stream of an airport and, in exchange, is provided a degree of control over key airport planning, investment and operation decisions. In other words, these contractual arrangements are, in effect, a substitute for vertical integration.

> Many governments now require airports to be financially independent. Since those airports are free from government subsidy, many have chosen to work with airlines. Carriers who sign a master use-and-lease agreement are awarded so-called signatory airline status. Those airlines become eventual guarantors of the airport's finance. In the case of 'residual' agreement, the signatory airlines pledge to cover the full cost of airport operations required for the airport to breakeven. The aeronautical service charges are determined by the 'residual cost' remained, after the revenues from non-signatory airlines and non-aviation sources have been deducted from the airport's total costs (debt service, interest, and operating expenses). In other cases, the main contribution from signatory airlines is service guarantee and usage commitment. This reduces uncertainty over future airport revenue, and thereby allows the airport to reduce financing costs when securing long term bank loans. In return, signatory airlines are given varying degrees of influence over airport planning and operations including slot allocation, terminal usage, capacity expansion projects, and exclusive or preferential facility usage.[59]

Perhaps the most common form of ownership solution to the hold-up problem is government ownership. Around the world, most airports remain government owned, often by local, city, or regional governments. The analysis above suggests that this prevalence of government ownership is not merely a historical accident, but, rather, a mechanism to provide an assurance to customers (airlines, aviation-related companies, and the travelling public) that their sunk investments will be protected through an assurance of a long-term stable path of cost-related prices, and the absence of undue discrimination.

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[58] Oum et al. (2006) cites a claim that "the US airports are among the most 'privatised' in the world, as US airports routinely turn to airlines for financial help in facility expansion and modernisation and in return offer long-term leases that often given airlines strategic control of airports through majority-in-interest (MII) arrangements". As emphasised later, vertical arrangements between airports and airlines does not eliminate the public policy concerns - as those arrangements can be used by incumbent airlines to restrict competition in the airline sector. Morrison and Winston (2008) argue that restrictions on the use of gates and the routes airlines can fly has restricted competition in favour of incumbent airlines.

[59] Oum and Fu (2009). There is more detail on airport-airline agreements in TRB (2010).

4.3.1.2 Contractual Solutions to the Airport Monopoly Problem

The theory set out above suggests that, where vertical integration is not feasible or desirable, we should expect to see long-term contractual arrangements between airports and airlines.[60] Oum and Fu (2009) emphasise that long-term contracts between airports and airlines are common.[61] Starkie (2012) cites evidence of long-term contracts between airports and airlines (especially low-cost carriers) of up to 20 years.

In addition, it is not hard to find examples of long-term concessions (public–private partnerships) for airports. For example, India has offered PPP concessions at four airports (Mumbai, Delhi, Bangalore and Hyderabad). A key question in all airport concessions is how tariffs for airport services will be adjusted over time. In the case of India, the government created a new institution (the Airports Economic Regulatory Authority) for the purpose of setting airport charges. In this respect, airport concessions in India are essentially indistinguishable from conventional monopoly price regulation.

In Germany, although there is a statutory cost-plus regulatory framework for airports administered by the states, several airports and airlines have in effect chosen to opt-out of this statutory framework. These airports instead operate under explicit contractual arrangements known as “framework agreements”. This practice, which started at Hamburg airport, subsequently spread to Frankfurt, Hannover and Düsseldorf. These agreements are typically relatively short-term (5 years) but with option for renewal.[62] Importantly, these arrangements include agreement to establish an oversight institution with the power to adjust the contracts as required, known (in the case of Hamburg airport) as the Price Cap Review Board. The Board includes representatives of airlines, airline associations, and the airport, and has significant responsibility—being in a position to change “virtually any of the price cap regulation contract paragraphs”.[63]

[60] As before, we will focus on long-term contractual arrangements for take-off and landing rights. Long-term contracts are common for the use of individual airport assets, especially when some customisation is required. See TRB (2011). For example, Qantas holds a 31-year lease, signed in 1987, over the northern end of the domestic terminal at Brisbane Airport. Sydney Morning Herald, “BNE: Qantas to sell Brisbane Airport for $112m”, 27 February 2014.

[61] “There are many cases where airlines and airports secure their co-operation via long-term contracts. In recent years the Low Cost Carriers (LCCs) have organised this type of long-term contract with airports. Many secondary airports offer LCCs favourable usage terms in order to attract their traffic. However, once an airline incurs sunk costs in establishing its services out of the airport, the airline loses bargaining power because of the high cost of switching to a new base. Therefore, many LCCs choose to sign up long-term contracts with airports in order to lock in the favourable terms”.

[62] The arrangement at Hamburg airport was renewed after the first term, but the experience at the other airports has been mixed. Where the agreements are not renewed the airports fall back into a statutory rate-of-return regulatory framework.

[63] Littlechild (2012), page 5.

As it turns out, consistent with the theory set out above, the Price Cap Review Board for Hamburg airport has been called upon to exercise its flexibility to address an unforeseen outcome:

> After the 9/11 incident in 2001 traffic fell sharply. The contract made no provision for reductions in traffic. If the subsequent traffic recover had been assessed as if it were normal growth, the sliding scale could have resulted in an unduly high value of X, thereby creating financial difficulties for the airport. In May 2002 the airlines agreed with the airport to suspend the sliding scale for the remainder of the contract.[64]

Finally, following the schema set out above, we can observe that some major airports are subject to conventional arms-length price regulation. As emphasised above, this form of regulation can be viewed as a form of long-term contract, with the regulator playing the role of the dispute resolution authority. Fuhr and Beckers (2006) emphasise that airport regulation is best viewed as a form of contractual governance mechanism, to protect and thereby promote the sunk investment of airlines. They also emphasise that conventional arms-length regulation (a contractual mechanism) is a substitute for vertical integration (an ownership mechanism) and that the better the quality of the dispute resolution mechanism the less the incentive of the airline to seek vertical integration:

> From an institutional point of view, airport price regulation represents a long-term contract between airports and airlines that is enforced by a third party—in our case, a government regulator. . . . Why is this? From the airline's perspective, regulation represents a safeguard against opportunistic pricing behaviour by the airport. . . . For the majority of airlines serving a hub airport, regulation represents a transaction cost minimizing governance structure. The local [hub-and-spoke carrier] . . . will be particularly vulnerable to hold-up by the airport, as it has accumulated large quasi-rents in the development of its hub-and-spoke schedule. . . . Through the acquisition of equity ownership in its hub airport, the [hub-and-spoke carrier] becomes an inside party, and establishes a complementary private safeguard to regulation. A regulator with a high reputation and strong institutional support for enforcing regulation will mitigate the [hub-and-spoke carrier's] incentive to seek equity ownership in its hub airport.[65]

4.3.2 Implications of the Transaction Cost Approach to Airport Regulation

The transaction cost approach to airport regulation goes some distance to explaining the range of airport regulatory and ownership arrangements we observe around the world. But, we can go further to explore the implications of this approach for other aspects of regulation.

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[64] Littlechild (2012), page 5. The recent pandemic represents another major shock to the air transport sector which will likely require similar exercise of discretion by regulators. See Forsyth et al. (2020).

[65] Fuhr and Beckers (2006).

For example, since the primary objective is the protection of the sunk investment by customers, this approach predicts that regulatory practice would eschew forms of price discrimination which threaten to charge higher prices to customers who have made more investment in reliance on the airport services. This is consistent with the observations above that airport regulators tend to eschew Ramsey pricing and tend to explicitly seek to limit the extent of price discrimination. Biggar (2012) observes:

> In fact, certain forms of price discrimination, such as Ramsey pricing, or perfect price discrimination require the airport to extract all of the value of the sunk investment of the airline and other downstream customers . . . . It is not surprising that these pricing schemes are treated by regulators with particular suspicion.

For the same reason, this approach suggests that airlines would favour certain forms of quantity-based rationing over price-based rationing of scarce airport capacity. Peak-load pricing tends to raise the price on those airlines which are unable to switch away from use of the airport at congested times—such as an airline which relies on a particular airport as a hub. In this case, the use of peak-load pricing threatens to expropriate some of the value of that airline's investment. In contrast, the rationing of scarce airport capacity through the allocation of take-off and landing slots, provided those slots are grandfathered to existing airlines, leaves the existing airlines no worse off than before. As a consequence, quantity-based rationing, combined with grandfathering, does not threaten the investment of incumbent airlines. In fact, around the world, we systematically observe slot-based rationing of scarce airport capacity rather than price-based rationing.

Biggar (2012) points out that rules regarding ring-fencing of aeronautical revenue can also be explained using this perspective:

> Similarly, the focus of airport regulators on ensuring airport charges reflect only relevant aeronautical costs and the existence of "non-diversion of revenue" rules can be explained as a commitment device: to provide an assurance to airport users that charges will not go up to fund irrelevant infrastructure, expansion into non-aeronautical services, or merely to increase the tax revenue of the airport owner.[66]

Overall, as Biggar (2012) concludes, it appears that the sunk investment approach goes some way to explaining the broad patterns of airport regulation we observe in practice.[67]

[66] Biggar (2012), page 378.

[67] Biggar (2012), page 378.

4.4 Comments and Discussion

4.4.1 The Public Interest Is Broader than the Interests of Airports and Airlines

The discussion above focused on the need for sunk investments by airlines. But the customers of airports include not just airlines but all other downstream consumers of air transport services (i.e. leisure travellers, business travellers and the companies that employ them, and freight services). These downstream customers also make sunk investments, which are potentially subject to the threat of hold-up. As a consequence, arrangements between airports and airlines alone do not alleviate all the public policy concerns. A contract that protects the sunk investments of an airline does not necessarily protect the sunk investments of other users of air transport services.

Airports tend to be the focus of an economic centre of activity (sometimes known as an 'aerotropolis') involving a wide range of industries and commerce which rely heavily on air transport services. These businesses also must make sunk investments—in their location, in their processes, staff training, and in the products and services they offer—many of which will be reliant on continuing access to air transport services. A long-term contract between the airport and an airline will not necessarily protect these users of air transport services. This arises because—depending on its position in the supply chain—a firm may care more about its charges *relative to its competitors* rather than the level of the charges.

For example, the sunk investments of an airline may be adequately protected by a clause which prevents the airport from charging less to any other airline (these are sometimes known as "most favoured nation" clauses). In contrast, downstream air transport customers (which compete in a broader market) may care about the absolute level of airport charges. In particular, downstream air transport customers may seek protection against increases in airport charges after they have made sunk investments (even if those increases are the same for all airlines).

In short, vertical arrangements between airports and airlines do not exhaust or eliminate the public policy concerns regarding the use of market power by airports. Further government action may be required—either through government ownership of the airport, or through the establishment of a regulatory framework (a form of long-term contract) to protect downstream users. Commercial arrangements (or vertical integration) between an airport and an airline may solve the sunk investment problem of the airline, but will not solve the sunk investment problem faced by downstream users of air transport services.

4.4.2 Airports and Airlines May Exercise Market Power in Other Ways

In the framework set out here, an airport is said to have market power if it is in a position to engage in hold-up of its trading partners. But an airport with market power may not only use this power to extract the value of the quasi-rents from specific investments upstream or downstream. In addition, an airport with market power might use its power to maintain or extend its position in the market. For example, if a rival airport was under consideration, the incumbent airport might refuse to deal with airlines which take some of their traffic to the new airport. In many countries, this would be a breach of competition law rules. Biggar and Heimler (2021) argue that the theory set out in this chapter also provides a sound economic foundation for competition law.

It is also possible that the market power is not located with the airport, but at the airline stage in the air transport supply chain. Some airports may have a dominant incumbent airline on which the airport is heavily reliant for generating traffic. Such an airline could, in principle, engage in hold-up of downstream air transport customers. In addition, such an airline could, in principle, use its power to insist on specific conditions which preserve its position—for example, by insisting on terms with the airport under which competing airlines are denied access or provided with degraded access to the airport. This might be achieved through arrangements which deny access to certain aircraft, certain routes, to slots, or to certain gates. Morrison and Winston (2008), for example, point to the practice of "exclusive-use gates" in the USA, as a potential barrier to entry:

> The prevalence of exclusive-use gates that are not made available to other carriers—a legacy of airline-airport contractual arrangements established during the 1950s and 1960s–makes it difficult for new entrants to provide service at several airports.. . . In principle, an airport has a legal obligation to provide reasonable access to the facility. Policymakers, however, have yet to define precisely what reasonable means. Hence, some incumbents are able to prevent competitors from having access even to gates that are little used.[68]

In short, control of hold-up by airports does not eliminate the potential for anti-competitive action by airports and airlines. Broader competition law rules may also need to be enforced.[69]

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[68] Morrison and Winston (2008), page 21.

[69] The transactions cost approach to competition law and competition policy is discussed in Biggar and Heimler (2021, 2022).

4.4.3 Why Do We Observe Arms-Length Regulation of a Government-Owned Facility?

The analysis above has emphasised that *either* government ownership *or* conventional arms-length regulation of a privately-owned facility are potential solutions to the monopoly problem. In practice we sometimes find—particular in the airport sector in Europe—that regulatory authorities often have responsibility over certain fully, or partially, government-owned monopoly facilities.[70] Is this inconsistent with the transaction cost theory?

In the case of a partially-privatized airport facility with minority government ownership the theory set out above still applies. In this case, the arms-length regulator plays the role of protecting the private owners against *both* the desire of the airport users for lower prices *and* the potential desire of government for lower prices (perhaps to stimulate economic activity).

In the case of majority government ownership, the theory set out above suggests that the need for arms-length regulation is diminished. However, in practice, we may still find that certain regulatory-like tasks are delegated to an independent body. To a certain extent, this is a puzzle that has not been adequately addressed in the regulation literature.

In our view there remain several possible reasons for arms-length regulation of a government-owned monopoly facility. These reasons include:

- First, even if the government operates the facility (in this case, the airport) in the interests of its own voters, there may remain other customers of, or suppliers to, the facility who do not vote for the government and who therefore remain subject to the threat of hold-up. For example, the government-owned airport could (in principle) raise the charges on foreign airlines who are reliant on the airport, or raise the rent to, say, suppliers of aviation fuel who have invested in assets at the airport. Protecting these other parties may require an independent regulatory authority.
- Second, an independent regulatory body can play a role in *depoliticising* the price-setting process. The government-as-owner may be susceptible to influence activities seeking to raise or lower the facility charges or to make, or not make certain major investments, or certain business decisions. The independent regulatory authority can assist the government to commit to making these decisions in a neutral and objective manner and to resist ad hoc intervention in the operation of the facility.
- Third, an independent body can provide a credible, expert oversight and monitoring role of the government-owned enterprise, assessing and benchmarking its cost efficiency, and providing independent advice to the government on the assessment of major new investment projects. These activities help improve the

[70] Gillen and Niemeier (2008).

efficiency and performance of the government-owned enterprise. This is not strictly a regulatory role but could be valuable nonetheless.

In short, although regulatory authorities will sometimes have a role to play in overseeing government-owned monopoly facilities, we do not see this as a contradiction to the theory set out above. In the case of a government-owned facility, the role of a regulatory authority could be quite different: to assist the government in its role as owner, to ensure efficiency in the performance of the facility, and to make pricing decisions in the public interest without political interference. This is in contrast to the role of the regulatory authority in the case of privately-owned facilities, where the role of the regulatory authority is to act as a neutral arbiter between the interests of the users and the interests of the facility owner. But, at the end of the day, the primary reason for the regulatory intervention (protection of sunk investments by trading partners) remains the same.

4.4.4 Why Do We Not See Independent Dispute Resolution in Practice?

The discussion above suggests that a public utility regulator plays the role of the dispute resolution/enforcement mechanism in any long-term contract. But why, then, do we not see more explicit reliance on independent dispute resolution in the airport sector?

But what does "independent dispute resolution" look like in practice, and how does it differ from what we might label "traditional regulation"? Traditional regulation is characterised by a permanent institution (the regulator) staffed with experts, with a mandate to pursue the public interest, and typically relatively cumbersome and drawn-out administrative proceedings. In contrast, independent dispute resolution might be said to involve ad hoc or as-needed creation of a temporary institution with greater flexibility over processes and timetables, and focused on the interests of the parties to the dispute.

In my view, as long as the dispute resolution mechanism pursues the broader public interest, these two arrangements are not fundamentally different, but merely differences on a continuum. In practice, it is possible to find examples of regulatory bodies whose behaviour is closer to what we might think of as traditional dispute resolution and some whose behaviour is more akin to administrative or bureaucratic processes—without any substantial difference in outcome.

Certainly, it is possible to find examples of regulatory institutions which are very much like dispute resolution. As noted earlier, in the case of the London Underground PPP contract, the regulatory authority was explicitly described as the PPP Arbiter. In Australia, once a facility is "declared" under Part IIIA of the Competition and Consumer Act, the access seeker has the right to seek arbitration by the federal regulatory authority (the Australian Competition and Consumer Commission). This process has been successfully applied to Sydney airport in the past.

Some authors have argued for greater reliance on dispute-resolution-like authorities in the case of airport regulation. For example, Littlechild (2012) argues for the adoption of dispute-resolution-like process for the regulation of airports in Germany:

> For light-handed regulation and monitoring policies, the main 'missing link' is a means of resolving disputes between airlines and airports that is less costly and time-consuming than civil law legal processes. ... If the role of the proposed independent supervisory body were to focus on dispute resolution rather than on implementing price regulation UK style, this would address the objection that actively implementing the EU Directive would require a large bureaucracy.[71]

In addition, whatever the formal role of the regulatory authority, many public utility regulatory frameworks explicitly allow or encourage the parties to negotiate during the regulatory determination process, against the backstop of the regulatory decision. This is neither more nor less than a dispute resolution process.

In any case, whatever the precise form of the regulatory authority, the primary contribution of the transaction cost approach is the assertion that the role of the regulatory authority is *best viewed* as the resolution of disputes in the administration of a long-term contract. In our view, this provides useful clarification as to how the authority should be structured and how it should organise its work.

The only remaining substantive differences concern whether or not the institution is permanent or created on an ad hoc basis and whether it pursues the broader public interest or the interests of the parties involved. In my view, in the light of the discussion above, the protection of hold-up in the supply chain may involve the consideration of interests broader than the narrow interests of parties to a dispute (i.e. broader than just an airport and an airline, say). The dispute resolution process must be able to take into account those broader interests. In my view, any remaining differences are largely immaterial.

4.4.5 Potential Reform of Airport Regulation

In closing, we can note here some of the key policy considerations to emerge from this approach.

The transaction cost approach to airport regulation emphasises the importance of paying attention to not just pricing issues, but *all aspects* of the design of the long-term regulatory contract (similar to, for example, the work of the World Bank on the design of PPPs[72]). In particular, the transactions cost approach to airport regulation highlights the need for policymakers to promote the following:

- Stability, consistency and clarity in the regulatory framework. Both the airport and its customers must make material long-lived sunk investments. These parties

[71] Littlechild (2012).

[72] See, for example, http://ppp.worldbank.org/public-private-partnership/ppp-overview/practical-tools/checklists-and-risk-matrices/airport-concession-checklist

need an assurance that their interests will be protected, even if the regulatory framework needs to be altered or adjusted in the future. Issues such as pricing during the transition to deregulation (where, for example, adequate inter-airport competition emerges) should be addressed at the outset.

- Expert, independent dispute resolution. The transaction cost approach highlights the parallels between the role of the regulator and the role of an independent arbiter in a long-term contract. Neither the airport nor its customers will be willing to make material long-lived sunk investments if they fear that their only recourse is to an institution which will systematically favour the other side. If necessary this role could be performed by an independent tribunal or the courts. However, many countries find that it is better to have this role performed by a permanent, independent institution capable of developing expertise in airport regulation. As the example of the London Underground Arbiter shows, this institution need not be created by legislative mandate and need not necessarily be answerable to government, but must follow the principles of natural justice and must ensure that the interests of all airport users (including the broader community) are taken into account.
- Incorporating all relevant parties in the regulatory process. Any adjustments or alterations to the regulatory contract should be negotiated, in the first instance, by the parties to that contract—the airport and its major airlines and downstream customers (in the knowledge that either side can appeal for a determination by the regulator). Experience in several countries around the world shows that direct negotiation between airports and airlines (against the backdrop of threat of appeal to a regulator) can result in agreements between airports and their customers, often with benefits to both parties. Regulatory oversight may be necessary to ensure that such agreements do not limit competition, and promote the interests of the broader community.[73]
- Ensuring that airports (or airport groups) provide the full range of services that customers desire. The rise of low-cost carriers (LCCs) in the last two decades has highlighted the latent demand for very low-cost air travel. It is important that airports provide services which allow airlines to meet the needs of this group of customers (which might involve providing a lower-quality no-frills experience) together with any other sub-groups of customers which might require different services in the future.
- Maintaining incentives in the regulatory contract. In any industry, intervention in the prices and revenues a firm can charge has fundamental implications for the incentives faced by that firm. In the case of airport regulation, the regulatory contract must maintain the incentives for both service quality and productive efficiency. Possibly approaches include an intermediate-powered incentive, such as a sliding-scale arrangement that shares demand risk between the airport and its customers, while retaining some incentives on both to maintain quality and promote services.

[73] See, for example, Littlechild (2008, 2012).

- Maintaining appropriate restrictions on price discrimination. Airport customers will be reluctant to make needed investments if, once a downstream service is successful, the airport is able to raise its charges to that specific service. Although price discrimination can be tolerated, its structure and extent should be agreed ex ante and variation restricted ex post. In particular, the flexibility of an airport to vary prices within a weighted-average price cap, unless accompanied by further limits on the rate of change, may pose a threat to needed investment and should be treated with care. Historically international agreements have limited such price discrimination. Such rules should be retained.
- Mechanisms for allocating scarce airport capacity. Scarce airport capacity should be rationed using market mechanisms and price signals. However, as long as incumbent airlines have made pre-existing sunk investments in reliance on their historic slot rights, these investments should be protected. This could be achieved by, for example, allocating slot rights to incumbent airlines and encouraging secondary trading in slots. This approach, however, effectively creates a coalition of incumbent airlines which stand to lose from an expansion of airport capacity. It is therefore important that this coalition not be able to restrict competition through, say, a veto over airport expansion decisions.
- Mechanisms for making investment decisions and allocating the costs of investment. Airports will periodically need to make large investment decisions (such as the addition of a runway) with different implications for different airport customers. Mechanisms are needed both to agree on particular investment decisions (what investment, what size, where, and when) and to allocate the costs amongst airport users in a manner related to the benefits. This will particularly be a problem where different airport users have different needs and different expectations about the benefit of a particular expansion. The regulatory contract should both prevent inefficient over-investment (failure to invest where there are socially beneficial outcomes); and inefficient under-investment.
- Mechanisms for the allocation of risk. Passenger and freight volumes vary from year to year. The regulatory framework should be able to handle major shocks to supply or demand (e.g. following 9/11). Broader changes in the economy can also have important impacts on the aviation industry. These risks must be recognised and allocated or shared in the regulatory contract between the airport and the different customers.

4.5 Conclusions

Airport regulation is a special case of the more general problem of price regulation of monopoly services. In order to understand how to reform monopoly price regulation we must understand the economic harm it is designed to address. Conventional textbook analysis tells us that the primary economic harm from monopoly is the deadweight loss, and the primary economic objective of price regulation is the reduction or elimination of that deadweight loss. But there is a problem: Regulators and policymakers do not, in fact, behave as though minimising deadweight loss is their primary concern.

In recent years an alternative approach has emerged. This approach focuses on the customer side of the market and the need for customers to make material sunk investments to extract the most value from the monopoly service. In the absence of some mechanism for protecting that investment, customers will be unwilling to make the investments required to make the best use of the monopoly service. Rather than the control of deadweight loss, it appears that the primary natural monopoly problem is the design of a governance mechanism to protect and promote the sunk investment of customers. The range of public policy responses to natural monopoly which we observe can be explained as different choices of ownership and contractual mechanisms to protect and promote the sunk investments of customers. In particular, this approach asserts that conventional public utility regulation is best viewed as a form of administered long-term contract, with the regulator playing the role of the dispute resolution and enforcement mechanism.

This problem arises as much in the field of airport regulation as elsewhere in the field of natural monopoly regulation. As Biggar (2012) observes, airport regulators do not behave as though the minimisation of deadweight loss is their primary concern. Some of the key policy recommendations by economists for the reform of airport regulation are systematically ignored. Could this be because those economists are addressing the wrong problem? Rather than seeking to address the harm known as deadweight loss, the transaction cost approach to airport regulation suggests that policymakers should be focusing on protecting and thereby promoting the sunk investment of airport customers—airlines, aviation-related businesses and the broader travelling public. This approach offers promise both as a positive theory—as a grounds for explaining the range of public policy towards airports which we observe around the world; and as a normative theory—as the basis for a further set of reforms for airport regulation going forward.

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Chapter 5
Cost-Based Versus Incentive Regulation for Airports

Eric Pels

Abstract This chapter contributes to the discussion on the most suitable form of airport regulation by focusing on the impact of airline behavior and the international focus of airports on the choice of regulatory scheme. Different objectives are discussed (welfare maximization, rent control, or efficient production), and the chapter touches upon the question of high- or low-powered regulation as the most suitable method to achieve said objectives.

Low-powered airport regulation potentially leaves the rents to airlines, and not necessarily the final consumers. High-powered regulation leaves the rents with the local airport rather than with the international airlines, which may be politically convenient. If airlines are active in competitive markets, low-powered regulation leaves rents to passengers, and if the majority of these passengers is foreign, this scheme may also not be politically feasible.

Keywords Rate-of return regulation · Price-cap regulation · Incentive regulation · Double marginalization · Policy competition

5.1 Introduction

Incentive regulation was developed due to the problems with traditional rate-of-return regulation. Since rate-of-return regulation, while useful to control rents, does not give firms the necessary incentive for cost efficiency, alternative forms of regulation were necessary. Price cap regulation leads to the possibility that quality is too low or firms receive monopoly rents. An "ideal form of regulation" gives the firm the proper incentive to minimize costs, while it also controls rents. Under sliding scale regulation the price the firm may charge is partly fixed and partly dependent on costs, allowing the regulator to offer high-powered schemes (focused

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mostly on prices, giving the firm the proper incentive to be cost-efficient) or low-powered (focused on mostly on costs, allowing firms to recover costs and so limiting the rents).

Both high- and low-powered schemes have been applied to airports, although most airports reviewed by Adler et al. (2015) seem to be regulated by some form of medium to high-powered regulation. High-powered price cap regulation of airports in the UK is frequently discussed in the literature. Hamburg, Frankfurt, and Brussels are examples of airports with a form of low-powered regulation.

While there is an abundance of literature on incentive regulation, and the literature on airport regulation has a strong emphasis on choosing the right form of regulation to achieve production and allocative efficiency, the current paper puts forward that the choice for low or high-powered regulation may also depend on market characteristics and the focus of the regulator.

The objective of this paper is to bring to light two issues with incentive regulation of airports. Firstly, the main beneficiary of airport regulation may be the airlines. If airlines have market power, low-powered airport regulation reduces the airport's ability to gain rents, but leaves the rents to airlines and not necessarily the final consumers. Secondly, airports serve airlines and passengers from various origins, while the regulator more than often is a local actor. High-powered regulation leaves the rents with the local airport rather than with the international airlines, which may be politically convenient. But if the airlines are active in competitive markets, low-powered regulation leaves rents to passengers, and if the majority of these passengers are foreign, this scheme may also not be politically feasible.

The paper is organized as follows. Sections 5.1–5.3 summarize some relevant points from the literature. The literature on regulation is very rich, and excellent papers on this topic exist; see e.g. Joskow (2014). In Sects. 5.2 and 5.3 we repeat some of the main arguments for why (not) to choose a specific type of regulation. In Sect. 5.4 we make our main contribution on airport regulation, highlighting the potential problems of applying "standard" methods of regulation to airports. Section 5.5 concludes.

5.2 ROR-Regulation

We define the rate of return as:

$$\text{ROR} = \frac{p \cdot Q - w \cdot L - r \cdot K}{p_k \cdot K} \tag{5.1}$$

where $p{\cdot}Q$ are revenues, $w{\cdot}L$ are expenditures on labor and $r{\cdot}K$ are expenditures on capital. p_k is the original purchase price of capital, so the ROR gives the profit divided by the initial investment. The firm in question has market power; otherwise, regulation would not be considered, and therefore the numerator (and the ROR) is nonnegative. If we assume the firm earns a monopoly profit, the ROR is positive. In the (hypothetical) fully competitive outcome, profits would be 0, so that the numerator and the ROR also would be 0. But in practice, a ROR of 0 is unlikely. For instance, in the presence of fixed costs, this would lead to financial losses. Therefore, the regulator can allow some positive ROR so that fixed costs can be recovered. Since revenues are closely related to costs, the possibilities for the firm to obtain rents are limited.

The difficulty with this type of regulation is that this may lead to what is known as the "Averch–Johnson effect." In the case that actual ROR exceeds the required ROR, the regulator requires the firm to lower its ROR. Even though the regulator's objective may be that the profit—the numerator—is lowered, intuitively the firm can respond by increasing K so that the numerator is decreased and the denominator increased: the ROR is decreased. In fact, the firm might even increase its consumer price if the increase in K is large enough. In short, the regulated firm has an incentive to increase capital relative to labor and therefore produce inefficiently to maximize profits. This is the Averch–Johnson effect and is also known as "Gold plating" because, compared to the unrestricted case, unnecessary investments are made.

5.2.1 Technical Illustration of the Averch–Johnson Effect

Readers not interested in the technical details can skip this section without missing the main point of the paper.

To see the theoretical logic behind the firm's actions, we follow Carlton and Perloff (2005) and consider the regulated firm's objective function:[1]

$$\max_{L,K} \pi = R - w \cdot L - r \cdot K \tag{5.2}$$

Subject to

$$\frac{R - w \cdot L - r \cdot K}{p_k \cdot K} \leq v \tag{5.3}$$

where $R = p(Q(L, K)) \cdot Q(L, K)$ denotes revenues and v is the required ROR, with $v \geq r$. If we standardize p_k to 1 to reduce notation we can rewrite the restriction as follows:

[1] In this paper we treat the profit-maximizing firm as the decision-maker. See, e.g., Joskow (2014) for a discussion of managerial rent seeking behavior under regulation. The result of managerial rent seeking behavior is inefficient production, which is also the outcome of the illustration in this subsection.

$$R \leq w \cdot L + (v + r) \cdot K \tag{5.4}$$

Therefore, the firm's maximization problem is:

$$\max_{L,K} \Lambda = R - w \cdot L - r \cdot K - \lambda \cdot (R - (v + r) \cdot K + w \cdot L) \tag{5.5}$$

The optimality conditions are:

$$\frac{\partial \Lambda}{\partial L} = \frac{\partial R}{\partial L} - w = 0 \tag{5.6}$$

$$\frac{\partial \Lambda}{\partial K} = \frac{\partial R}{\partial K} - r + \frac{\lambda}{(1 - \lambda)} \cdot v = 0 \tag{5.7}$$

$$R - w \cdot L - (v + r) \cdot K = 0 \tag{5.8}$$

$$\lambda > 0 \tag{5.9}$$

Equation (5.6) says that the value of marginal revenue product of labor, ∂R/∂L, equals the (marginal) cost of labor,*w*, which makes sense for a profit-maximizing company. Equation (5.7) says that the value of the marginal revenue product of capital, *r*, equals the price of capital plus adjustment factor. For the restricted firm, the ratio of the value of marginal revenue product of labor to the value of the marginal revenue product of capital equals the ratio of the price of labor to the price of capital minus an adjustment factor: $MP_L/MP_K = w/[r - v \cdot \lambda/(1 - \lambda)$. In case the constraint is not binding, $\lambda = 0$ and $MP_L/MP_K = w/r$.

The implication of the introduction of *v* is that the profit-maximizing firm sees *v* as an adjustment to its cost of capital: the cost of capital is reduced relative to the cost of labor, and quantities of capital and labor are adjusted accordingly, following the optimality conditions. Intuitively, since $\lambda > 0$ and $\lambda \neq 1$,[2] the introduction of a regulated *ROR v* reduces the slope of the iso-cost curve. The new iso-cost curve is tangent with the isoquant at a different point, with a lower amount of capital and a higher amount of labor. To show the firm really has an incentive to increase capital relative to labor, we follow Takayama (1969) by taking the first order derivative of (5.8) with respect to *v*:

$$\left[\frac{\partial R}{\partial K} - (v + r)\right] \cdot \frac{\partial K}{\partial v} + \left[\frac{\partial R}{\partial L} - w\right] \cdot \frac{\partial L}{\partial v} = K \tag{5.10}$$

Equation (5.6) implies the second term on the left-hand side is 0, so that

[2] This can be seen by rewriting (5.7) as $\left(\frac{\partial R}{\partial K} - r\right)(1 - \lambda) + \lambda \cdot v = 0$. $\lambda = 1$ would imply $v = 0$, which, we argued above, is not feasible.

$$\frac{\partial K}{\partial v} = \frac{K}{\frac{\partial R}{\partial K} - (v + r)} \tag{5.11}$$

If we evaluate expression (5.11) at the unconstrained optimum, where $\partial R/\partial K = r$ and $K = K^0$, then $\partial R/\partial K = K^0/(-v)$, which is always negative: the introduction of v causes the firm to lower its capital.

5.2.2 Rate-of-Return Regulation Gives Improper Incentive

Thus the conclusion is that when the regulator introduces v, it only changes the relative price of capital, and the firm adjusts its inputs accordingly. The firm still maximizes profits, given the regulator's action. The outcome is that the firm operates inefficiently, compared to the case where the regulator imposes no ROR, or where the constraint is not binding. But the inefficiency is the result of the profit-maximizing behavior of the firm and the fact that this form of regulation does not give the firm an incentive to change this behavior.

5.3 Incentive Regulation

As discussed in Sect. 5.2, cost-based or rate-of-return regulation does not give a firm a proper incentive for efficiency. Alternative forms of regulation were developed, and these will be discussed in this section.

5.3.1 Price Cap Regulation

Price cap regulation was developed to control prices rather than profits (Cowan 2002), giving the firm the incentive to minimize costs. Under price cap regulation, prices are allowed to increase by the consumer price index, minus expected efficiency savings x. Factor x ensures real prices fall over time (Cowan 2002), and reflects the idea that over time the firm or its managers must continue to look for cost-minimizing solutions. Since this form of regulation only regulates the price level and not the structure, a multiproduct firm, or a firm, such as an airport, offering capacity throughout the day, can still select the profit-maximizing structure (Niemeier 2002; Niemeier and Forsyth 2008). For instance, in the case of an airport, it can still exploit differences in willingness-to-pay throughout the day by selecting an appropriate pricing structure. The only constraint is that prices cannot increase by more than the consumer price index, minus expected efficiency savings x. A busy airport might want to set higher prices during the peak, but the CPI and x put a limit on the possibility of “true” peak load pricing. Price cap regulation may suffer from two problems (Joskow 2014). Firstly, if the regulator sets a relatively high price cap to allow the firm to recover costs, it potentially leaves room for the firm to extract rents at the expense of consumers. The reason for this is the regulator’s uncertainty about the firm’s actual costs. Secondly, the firm may reduce quality to save costs, also at the expense of consumers.

5.3.1.1 Cost-Minimizing Behavior and Rents

Readers not interested in the technical details can skip this subsection without missing the main point of the paper.

To illustrate the first problem with price cap regulation mentioned above, let the firm choose capital and labor to maximize profits: [3]

$$\max_{L,K} \pi = p^* \cdot Q(L, K) - w \cdot L - r \cdot K \tag{5.12}$$

The first-order conditions for profit maximization are:

$$\frac{\partial \pi}{\partial L} = p^* \cdot \frac{Q(L, K)}{\partial L} - w = 0 \tag{5.13}$$

$$\frac{\partial \pi}{\partial K} = p^* \cdot \frac{Q(L, K)}{\partial L} - r = 0 \tag{5.14}$$

From Eqs. (5.13) and (5.14) it is clear that profit maximization implies that $MP_L/MP_K = w/r$, as we would expect for a cost-minimizing firm with fixed price p^*. Productive efficiency is reached, but since $p*$ is given and most likely above marginal cost for a firm operating under scale economies, as we would expect for the majority of airports, the firm is still able to extract rents at the expense of consumers. Furthermore, the firm may postpone investments, and thus reduce quality, to save costs, at the expense of consumers, or, if capital and labor are heterogeneous, choose low-quality options to reduce costs, again at the expense of consumers.

5.3.2 Other Forms of Regulation

Since rate-of-return regulation leads to costs that are too high, although monopoly rents are controlled, and price cap regulation leads to the possibility that quality that

[3] This is the most basic formulation and ignores pricing dynamics, e.g., the possibility of peak load pricing. The point of this subsection is to point out the cost-minimizing behavior that results from this form of regulation.

is too low or firms receiving monopoly rents, more advanced forms of incentive regulations were developed. A further complication is the information asymmetry concerning costs and the opportunity to reduce costs: firms have better knowledge of costs and opportunities than the regulator.

Under sliding scale regulation the price the firm may charge is partly fixed and partly dependent on costs. Following Joskow (2014), we write the firm's revenues as

$$R = a + (1 - b) \cdot C \tag{5.14}$$

where R is revenues (the firm is allowed to generate under regulation) and C is the firm's real cost. Under rate-of-return regulation, a and b are 0, while under price-cap regulation a is the regulator's expectation of the efficient cost, C*,[4] and $b = 1$. Under sliding scale regulation, the regulator chooses a and b, and chooses for high-powered regulation when a is close C* and b is close to 1. This regulation scheme fits firms with good opportunities to operate at relatively low-cost levels. Any effort to reduce costs goes to the firm, at the expense of potential rents obtained by the firm. Low-powered regulation means a and b are closer to 0. Such a scheme is suitable when the regulator is uncertain about the firm's opportunities to operate at relatively low-cost levels. Revenues cover (most of) the costs, so that the firm will continue to operate, and the rent is controlled. Laffont and Tirole (1986) show it is optimal for the regulator to offer different schemes (combinations of a and b) to the firm, so that the firm will choose how to be regulated, based on its opportunities to achieve a low C*.

In order to determine a regulatory scheme, with different options as described above, the regulator needs an objective function. Joskow (2014) mentions that the bulk of the literature uses welfare maximization as the regulator's objective to maximize welfare (and minimize the rent transfer from consumers to producers), under a participation constraint that allows the firm to remain in business. In Sect. 5.4 we discuss such an objective in an airport setting.

5.4 Airport Regulation

Adler et al. (2015) discuss incentive regulation of airports. High-powered price cap regulation, or variants thereof, were used in Australia and the UK. Price cap regulation was abolished in Australia in 2002. Up until 2002, price cap regulation in the UK had a relatively high x-factor to ensure efficiency gains. After 2002, the emphasis turned to investments, and the x-factor was reduced in order to allow for investments. Many airports were subject to some form of low-powered regulation,

[4] Joskow (2014) discusses firms of high cost type and low cost type and information asymmetry between the firm and regulator. We not discuss this in any detail here and will focus later on another issue relevant for airport: the objective function necessary to choose a and b.

albeit with different success levels. Adler et al. (2015) conclude that, given the limitations of the study, a move to incentive regulation increases productive efficiency.

5.4.1 Double Marginalization

The regulator's objective mentioned in Sect. 5.3.2 (implicitly) assumes the firm supplies the final consumer. In the airport case, the airport supplies both the airline and the consumer. And in turn, the airline supplies the consumer. Airports "supply" passengers with the necessary infrastructure for accessibility: passengers can interact with airlines, drop off or pick up luggage, and board or disembark planes. For this accessibility, passengers pay an airport tax, usually via the airline. The airport supplies the airline with access to runways and ramps, access to passengers etc., and the airline pays in return an airport charge. To summarize: the airport and airline both serve the passenger. And the airport also serves the airline, but based on passenger demand: without passenger demand airlines have no demand for airport capacity.

If, for simplicity, we ignore the direct relation between airports and passengers and focus only on airlines, we can argue the issue of double marginalization[5] is relevant when airlines have market power.[6] In this case, airlines maximize profits by setting the marginal revenues equal to marginal costs: additional passengers are accepted as long as the additional profit they bring in is nonnegative. If we assume the airline's marginal cost is the airport charge per passenger (Niemeier 2021),[7] then the airline's optimality condition is that the airport charge equals the marginal revenue. If the airport prices are at marginal cost c, then airline marginal revenues equal c, as depicted in Fig. 5.1, where Q is the number of passengers. This leads to a number of passengers Q^* and a fare f^*.

However, if the airport does not set its price at marginal cost but maximizes profits, the airport uses the airline's marginal revenue function as its inverse demand function for capacity. To see this, pick any value of c for which the airline's marginal revenues are nonnegative, and at this value of c there is a corresponding level of Q at which c equals the airline's marginal revenues. At this level of Q airline profits are maximized, and there is a specific demand for airport capacity to accommodate Q. So for any airport charge c and Q that meet the requirement that marginal costs (c) are equal to marginal revenues, airline profits are maximized and demand for airport capacity necessary to accommodate Q is determined. The airport can thus select an

[5] See, e.g., Zhang and Zhang (2006).

[6] We do not need to make the assumption that airports and passengers do not interact directly, but the assumption makes the discussion a bit simpler. The intuition behind the result does not change.

[7] Of course this a major simplification. We could proceed without this assumption. That would not change the intuition, but would only complicate notation.

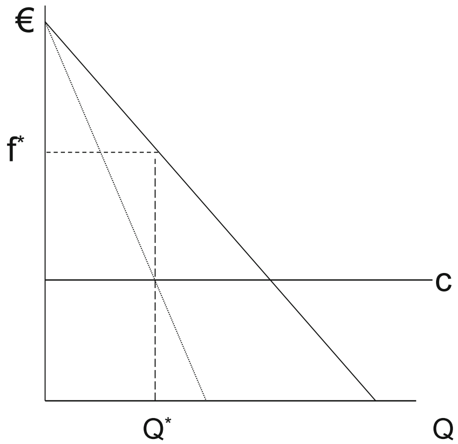

Fig. 5.1 Standard monopoly case

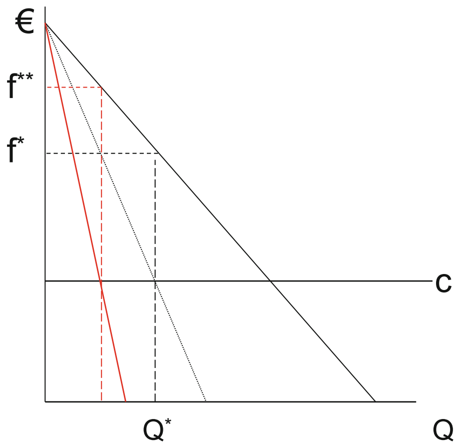

Fig. 5.2 Double marginalization

airport charge and Q^{**} that maximizes its own profits. This is achieved by setting marginal revenues equal to marginal costs for the airport. The airport's marginal revenues are determined from the airline's inverse demand function for capacity, and since the airline's inverse demand function for capacity is the same as the airline's marginal revenues, we have double marginalization. This is depicted in Fig. 5.2. The thick red line is the airport's marginal revenue curve, and airport profits are maximized where marginal revenues equal c. This is at output Q^{**}. The airline pays f^* to the airport for infrastructure use and gets the proper incentive to offer Q^{**}, and the passenger pays f^{**} to the airline.

The point of this discussion is that low-powered airport regulation reduces the airport's ability to gain rents, but leaves the rents to airlines and not necessarily the final consumers. Output may increase to Q^* if airlines have market power and the airport operates at the lowest cost, which is not necessarily the case with low-powered regulation. But also at Q^* there are significant rents, that likely accrue to the airline. High-powered regulation, on the other hand, will result in an efficient airport but leaves rents to the airport.

The relevant policy questions, therefore, concern the potential airline market power, and, related to that, the incentives airlines have to pass rents onto the final consumers through lower fares. To what extent do airlines have market power? Some of the older literature (Brander and Zhang 1990; Oum et al. 1993) finds that airline markets may be characterized by Cournot competition, so that airlines have some market power.[8] More recent literature (Fageda 2006), for Spanish markets, Perloff et al. (2007), and Nazarenus (2011) repeating the study of Brander and Zhang (1990) using data for 2007) indicate airline markets moved toward Bertrand competition, with prices closer to marginal costs and no market power. The reason for the shift from Cournot to Bertrand is the deregulation and the emergence of low-cost carriers. If we follow the more recent studies and assume airline markets can be characterized by Bertrand competition,[9] low-powered regulation seems preferable as most rents accrue to the final passengers. Hamburg, Frankfurt, and Brussels are examples of airports with a form of low-powered regulation. For example, Frankfurt is a hub for Lufthansa and is used as a transfer point in many indirect, competitive, markets. But in the local markets in which no low-cost carrier is active, competition may still be limited; see, e.g., Zhang (1996). Hamburg and Brussels are served more by point-to-point carriers and low-cost airlines.

But it is not straightforward that all markets can be characterized by Bertrand competition. Thick markets attract different airlines, but relatively thin markets will be served by only as limited number of airlines. If low-cost carriers are not present in a market, competition may still be limited. In such a case, high-powered regulation to achieve cost efficiency and potentially leaves some rents with local airports could be considered. This option is further explored in the next section.

5.4.2 Policy Competition

Joskow (2014) mentions that the bulk of the regulation literature uses welfare maximization as the regulator's objective. In airport and airline markets we typically see airports serving international airlines and passengers. Some airports may be owned by (local) governments or local private shareholders, while international shareholders may own other airports. The regulator's objective, therefore, is not straightforward. If welfare maximization is assumed, then in an ideal world all regulators (or a single regulator) maximize welfare for all final passengers,

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[8] Note that prior to the deregulation of the aviation markets, market contestability was used as an argument in favor of deregulation. After the aviation markets in the USA were deregulated, it was found, however, that the number of competitors had decreased in a lot of markets.

[9] Note that in this case pricing behavior alone does not guarantee a competitive output. Airlines first announce their schedule, so that the number seats and therefore potential output is, to a large extent, fixed. This may still imply Cournot behavior. See, e.g., Kreps and Scheinkman (1983).

irrespective of their place of residence. But from the literature on policy competition (see e.g. De Borger and Proost 2012) we know that (local) governments may show strategic behavior. In the case of airport regulation, regulators can make a distinction between local and other passengers or airlines. In specifying the welfare function, different weights may be given to local and other airlines or passengers.

Consider a local airport served by only a limited number of airlines. In such a case the airlines may have market power, as discussed in the previous subsection. Low-powered regulation likely leaves rents to the airlines. If these are foreign airlines serving local passengers (e.g., a foreign low-cost airline serving a local or international market), such a scheme may be politically unfeasible, even though it may maximize (global) welfare. In such a case, high-powered regulation leaves the rents with the local airport rather than with the international airlines, which may be politically more acceptable if the local government and/or local investors own the airport. On the other hand, low-powered regulation of an airport serving many competitive airlines leaves rents to passengers, and if the majority of these passengers are foreign (e.g., tourists), this scheme may also not be politically feasible. High-powered regulation of, e.g., London Heathrow may therefore be suitable from this perspective. If the regulator is required to maximize local welfare, the form of regulation (high or low-powered), and/or the specification of the welfare function to determine a and b in Eq. (5.14) is, therefore, crucial.

5.4.3 Slot-Controlled Airports

The busiest airports in Europe are slot controlled; see, e.g., Sheng et al. (2019) for an analysis of airline behavior at slot-controlled airports. Scarcity rents are present when the number of available slots is below the necessary number of slots at market clearing prices. Dray (2020) finds that capacity expansion at slot-controlled airports usually leads to additional destinations being added, rather than capacity expansion on existing destinations. This means it is likely that scarcity rents in existing markets, if these exist, remain after airport capacity is expanded. In a perfectly competitive market, these rents accrue to the final passengers. In a different situation, in which airlines operate in a competitive environment, low-powered regulation, such as in Frankfurt, leaves most of the (scarcity) rents with the airlines. If a home carrier dominates the airport, this might be a desirable outcome. But if a regulator called for an airline to give up slots to the benefit of (international) competitors (e.g., British Airways and partners at London Heathrow), high-powered regulation leaves rents with the airports instead of international airlines and passengers. Depending on the (local) objective, this may be desirable for the local regulator.

5.5 Conclusion

Rate-of-return regulation leads to costs that are too high, although monopoly rents are controlled, and price cap regulation leads to the possibility that quality that is too low or firms receiving monopoly rents. Because of these shortcomings, more advanced forms of incentive regulations were developed. This is well known from the literature, and this paper repeated the most basic arguments. Incentive regulation, such as sliding scale regulation, was developed to counter these problems, and the literature on incentive regulation is well developed.

The purpose of the current paper is to contribute to the discussion on the most suitable form of airport regulation. Other than focusing on cost efficiency (see, e.g., Adler et al. 2015), the current paper focuses on the impact of airline behavior and the international focus of airports on the choice of regulatory scheme. The paper tries to achieve this by starting up a discussion: what is the objective of the regulator (welfare maximization, rent control, or efficient production), and is high or low-powered regulation the most suitable method to achieve this objective?

The main results of the paper are as follows. Low-powered airport regulation reduces the airport's ability to gain rents, but potentially leaves the rents to airlines, and not necessarily the final consumers. This happens when airlines have market power. Secondly, high-powered regulation leaves the rents with the local airport rather than with the international airlines, which may be politically convenient. Furthermore, if the airlines are active in competitive markets, low-powered regulation leaves rents to passengers, and if the majority of these passengers is foreign, this scheme may also not be politically feasible. Seen from this perspective, high-powered regulation of, e.g., London Heathrow may therefore be suitable, while low-powered regulation of, e.g., Frankfurt may be less suitable. The key issues here are potential airline market power and the objective of the local regulator. While the results discussed above are qualitative and to some extent speculative, these results point out that detailed insight into competition levels and the objective of regulators in relation to policy competition is necessary.

The research agenda that follows from this paper is as follows. Firstly, for some of the arguments, the paper assumes Bertrand competition in airline markets. Although this is in line with some of the more recent applied literature, the fact that airlines announce schedules in advance may still imply Cournot outcomes, even though prices may be low. Furthermore, markets are diverse, and not all markets are served by low-cost airlines and/or multiple airlines. Further research is necessary to support or refute the qualitative findings in this paper. Secondly, this paper provides a qualitative discussion of the potential effects of policy competition. More fundamental analysis is necessary.

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Chapter 6
Airport Privatization and Regulation: Effects on Airport Charge, Capacity, and Social Welfare

Yukihiro Kidokoro and Anming Zhang

Abstract This paper examines airport privatization and various forms of airport regulation, taking into account of behavior of public administration and non-aeronautical service of an airport. First, we find that the regulator may set the price of non-aeronautical service lower than its marginal cost in order to counteract a high airport charge, if it can regulate non-aeronautical service. Second, price-cap regulation on aeronautical service could reduce airport charge, but also introduce an underinvestment in airport capacity that could lower social welfare. Whether price-cap or cost-based regulation is superior depends on the relative importance of the underinvestment effect under price-cap regulation, versus a regulatory waste associated with cost-based regulation.

Keywords Airport privatization · Price-cap regulation · Cost-based regulation · Aeronautical service · Non-aeronautical service · Regulator behavior · Capacity investment · Single-till regulation · Dual-till regulation · Social welfare · Public Airport · Market distortion · Regulatory waste · Airline competition · Competition among non-aeronautical service providers

6.1 Introduction

The issues of airport privatization and regulation have experienced increased attention by scholars, owing in large part to policy reforms in the airport sector.[1] Starting with the privatization of major airports in the United Kingdom in 1987, more and

[1] See, e.g., Morrison and Winston (2000), Starkie (2002), Winston and de Rus (2008), Basso (2008), Niemeier (2009), Assaf and Gillen (2012), Bilotkach et al. (2012), Adler et al. (2015), Valdes and

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more airports have been privatized around the world. For instance, Australia privatized its major airports in 1997, and Mexico began its airport privatization in the late 1990s.[2] Due to the local monopoly nature of airports (e.g., Gillen et al. 1987, 1989; Forsyth 2004b), airport charges are usually subject to economic regulation, and the privatization may make regulation increasingly necessary. Such regulation has focused on "aeronautical service" (activities associated primarily with runways, aircraft parking, and terminals) which is considered as an airport's "core business" (e.g., Morrison 1987; Forsyth 2002; Currier 2008; Gillen 2011; Adler et al. 2015; Czerny and Zhang 2015b; Czerny et al. 2016a). The two dominant forms of regulation are cost-based regulation and price-cap regulation, whereas the light-handed regulation (LHR) has also been implemented in Australia, New Zealand, and Switzerland as well as at many small/medium-sized airports throughout the UK and some airports in Eastern Europe (Forsyth 2004b, 2008; Gillen 2011). For example, since 2002, Australia's regulatory framework has shifted to a LHR at its top four airports, under which their charges are only subject to approval and/or monitoring by the regulator.

In this paper, we examine airport privatization and various forms of airport regulation at a congestible airport. Our investigation has two main modeling features. First, we explicitly consider a cost-efficiency difference between the "welfare maximization" benchmark and a "public airport" that is owned and managed as a government entity. Most of the studies in the literature (e.g., Zhang and Zhang 2003; Basso 2008; Mantin 2012; Czerny 2013; Noruzoliaee et al. 2015) considered only a public airport that maximizes social welfare, thereby making no assessments about the effect of privatization on airport cost efficiency. However, actual behavior of a public airport may not correspond to the welfare-maximization benchmark, because it typically has higher costs than a private airport. For example, the empirical results of Parker (1999), Oum et al. (2008), and Adler and Liebert (2014) reveal that a fully private airport operates more cost efficiently than a public airport. We will show that the higher costs of public airports cause various distortions and thus affect the assessments of the extent of privatization and regulation.

Second (and more importantly), our analysis explicitly models "non-aeronautical service" as an imperfectly competitive market. The non-aeronautical service refers to such activities as airport retailing, advertising, car rentals, car parking, and land rentals. A typical assumption in the literature is that non-aeronautical service yields a (positive) profit, which is consistent with the fact that major airports do earn large profits from non-aeronautical service. However, the market structure of

Sour (2017), Lohmann and Trischler (2017), and Engel et al. (2018). Recent literature reviews include Zhang and Czerny (2012) and Czerny et al. (2016a).

[2] Airport privatization also took place in New Zealand, Europe, Asia, South America, and Africa (Forsyth 2002; Hooper 2002; Oum et al. 2004, 2008; Winston and de Rus 2008). The authorities in the United States were contemplating the privatization of some airports (e.g., Chicago Midway airport) and are now planning to privatize air traffic control (ATC) service. In Canada, airports have devolved from direct Federal control to become autonomous entities, and major airports are now managed by private not-for-profit corporations.

non-aeronautical service has not been modeled explicitly. Furthermore, while the non-aeronautical service becomes increasingly important, the existing studies typically focus only on the aeronautical sector, or treat non-aeronautical service in an exogenous fashion.[3] In comparison, our model incorporates consumers, airlines, and an airport that has both the aeronautical and non-aeronautical services in a single analytical framework, with non-aeronautical service being treated endogenously. Although we assume that the aeronautical and non-aeronautical services are complementary to each other, the degree of complementarity is arbitrary. An advantage of our setup is that we are able to treat the regulation on the aeronautical service and the regulation on the non-aeronautical service independently: for instance, the aeronautical service can be operated under cost-based or price-cap regulation while the non-aeronautical service under price-cap regulation or no regulation.

With these two modeling features, we examine the effects of airport privatization and compare three regulatory forms, namely, price-cap regulation, cost-based regulation, and no regulation.[4] First, we find that the regulator could possibly set the price of non-aeronautical service lower than its marginal cost to counteract a high airport charge, if it can regulate non-aeronautical service. Second, while privatization with price-cap regulation on aeronautical service reduces the airport charge, it can also introduce underinvestment in airport capacity and thus increase airport congestion. Whether price-cap or cost-based regulation is superior depends on the relative importance of the "underinvestment effect" under price-cap regulation, versus a "regulatory waste" associated with cost-based regulation. At a congested (non-congested, respectively) airport, cost-based regulation (price-cap regulation, respectively) is better, because the underinvestment effect is a more (less,

[3] Since historically non-aeronautical service (often referred to as "concessions") had been small in size as compared to aeronautical service and had been supplementary to the core business, it was generally left unregulated. Over the last 30 years, however, the non-aeronautical revenue has become more and more important (e.g., Zhang and Zhang 1997, 2003; Forsyth 2004a; Thompson 2007; Odoni 2009; Morrison 2009; D'Alfonso et al. 2013, 2017; D'Alfonso and Bracaglia 2017; Orth et al. 2015). As a result, airports worldwide now derive as much revenue, on average, from non-aeronautical service as from aeronautical service. In addition, non-aeronautical businesses tend to be more profitable than aeronautical operations (e.g., Jones et al. 1993; Starkie 2001; Francis et al. 2004). For instance, Jones et al. (1993) have shown that, in 1990–1991, approximately 60% of the revenue of BAA's three airports around London (Heathrow, Gatwick, and Stansted) resulted from concession activities. The operating margin for aeronautical charges was −7% for the three airports as a group, while the operating margin for concession revenue was 64 percent.

[4] The "no regulation" case may be considered a proxy for light-handed regulation (LHR). Based on the existing studies, the rationales for LHR include: (1) airports have incentives to lower aeronautical charges in order to attract more traffic and increase their concession revenues (Starkie 2001)—see our analysis below for a similar result; and (2) the threat of re-regulation can help mitigate the potential exploitation of market power by privatized airports (Forsyth 2008). An obvious danger is that the deterrence effect of re-regulation is insufficient to prevent airports from taking full advantage of their market power in setting charges (Lohmann and Trischler 2017). Yang and Fu (2015) examine the implications of LHR (and price-cap regulation) for capacity investments at a congested airport.

respectively) serious concern than the regulatory waste. We will further elaborate these results using numerical examples.

Our paper is most closely related to the existing literature on airport privatization and regulation, as discussed above. In terms of modeling the non-aeronautical market, for simplicity we abstract away the locational-rent consideration, although the high profitability of non-aeronautical operations can also arise from the locational-rent (Forsyth 2004a; Kidokoro et al. 2016). The market power in non-aeronautical service has, in effect, been indicated by other researchers. For instance, in the airport car rental business—an important part of non-aeronautical service—several empirical studies (Singh and Zhu 2008; Khan et al. 2009; Czerny et al. 2016b) model it as an oligopoly. However, how this imperfectly competitive non-aeronautical market is endogenously linked to airport charge, airport capacity and regulation has not yet been modeled in a full-fledged framework.

Another strand of the literature has explored the implications of a positive profit in non-aeronautical service for: (1) the need for aeronautical regulation (e.g., Beesley 1999; Starkie 2001; Zhang and Zhang 2003; Oum et al. 2004; Kratzsch and Sieg 2011); (2) optimal forms of regulation (e.g., Crew and Kleindorfer 2000; Czerny 2006; Yang and Zhang 2011); (3) airport pricing, capacity investment, and cost recovery (e.g., Zhang and Zhang 1997, 2006; Zhang et al. 2010; D'Alfonso et al. 2013, 2017; D'Alfonso and Bracaglia 2017; Kidokoro et al. 2016; Kidokoro and Zhang 2018); and (4) airport privatization (e.g., Bilotkach et al. 2012; Gillen and Mantin 2014; Bettini and Oliveira 2016).[5] This positive non-aeronautical profit is taken as an exogenous factor in these analyses, however, rather than an outcome of strategic interactions among the operators of non-aeronautical service. As indicated above, the present paper will explicitly model such oligopoly rivalry while, at the same time, linking that analysis to airport charge, capacity, and regulation in an integrated framework.[6]

The paper is organized as follows. Section 6.2 sets up the basic model, and Sect. 6.3 examines airport charge, capacity, and non-aeronautical price for both the welfare-maximization benchmark and the case of a public airport. Section 6.4 investigates the results for the case of privatization. The comparisons among price-cap regulation, cost-based regulation, and no regulation are also conducted

[5]For example, Bilotkach et al. (2012) point out that privatized airports have a greater incentive, relative to public airports, to explore and expand non-aeronautical activities, owing, at least in part, to their profitability. At the same time, the positive profits generated from non-aeronautical activities allow airport privatization politically feasible and attractive. For example, a government could fetch a large (lump-sum) amount of money when selling its airports to private hands, or receive continuous payments from the privatized airports as a landlord, or both.

[6]The exception is Kidokoro and Zhang (2018) who examine the implications of imperfectly competitive non-aeronautical service for airport cost recovery. The interactions between the core (aeronautical) and side (non-aeronautical) businesses were also recently investigated in more general contexts (e.g., Flores-Fillol et al. 2018; Czerny and Lindsey 2014). Airport privatization and regulation are not the main concern in these studies, however.

in Sect. 6.4. Section 6.5 reports numerical results, and Sect. 6.6 contains concluding remarks.

6.2 Basic Model

Our model is a standard microeconomic model, which includes consumers, airlines, an airport that has both the aeronautical and non-aeronautical services, and the regulator. We explain these players in turn.[7]

6.2.1 Consumers

Consider a congestible airport that provides both the aeronautical (e.g., runway) and non-aeronautical services, with passengers incurring congestion (delay) costs when consuming air travel.[8] Consumers under consideration are assumed to maximize their quasi-linear and strictly concave utility function subject to an income constraint:

$$\text{Max}\, U = z + u(q_0, x_1), \qquad \text{subject to}\; z + (p_0 + t(q_0,\ K))q_0 + p_1 x_1 = I \quad (6.1)$$

where z is a numeraire good whose price is normalized to unity, I is consumer income, q_0 is the aggregate demand for air trips emanating from the airport (to a destination and back), and $p_0 + t(q_0, K)$ is the trip's "full price," which is the sum of airfare p_0 and time cost $t(q_0, K)$, following Becker (1965). We assume that consumers take the trip's full price as given, in the same way as the standard treatment in congestion model in transportation economics. The time cost refers to the passengers' cost suffering from flight delays, which arise due to airport (runway) congestion.[9] This cost is a function of traffic volume q_0 and airport capacity K, satisfying

[7] Our model assumes perfect foresight of travelers. Flores-Fillol et al. (2018), D'Alfonso et al. (2017), D'Alfonso and Bracaglia 2017, and Czerny and Zhang (2020) include analyses of travelers with imperfect foresight, in which travelers cannot fully understand the value of non-aeronautical services beforehand.

[8] Our consideration of congestible airports is relevant and is consistent with the recent literature. Air travel delays have been a major problem in many countries. While the causes of delays can vary across countries, the volume of traffic relative to limited runway capacity (and the resulting congestion) is a major cause. Two major congestion measures that manage the demand side are quantity-based control ("slots") and pricing (e.g., Czerny et al. 2008; Brueckner 2009; Verhoef 2010; Basso and Zhang 2010; Pertuiset and Santos 2014; Gillen et al. 2016; Guiomard 2017). This paper will focus on the use of pricing measure.

[9] Here we consider runway congestion. Passenger congestion could also rise in the terminal, which may or may not interact with runway congestion (Wan et al. 2015).

$$\frac{\partial t}{\partial q_0} > 0, \quad \frac{\partial t}{\partial K} < 0, \text{ and } \frac{\partial^2 t}{\partial q_0 \partial K} < 0. \tag{6.2}$$

The first inequality in (6.2) shows that the time cost increases in the number of air trips (holding capacity constant). The second and third inequalities show that the time cost and the marginal time cost decrease in airport capacity. Further, x_1 denotes the quantity of the airport's non-aeronautical service, which is (imperfectly) complementary to the aeronautical service,[10] and p_1 is the price for x_1. The properties of $\frac{\partial u}{\partial q_0} > 0$, $\frac{\partial u}{\partial x_1} > 0$, $\frac{\partial^2 u}{\partial {q_0}^2} < 0$, and $\frac{\partial^2 u}{\partial {x_1}^2} < 0$ directly follow from the assumption of strictly concave utility function.

For consumer utility maximization (6.1), the first-order conditions (FOCs) are:

$$p_0 + t(q_0, K) = \frac{\partial u(q_0, x_1)}{\partial q_0}, \tag{6.3}$$

$$p_1 = \frac{\partial u(q_0, x_1)}{\partial x_1}. \tag{6.4}$$

6.2.2 Airlines

Air carriers engage in output competition and, for simplicity, are assumed to offer a homogeneous service with zero marginal cost.[11] The number of airlines is N. N is arbitrary, and accordingly, our analysis includes perfect competition among airlines (the so-called atomistic carriers) as a special case. The profit-maximizing problem of a representative carrier, indexed as n, can be formulated as:

$$\text{Max} \quad \pi_n^{Airline} = p_0 q_n - \tau_0 q_n = \left(\frac{\partial u(q_0,\ x_1)}{\partial q_0} - t(q_0,\ K) - \tau_0 \right) q_n, \quad n = 1, \ldots, N, \tag{6.5}$$

[10] The complementarity assumption is a standard practice in considering that an airport engages in both the aeronautical and non-aeronautical services (e.g., Zhang and Zhang 1997, 2003; Kratzsch and Sieg 2011; Fuerst et al. 2011; Bracaglia et al. 2014; Choo 2014).

[11] The assumption of Cournot competition among airlines is a standard modeling practice in the recent literature on airport congestion pricing, capacity, and regulation (e.g., Brueckner 2002; Pels and Verhoef 2004; Zhang and Zhang 2006; Basso 2008; Czerny 2013; Silva et al. 2014).

where $q_0 = \sum_{n=1}^{N} q_n$, τ_0 denotes the airport's charge for its aeronautical service ("airport charge" hereafter), and (6.3) is applied.[12] We assume that a carrier n follows Cournot competition in an extended way: it chooses its output, q_n, to maximize its profits, given not only other carriers' output but also the quantity of the airport's non-aeronautical service, i.e. it does not consider the effect on other carriers' output or non-aeronautical service x_1.[13] The FOCs of profit-maximization problem (6.5) are

$$\frac{\partial \pi_n^{Airline}}{\partial q_n} = \frac{\partial u(q_0, x_1)}{\partial q_0} - t(q_0, K) - \tau_0 + \left(\frac{\partial^2 u}{\partial {q_0}^2} \frac{\partial q_0}{\partial q_n} - \frac{\partial t}{\partial q_0} \frac{\partial q_0}{\partial q_n} \right) q_n$$
$$= 0, \quad n = 1, \ldots, N. \tag{6.6}$$

Substituting (6.3) into (6.6), and with symmetric carriers, we obtain the (equilibrium) fare as

$$p_0 = \tau_0 - \left(\frac{\partial^2 u}{\partial {q_0}^2} - \frac{\partial t}{\partial q_0} \right) \frac{q_0}{N} \geq \tau_0. \tag{6.7}$$

where the sign follows from the assumptions of $\frac{\partial^2 u}{\partial {q_0}^2} < 0$ and (6.2). The second term in fare Eq. (6.7) shows an excess (per passenger) profit under Cournot competition. As a result, we obtain, by substituting (6.7) into the profit function in (6.5), the following non-negative profit for an airline:

$$\pi_j^{Airline} = (p_0 - \tau_0) q_j = -\left(\frac{\partial^2 u}{\partial {q_0}^2} - \frac{\partial t}{\partial q_0} \right) \left(\frac{q_0}{N} \right)^2 \geq 0. \tag{6.8}$$

[12]Note that the airport charge is per-passenger based. Given our setup, the "fixed proportions" assumption holds and so the per-passenger and per-flight charges can be made equivalent (e.g., Brueckner 2002; Basso 2008). For distinct roles of per-passenger and per-flight charges, see Silva and Verhoef (2013), Czerny and Zhang (2015a), Lin and Zhang (2017), and Czerny et al. (2017).

[13]Solving (6.4) regarding x_1 and substituting the resulting expression into (6.3), we have $p_0 + t(q_0, K) = \frac{\partial u(q_0,\ x_1(q_0,\ p_1))}{\partial q_0}$. Our assumption implies that each airline does not consider the effect on the demand for non-aeronautical service in choosing its own seat supply, i.e. $\frac{\partial u}{\partial x_1} \frac{\partial x_1}{\partial q_0} \frac{\partial q_0}{\partial q_n} = 0$. In other words, each airline only takes the relationship expressed in (6.3) into account. Kidokoro and Zhang (2022a, b) instead considers that each airline ('service provider' in their papers) maximize its output given the price of non-aeronautical service ('p_2 ' in their papers) in the model without investment. In their models, both (6.3) and (6.4) are fully taken into account.

6.2.3 Non-Aeronautical Service Market

Currently airports offer various non-aeronautical services, such as car rentals, retail shopping, and food & beverages. For analytical simplicity we consider one such service. Specifically, we assume that there are a finite number of “shops” at the airport providing homogenous service x_1. Different from Kidokoro et al. (2016) who also consider investment in non-aeronautical capacity (the size of space for non-aeronautical services), we assume for simplicity that no space is needed for non-aeronautical services. This simplification allows us to focus on investment in aeronautical service and so match with the congestion problem that arise from runway capacity.

Each shop’s profit is given by

$$\pi_m^{Nonaero} = (p_1 - c_1)x_{1m} = \left(\frac{\partial u(q_0,\ x_1)}{\partial x_1} - c_1\right)x_{1m}, \tag{6.9}$$

where x_{1m} is the supply of non-aeronautical service by shop m, for $m = 1, \ldots, M$, c_1 is its (constant) marginal cost, and (6.4) is applied. In the same way as airlines, we assume that a shop m follows Cournot competition in an extended way: it chooses its output, x_{1m}, to maximize its profits, given not only other shops’ supply but also the demand for air trips, i.e. it does not consider the effect on other shops’ supply or air trips q_0.[14] Total non-aeronautical profit is the sum of shops’ profit (6.9):

$$\Pi^{Nonaero} = \sum_{m=1}^{M} \pi_m^{Nonaero} = \left(\frac{\partial u(q_0,\ x_1)}{\partial x_1} - c_1\right)x_1, \tag{6.10}$$

where $x_1 = \sum_{m=1}^{M} x_{1m}$.

6.2.4 Airport’s Profit and Social Welfare

The airport’s combined profit is defined as,

[14] Solving (6.3) regarding q_0 and substituting the resulting expression into (6.4), we have $p_1 = \frac{\partial u(q_0(x_1,\ p_0,\ K),\ x_1)}{\partial x_1}$. Our assumption implies that each shop does not consider the effect on the demand for air trips in choosing its own supply, i.e., $\frac{\partial u}{\partial q_0}\frac{\partial q_0}{\partial x_1}\frac{\partial x_1}{\partial x_m} = 0$. In other words, each shop only takes the relationship expressed in (6.4) into account. As pointed in footnote 13, we can consider another setup in the way of Kidokoro and Zhang (2022a, b): each shop maximize its output given airfare. If we follow this approach, both (6.3) and (6.4) are fully taken into account.

$$\Pi^{Airport} = (\tau_0 - c_0)q_0 + \beta\Pi^{Nonaero} - C(K) \tag{6.11}$$

The first term is the aeronautical profit, where c_0 is the airport's operating cost per passenger. The second term is the airport's share of total non-aeronautical profit $\Pi^{Nonaero}$. The airport not only engages in aeronautical service but also absorbs part of the shop profit, with parameter $0 < \beta \leq 1$ representing the profit absorption rate. For instance, when $\beta = 1$, the airport takes all the shop profit. We do not model how the value of β is determined. In practice, it can be influenced by various factors, including the bargaining power of the non-aeronautical sector. Large (and brand name) merchants would have a bargaining power than smaller local (no-name) shops. The value of β has no material impact on our theoretical results, but does change final outcomes, as we will see from the numerical examples in Sect. 6.6. The third term, $C(K)$, is the airport's capacity cost which increases in K.

Social welfare (SW) can then be written as:

$$SW = U + \sum_{j=1}^{N} \pi_j^{Airline} + \Pi^{Airport} + (1-\beta)\Pi^{Nonaero} = I + u(q_0, x_1)$$
$$-(c_0 + t(q_0,\ K))q_0 - C(K) - c_1 x_1 \tag{6.12}$$

which shows that SW equals income plus utility, minus the total costs of providing air trip and non-aeronautical services.

6.3 Welfare Maximization vs. Public Airport

We first examine the welfare-maximization case by a planner who sets airport charge, price of non-aeronautical service, and airport capacity. Solving (6.4) and (6.6), we obtain $q_0(\tau_0, p_1, K)$ and $x_1(\tau_0, p_1, K)$: it can be shown (in Appendix 1) $\frac{dq_0}{d\tau_0} < 0$, $\frac{dq_0}{dK} > 0$, $\frac{dx_1}{d\tau_0} < 0$, and $\frac{dx_1}{dK} > 0$. Substituting $q_0(\tau_0, p_1, K)$ and $x_1(\tau_0, p_1, K)$ into (6.12), social welfare can be rearranged as,

$$\begin{aligned} SW = I &+ u(q_0(\tau_0,\ p_1,\ K), x_1(\tau_0,\ p_1,\ K)) \\ &- (c_0 + t(q_0(\tau_0,\ p_1,\ K),\ K))q_0(\tau_0, p_1, K) \\ &- C(K) - c_1 x_1(\tau_0, p_1, K). \end{aligned} \tag{6.13}$$

Maximizing (6.13) with respect to τ_0, p_1, and K and rearranging the FOCs, we obtain:

$$\tau_0 = c_0 + \frac{\partial t}{\partial q_0} q_0 + \left(\frac{\partial^2 u}{\partial q_0{}^2} - \frac{\partial t}{\partial q_0}\right)\frac{q_0}{N} \leq c_0 + \frac{\partial t}{\partial q_0} q_0, \tag{6.14}$$

$$p_1 = c_1, \tag{6.15}$$

$$-\frac{\partial t}{\partial K} q_0 = \frac{\partial C}{\partial K}. \tag{6.16}$$

The derivation of (6.14)–(6.16) is shown in Appendix 2. Eq. (6.14) shows that except for the case of perfect competition, the airport charge is lower than the marginal cost, which is the sum of the airport's marginal cost and the passenger congestion cost.[15] This is a standard result in the literature (e.g., Brueckner 2002; Pels and Verhoef 2004; Zhang and Zhang 2006). As indicated above, imperfect competition among airlines makes the fare higher than the marginal cost. To counteract this effect, the planner chooses a reduced airport charge by $\left(\frac{\partial^2 u}{\partial {q_0}^2} - \frac{\partial t}{\partial q_0}\right)\frac{q_0}{N}$ (≤ 0). Eq. (6.15) simply shows that the price of non-aeronautical service equals its marginal cost, whereas Eq. (6.16) demonstrates that the marginal benefit of airport capacity equals its marginal cost, which is also a standard result in the literature (e.g., Zhang and Zhang 2006; Zhang et al. 2010; Kidokoro et al. 2016).

Next we consider a public airport. The existing literature has identified the behavior of a public airport with that of welfare maximization. As public airports typically have higher costs than private airports under monopolistic conditions as pointed out by Adler and Liebert (2014), we cannot guarantee that they yield the same result. More specifically, we consider three types of cost differences: the marginal costs on aeronautical service and airport capacity costs (these two are on aeronautical services), and the marginal costs on non-aeronautical services. We assume that the marginal costs on aeronautical and non-aeronautical services and the airport capacity cost for a public airport are, respectively, $(1 + \theta_0)c_0$, $(1 + \theta_1)c_1$, and $(1 + \theta_K)C(K)$, where $\theta_0 > 0$, $\theta_1 > 0$, and $\theta_K > 0$ are parameters reflecting higher costs caused by public operations. Social welfare, SW^{Public}, can be written as

$$\begin{aligned} SW^{Public} = {} & I + u(q_0(\tau_0,\ p_1,\ K), x_1(\tau_0,\ p_1,\ K)) \\ & - ((1+\theta_0)c_0 + t(q_0(\tau_0, p_1, K), K))q_0(\tau_0, p_1, K) - (1+\theta_K)C(K) \\ & - (1+\theta_1)c_1 x_1(\tau_0, p_1, K). \end{aligned} \tag{6.17}$$

Maximizing (6.17) with respect to τ_0, p_1, and K and rearranging the resulting expressions, we obtain

$$\begin{aligned} \tau_0 = (1+\theta_0)c_0 + \frac{\partial t}{\partial q_0} q_0 + \left(\frac{\partial^2 u}{\partial {q_0}^2} - \frac{\partial t}{\partial q_0}\right)\frac{q_0}{N} > c_0 + \frac{\partial t}{\partial q_0} q_0 \\ + \left(\frac{\partial^2 u}{\partial {q_0}^2} - \frac{\partial t}{\partial q_0}\right)\frac{q_0}{N}, \end{aligned} \tag{6.18}$$

[15] It can be checked that the airport charge approaches the marginal cost when the number of airlines increases to infinity and thus, the airline market approaches perfect competition.

$$p_1 = (1 + \theta_1)c_1 > c_1, \tag{6.19}$$

$$-\frac{\partial t}{\partial K} q_0 = (1 + \theta_K)\frac{\partial C}{\partial K} > \frac{\partial C}{\partial K}. \tag{6.20}$$

The derivation of (6.18)–(6.20) is shown in Appendix 3. By comparing (6.18)–(6.20) with (6.14)–(6.16), we highlight the features of public airports. Equation (6.19) demonstrates that the price of non-aeronautical service is higher than the marginal cost. It also yields a closed-form solution for p_1. Although substituting the p_1 solution to (6.18) and (6.20) won't give us a closed-form solution for τ_0 and K under our general functional forms,[16] we can compare (6.18) and (6.20) with the welfare-maximization counterparts, (6.14) and (6.16). Equation (6.18) shows that the higher marginal cost by public operation works to make the airport charge higher than the welfare-maximizing level (for given values of p_1 and K). Equation (6.20) states that the higher capacity cost by public operation works to make airport capacity smaller than the welfare-maximizing level (for given values of τ_0 and p_1). These results clearly identify the negative effects on airport charge, non-aeronautical price, and airport capacity caused by higher costs of public administration. Airport privatization may improve cost inefficiency. Privatized entities may, on the other hand, explore market power (see, e.g.. the empirical findings of Bel and Fageda 2010, and Adler and Liebert 2014 about higher airport charges associated with privatization of aeronautical service). These issues, and related regulation and regulation form, will be examined below.

6.4 Privatization of Aeronautical and Non-Aeronautical Services

6.4.1 No Regulation on Aeronautical Service

We consider the case in which both aeronautical and non-aeronautical services are privatized, and the cost inefficiencies by public management are removed, beginning with no regulation imposed on either sector.

Assuming that each private shop follows Cournot competition in an extended way, i.e., chooses its quantity to maximize its profit (given the other shops' quantities and the aggregate demand for air trips), the resulting FOCs are, by (6.9),

[16]The closed-form solutions are in general hard to obtain even for specific functional forms (e.g., linear demands and costs), due to (for example) the non-linear time costs.

$$\frac{\partial \pi_m^{Nonaero}}{\partial x_{1m}} = \frac{\partial u(q_0, x_1)}{\partial x_1} - c_1 + \frac{\partial^2 u(q_0, x_1)}{\partial {x_1}^2} x_{1m} = 0, \qquad m = 1, \ldots, M. \tag{6.21}$$

Summing (6.21) over m, we have

$$M\left(\frac{\partial u(q_0,\ x_1)}{\partial x_1} - c_1\right) + \left(\frac{\partial^2 u(q_0,\ x_1)}{\partial {x_1}^2}\right) x_1 = 0 \tag{6.22}$$

which, by (6.4) and $\frac{\partial^2 u}{\partial {x_1}^2} < 0$, yields:

$$p_1 = c_1 - \frac{\partial^2 u(q_0, x_1)}{\partial {x_1}^2} \frac{x_1}{M} \geq c_1. \tag{6.23}$$

Inequality (6.23) indicates that imperfect competition in the non-aeronautical market makes the price of non-aeronautical service greater than its marginal cost (unless $M = \infty$).

Solving (6.6) and (6.22), we obtain (equilibrium) functions $q_0(\tau_0, K)$ and $x_1(\tau_0, K)$ in the same way as Sect. 6.3. The airport profit is the sum of the profit from aeronautical service and that from non-aeronautical service, and is given in (6.11). Substituting the above $q_0(\tau_0, K)$ and $x_1(\tau_0, K)$ into (6.11) leads to the following airport profit,

$$\begin{aligned} \Pi^{Airport4.1.1} &= (\tau_0 - c_0) q_0(\tau_0, K) \\ &+ \beta\left(\frac{\partial u(q_0(\tau_0,\ \ K),\ x_1(\tau_0,\ \ K))}{\partial x_1(\tau_0,\ K)} - c_1\right) x_1(\tau_0, K) - C(K) \end{aligned} \tag{6.24}$$

over which the (private) airport maximizes with respect to its decision variables, τ_0 and K. Solving this profit-maximization problem, we derive:

$$\tau_0 = c_0 - \frac{q_0}{\frac{\partial q_0}{\partial \tau_0}} - \frac{\beta \frac{\partial \Pi^{Nonaero}}{\partial \tau_0}}{\frac{\partial q_0}{\partial \tau_0}}, \tag{6.25}$$

$$-\left(\frac{\partial t}{\partial K} + \frac{\partial^2 t}{\partial q_0 \partial K} \frac{q_0}{N}\right) q_0 = \frac{dC}{dK} \geq -\frac{\partial t}{\partial K} q_0. \tag{6.26}$$

Equation (6.23), which is the decision rule for the price of non-aeronautical service under privatization, also holds here. That is, the price of non-aeronautical service is greater than its marginal cost, owing to imperfect competition in the non-aeronautical market.

The derivation of (6.25) and (6.26) is shown in Appendix 4. Equation (6.25) shows that in determining airport charge τ_0, the positive profit from non-aeronautical service works to counteract the monopoly's markup, $-\frac{q_0}{\partial q_0/\partial \tau_0}$ (>0), when the trip demand and the profit from non-aeronautical service are complementary. This point was made by Starkie (2001), Zhang and Zhang (2003), and others (without explicitly modeling of the non-aeronautical sector). Basically, with air trip and the non-aeronautical profit being complementary and imperfectly competitive non-aeronautical market, a private airport has an incentive to reduce its airport charge in order to gain profit from non-aeronautical service. Equation (6.26) states that imperfect competition among airlines has an effect for overinvestment, owing to positive term $-\left(\frac{\partial^2 t}{\partial q_0 \partial K}\frac{q_0}{N}\right)q_0$, relative to the welfare-maximization level, as in Zhang and Zhang (2006) and Kidokoro et al. (2016).[17]

We now introduce price-cap regulation on non-aeronautical service:

$$p_1 = \overline{p}_1. \tag{6.27}$$

Solving (6.4), (6.6), and (6.27), we obtain $q_0(\tau_0, \overline{p}_1, K)$ and $x_1(\tau_0, \overline{p}_1, K)$ in the same way as Sect. 6.3. Substituting these into (6.11) yields:

$$\begin{aligned}\Pi^{Airport4.1.2} &= (\tau_0 - c_0)q_0(\tau_0, \overline{p}_1, K)\\ &+ \beta\left(\frac{\partial u(q_0(\tau_0,\ \overline{p}_1,\ K),\ x_1(\tau_0,\ \overline{p}_1,\ K))}{\partial x_1(\tau_0,\ \overline{p}_1,\ K)} - c_1\right)x_1(\tau_0, \overline{p}_1, K) - C(K).\end{aligned} \tag{6.28}$$

Note that airport profit (6.28) is obtained from (6.11) with q_0 and x_1 being replaced by functions $q_0(\tau_0, \overline{p}_1, K)$ and $x_1(\tau_0, \overline{p}_1, K)$. The airport maximizes (6.28) with respect to τ_0 and K, which leads to the optimal τ_0 and K as functions of the price cap on non-aeronautical service, $\overline{p}_1$. Denoting these functions $\tau_0(\overline{p}_1)$ and $K(\overline{p}_1)$, the government (regulator) then maximizes social welfare:

$$\begin{aligned}SW^{4.1.2} = I &+ u(q_0(\tau_0(\overline{p}_1),\ \overline{p}_1,\ K(\overline{p}_1)), x_1(\tau_0(\overline{p}_1),\ \overline{p}_1,\ K(\overline{p}_1)))\\ &- (c_0 + t(q_0(\tau_0(\overline{p}_1), \overline{p}_1, K(\overline{p}_1)), K(\overline{p}_1)))q_0(\tau_0(\overline{p}_1), \overline{p}_1, K(\overline{p}_1))\\ &- C(K(\overline{p}_1)) - c_1x_1(\tau_0(\overline{p}_1), \overline{p}_1, K(\overline{p}_1))\end{aligned} \tag{6.29}$$

with respect to $\overline{p}_1$. From the maximization solutions we obtain (6.25), (6.26), and

$$\overline{p}_1 = c_1 - \frac{\left(\tau_0 - \left(c_0 + \frac{\partial t}{\partial q_0}q_0 + \left(\frac{\partial^2 u}{\partial q_0{}^2} - \frac{\partial t}{\partial q_0}\right)\frac{q_0}{N}\right)\right)\varepsilon_{q_0,\overline{p}_1}q_0 + \left(-\frac{\partial t}{\partial K}q_0 - \frac{dC}{dK}\right)\varepsilon_{K,\overline{p}_1}K}{\varepsilon_{x_1,\overline{p}_1}x_1}. \tag{6.30}$$

[17] Essentially, an investment in airport capacity lowers marginal time cost, and this also works to reduce airfare, as long as the competition among airlines is imperfect, as indicated in (6.7). The reduced airfare decreases airlines' revenues ceteris paribus, but at the same time, it increases the airport's revenues through an increase in the air trip demand. When considering an increase in the capacity, the airport does not take into account the former negative impact on airlines' revenues. As a result, the aeronautical capacity is overinvested.

The derivation of (6.25), (6.26), and (6.30) is shown in Appendix 5. The conditions on airport charge and capacity, (6.25) and (6.26), remain unchanged. A difference by introducing the price-cap regulation on non-aeronautical service arises in the determination of the non-aeronautical price. Equation (6.30) shows that this price can be lower than the marginal cost, depending on the distortions in airport charge and airport capacity (recall those decisions remain in the hands of the privatized airport). In particular, the regulator can counteract the effect of monopoly airport charge by manipulating the non-aeronautical price: consider the situation when the effect of the price of non-aeronautical service on airport capacity is negligible (i.e., $\varepsilon_{K,\overline{p}_1} \approx 0$). Then if the airport charge is higher than the welfare-maximization level, the second term on the RHS of (6.30) is negative. (Recall that the aeronautical and non-aeronautical services are complementary, hence $\varepsilon_{q_0,\overline{p}_1}$ and $\varepsilon_{x_1,\overline{p}_1}$ have the same sign.) This makes the price of non-aeronautical service lower than its marginal cost. Additionally introducing price-cap regulation to non-aeronautical service improves social welfare, as the government has one more policy variable.

This method adjusts the price of non-aeronautical service, instead of the price of aeronautical service. (Adjusting airport charge will be analyzed in the next subsection.) In an extreme case where aeronautical and non-aeronautical services are *perfectly* complementary, that is, $q_0 = x_1$, rearranging (6.30) yields:

$$\tau_0 + \overline{p}_1 = \left(c_0 + \frac{\partial t}{\partial q_0} q_0 + \left(\frac{\partial^2 u}{\partial {q_0}^2} - \frac{\partial t}{\partial q_0} \right) \frac{q_0}{N} \right) + c_1 - \frac{\partial^2 t}{\partial q_0 \partial K} \frac{{q_0}^2}{N} \frac{\varepsilon_{K,\overline{p}_1} K}{\varepsilon_{x_1,\overline{p}_1} x_1}. \tag{6.31}$$

The difference from the sum of the RHSs of (6.14) and (6.15) in welfare maximization is the third term on the RHS of (6.31), which stems from imperfect competition at the airline level. This implies that the combined price of aeronautical and non-aeronautical services, $\tau_0 + \overline{p}_1$, is the same as the welfare-maximization level under perfect airline competition. Because only the total price matters, controlling the price of non-aeronautical service is equivalent to controlling that of aeronautical service. In practice, however, perfect complementarity between aeronautical and non-aeronautical services is a strong assumption. Thus, adjusting the price of non-aeronautical service instead of that of aeronautical service would be an imperfect substitute even under perfect airline competition.

Summarizing the analysis in Sect. 6.4.1 we have the following proposition:

Proposition 1 *(1) Under simple privatization with no regulation on both aeronautical and non-aeronautical services, the airport charge is given by the marginal cost plus a monopoly markup, minus a term reflecting the distortion in non-aeronautical service. Thus, the non-aeronautical profit imposes a downward pressure on airport charge. Further, imperfect competition in non-aeronautical service makes the non-aeronautical price higher than the marginal cost, which is the same as that* *under partial privatization, while imperfect competition among airlines has an effect for overinvestment in airport capacity. (2) When price-cap regulation is additionally introduced to non-aeronautical service, the regulator may set this price lower than the marginal cost so as to counteract the distortions in airport charge and airport capacity.*

6.4.2 Price-Cap Regulation on Aeronautical Service

This subsection examines the case where price-cap regulation is imposed on privatized aeronautical service,

$$\tau_0 = \overline{\tau}_0, \tag{6.32}$$

with $\overline{\tau}_0$ being the price cap. Solving (6.6), (6.22), and (6.32), we obtain functions $q_0(\overline{\tau}_0, K)$ and $x_1(\overline{\tau}_0, K)$ in the same way as Sect. 6.3. Substituting these into (6.11) yields

$$\Pi^{Airport4.2.1} = (\overline{\tau}_0 - c_0)q_0(\overline{\tau}_0, K) + \beta\left(\frac{\partial u(q_0(\overline{\tau}_0,\ K),\ x_1(\overline{\tau}_0,\ K))}{\partial x_1(\overline{\tau}_0,\ K)} - c_1\right)x_1(\overline{\tau}_0, K) - C(K). \tag{6.33}$$

For given $\overline{\tau}_0$, the airport maximizes profit (6.33) with respect to K. From this maximization, we derive $K(\overline{\tau}_0)$. Incorporating $K(\overline{\tau}_0)$ into its objective function, the regulator maximizes

$$SW^{4.2.1} = I + u(q_0(\overline{\tau}_0,\ K(\overline{\tau}_0)), x_1(\overline{\tau}_0,\ K)(\overline{\tau}_0)) - (c_0 + t(q_0(\overline{\tau}_0, K(\overline{\tau}_0)), K(\overline{\tau}_0)))q_0(\overline{\tau}_0, K(\overline{\tau}_0)) - C(K(\overline{\tau}_0)) - c_1x_1(\overline{\tau}_0, K(\overline{\tau}_0)) \tag{6.34}$$

with respect to price-cap $\overline{\tau}_0$. From the solutions of these maximizations we obtain (the derivation is shown in Appendix 6):

$$\overline{\tau}_0 = c_0 + \frac{\partial t}{\partial q_0}q_0 + \left(\frac{\partial^2 u}{\partial {q_0}^2} - \frac{\partial t}{\partial q_0}\right)\frac{q_0}{N} - \frac{(p_1 - c_1)\varepsilon_{x_1,\overline{\tau}_0}x_1 + \left(-\frac{\partial t}{\partial K}q_0 - \frac{dC}{dK}\right)\varepsilon_{K,\overline{\tau}_0}K}{\varepsilon_{q_0,\overline{\tau}_0}q_0}, \tag{6.35}$$

$$-\left(\frac{\partial t}{\partial K}+\frac{\partial^2 t}{\partial q_0 \partial K}\frac{q_0}{N}\right)q_0 > \frac{dC}{dK} \quad \text{when} \quad \overline{\tau}_0 < c_0 - \frac{q_0}{\frac{\partial q_0}{\partial \tau_0}} - \frac{\beta \frac{\partial \Pi^{Nonaero}}{\partial \tau_0}}{\frac{\partial q_0}{\partial \tau_0}}. \tag{6.36}$$

Equation (6.23), the condition on the price of privatized non-aeronautical service, also holds here. Thus, the non-aeronautical price is greater than its marginal cost, owing to imperfect competition. Equation (6.35) states that the price cap on airport charge, being based on welfare maximization, accounts for the distortions from both non-aeronautical price and airport capacity. The former distortion always results in a downward pressure on airport charge, because of complementarity between aeronautical and non-aeronautical services, that is, $\varepsilon_{q_0,\overline{\tau}_0} < 0$ and $\varepsilon_{x_1,\overline{\tau}_0} < 0$. Such a downward tendency is consistent with the empirical result of Adler and Liebert (2014), who found that regulation is associated with lower airport charges. Furthermore, eq. (6.36) indicates that price-cap regulation has an effect to suppress capacity investment, consistent with the results of Spence (1975), Sheshinski (1976), Kidokoro (2002, 2006), and Yang and Zhang (2012), as long as the price cap is set below the monopoly level.[18] This is because the regulated airport cannot raise its charge if it increases airport capacity and hence service quality (reduced airport congestion). If airlines were subject to perfect competition, we have $\frac{\partial^2 t}{\partial q_0 \partial K}\frac{q_0}{N} = 0$, which yields $-\frac{\partial t}{\partial K}q_0 > \frac{dC}{dK}$ and hence underinvestment compared to the welfare-maximization level. Thus, while introducing price-cap regulation to aeronautical service raises social welfare (the regulator has one more policy variable), one must be cautious about a negative effect of the regulation on airport service quality.[19]

The final case to be examined in Sect. 6.4.2 is one where price cap regulation is imposed on both aeronautical and non-aeronautical services. The two regulations are expressed in (6.32) and (6.27), respectively. Solving (6.6), (6.27), and (6.32), we obtain $q_0(\overline{\tau}_0, \overline{p}_1, K)$ and $x_1(\overline{\tau}_0, \overline{p}_1, K)$ in the same way as Sect. 6.3. Substituting these two functions into (6.11) yields airport profit

$$\begin{aligned}\Pi^{Airport4.2.2} &= (\overline{\tau}_0 - c_0)q_0(\overline{\tau}_0, \overline{p}_1, K) \\ &+ \beta\left(\frac{\partial u(q_0(\overline{\tau}_0, \ \overline{p}_1, \ K), \ x_1(\overline{\tau}_0, \ \overline{p}_1, \ K))}{\partial x_1(\overline{\tau}_0, \ \overline{p}_1, \ K)} - c_1\right)x_1(\overline{\tau}_0, \overline{p}_1, K) - C(K).\end{aligned} \tag{6.37}$$

For given price-caps $\overline{\tau}_0$ and $\overline{p}_1$, the airport maximizes this profit with respect to K, which leads to its optimal capacity as $K(\overline{\tau}_0, \overline{p}_1)$. From function $K(\overline{\tau}_0, \overline{p}_1)$ the regulator then maximizes social welfare

[18] Spence (1975), Sheshinski (1976), and Kidokoro (2002, 2006) derive this result, given that the price-cap is exogenously determined. Yang and Zhang (2012) consider an endogenous determination of price cap, although they show the results only numerically.

[19] If we consider that space (area of shops) is needed for non-aeronautical service and that investment (construction of shop areas) is needed to create the space, this underinvestment also applies for the space for non-aeronautical service when price cap regulation is introduced to the non-aeronautical sector.

$$
\begin{aligned}
SW^{4.2.2} = & I + u(q_0(\overline{\tau}_0, \ \overline{p}_1, \ K(\overline{\tau}_0, \ \ \overline{p}_1)), x_1(\overline{\tau}_0, \ \overline{p}_1, \ K(\overline{\tau}_0, \ \ \overline{p}_1))) \\
& - (c_0 + t(q_0(\overline{\tau}_0, \overline{p}_1, K(\overline{\tau}_0, \ \overline{p}_1)), K(\overline{\tau}_0, \overline{p}_1)))q_0(\overline{\tau}_0, \overline{p}_1, K(\overline{\tau}_0, \ \overline{p}_1)) \\
& - C(K) - c_1 x_1(\overline{\tau}_0, \overline{p}_1, K(\overline{\tau}_0, \ \overline{p}_1))
\end{aligned}
\tag{6.38}
$$

with respect to $\overline{\tau}_0$ and $\overline{p}_1$. From the solutions of these maximizations we obtain (6.36) and

$$
\begin{aligned}
\overline{\tau}_0 = & c_0 + \frac{\partial t}{\partial q_0} q_0 + \left(\frac{\partial^2 u}{\partial {q_0}^2} - \frac{\partial t}{\partial q_0} \right) \frac{q_0}{N} - \left(- \frac{\partial t}{\partial K} q_0 - \frac{dC}{dK} \right) \\
& \times \frac{\varepsilon_{K,\overline{\tau}_0} \varepsilon_{x_1,\overline{p}_1} - \varepsilon_{K,\overline{p}_1} \varepsilon_{x_1,\overline{\tau}_0}}{\varepsilon_{q_0,\overline{\tau}_0} \varepsilon_{x_1,\overline{p}_1} - \varepsilon_{q_0,\overline{p}_1} \varepsilon_{x_1,\overline{\tau}_0}} \frac{K}{q_0},
\end{aligned}
\tag{6.39}
$$

$$
\overline{p}_1 = c_1 - \left(- \frac{\partial t}{\partial K} q_0 - \frac{dC}{dK} \right) \frac{\varepsilon_{K,\overline{\tau}_0} \varepsilon_{q_0,\overline{p}_1} - \varepsilon_{K,\overline{p}_1} \varepsilon_{q_0,\overline{\tau}_0}}{\varepsilon_{x_1,\overline{\tau}_0} \varepsilon_{q_0,\overline{p}_1} - \varepsilon_{x_1,\overline{p}_1} \varepsilon_{q_0,\overline{\tau}_0}} \frac{K}{x_1}. \tag{6.40}
$$

The derivation of (6.36), (6.39), and (6.40) is shown in Appendix 7. The downward effect on airport capacity continues to exist, for we still have eq. (6.36). The difference from introducing the price cap to non-aeronautical service is that this capacity impact affects the choice of both airport charge (6.39) and non-aeronautical price (6.40). Now that the regulator can control the non-aeronautical price, the term associated with the price-cost margin of non-aeronautical service in (6.35) disappears. Although we cannot determine the net changes in airport charge and non-aeronautical price—that is, the airport charge and the non-aeronautical price can be higher or lower than the welfare-maximizing level and the marginal cost, respectively—additionally introducing price-cap regulation to non-aeronautical service improves social welfare higher, owing to one more instrument in the regulator's hands.

Summing up the analysis in this subsection we have the following proposition:

Proposition 2 *(1) Under privatization with price-cap regulation on aeronautical service, there is a tendency for underinvestment in airport capacity, and the airport charge is determined by the welfare-maximizing level plus the distortions in airport capacity and imperfectly competitive non-aeronautical service. (2) When price-cap regulation is additionally imposed on non-aeronautical service, the non-aeronautical price can be higher or lower than the marginal cost depending on the distortion in airport capacity, while the effect of non-aeronautical service on airport charge disappears.*

6.4.3 Cost-Based Regulation on Aeronautical Service

Now, cost-based regulation (rather than price-cap regulation as in Sect. 6.4.2) is imposed on aeronautical service. We again start the analysis with no regulation on non-aeronautical service. Solving (6.6) and (6.22), we obtain $q_0(\tau_0, K)$ and $x_1(\tau_0, K)$

in the same way as Sect. 6.3. Substituting these functions into (6.11) yields airport profit

$$\Pi^{Airport4.3.1} = (\tau_0 - c_0)q_0(\tau_0, K) + \beta\left(\frac{\partial u(q_0(\tau_0, K), x_1(\tau_0, K))}{\partial x_1(\tau_0, K)} - c_1\right)x_1(\tau_0, K) - C(K). \tag{6.41}$$

Further, using $q_0(\tau_0, K)$ and $x_1(\tau_0, K)$ we define the cost-based regulation as,

$$\tau_0 q_0(\tau_0, K) - c_0 q_0(\tau_0, K) - C(K) - w = 0, \tag{6.42}$$

where w (≥ 0) is a regulatory waste associated with cost-based regulation. Since we have imposed zero cost on price-cap regulation (on either aeronautical or non-aeronautical service), there exists an asymmetry between the two regulation forms. As suggested by Braeutigam and Panzar (1989) and Kidokoro (2002, 2006), cost-based regulation has a weaker incentive for cost reduction, which may lead to an additional regulatory waste relative to price-cap regulation.

Under cost-based regulation, the airport chooses τ_0 and K to maximize profit (6.41) under the constraint of (6.42). Solving the maximization problem we obtain Eq. (6.26) for airport capacity, together with cost-based regulation (6.42) which determines airport charge. (The derivation of (6.26) is shown in Appendix 8.) Equation (6.23), the condition on the price of privatized non-aeronautical service, also holds here. The fact that the condition determining airport capacity is the same as the one under no regulation on aeronautical service, (6.26), implies that cost-based regulation won't have an "underinvestment" effect that is present under price-cap regulation. The intuition is fairly clear: Here, an increase in cost, caused by an increase in capacity investment, can be recouped through an increase in airport charge. Thus, as compared to price-cap regulation, cost-based regulation has the advantage of no negative impact on airport capacity (and hence airport service quality).[20] Cost-based regulation has a regulatory waste however, which works to increase airport charge. In determining whether price-cap regulation is better than cost-based regulation, therefore, we need to compare a welfare loss from a decrease in airport capacity (service quality) under price-cap regulation, with the loss from an increase in airport charge (due to regulatory wastes) under cost-based regulation. We will check this trade-off in more details in Sect. 6.5, using numerical examples.

[20]This result is consistent with Yang and Zhang (2012) who investigate the impact of economic regulation on transport infrastructure capacity and service quality. They find that for a monopoly profit-maximizing infrastructure (airport, for example), its capacity is the largest under cost-based regulation, which is followed by rate-of-rate (ROR) regulation, no regulation, and price cap regulation. Service quality has the same order as capacity investments: it is the highest under cost-based regulation, then ROR regulation, no regulation, and is the lowest under price cap regulation. Furthermore, Yang and Zhang's analysis reveals an efficiency-delays trade-off: Whilst cost-based regulation leads to lower efficiency relative to price-cap regulation, it is associated with higher service quality (lower congestion delays).

We next apply price-cap regulation to non-aeronautical service, which is represented by (6.27). Solving (6.4), (6.6), and (6.27), we obtain $q_0(\tau_0, \overline{p}_1, K)$ and $x_1(\tau_0, \overline{p}_1, K)$ in the same way as Sect. 6.3. Substituting these functions into (6.11) yields airport profit

$$\Pi^{Airport4.3.2} = (\tau_0 - c_0)q_0(\tau_0, \overline{p}_1, K) + \beta\left(\frac{\partial u(q_0(\tau_0, \overline{p}_1, K), x_1(\tau_0, \overline{p}_1, K))}{\partial x_1(\tau_0, \overline{p}_1, K)} - c_1\right)x_1(\tau_0, \overline{p}_1, K) - C(K). \quad (6.43)$$

The cost-based regulation on aeronautical service is now represented by

$$\tau_0 q_0(\tau_0, \overline{p}_1, K) - c_0 q_0(\tau_0, \overline{p}_1, K) - C(K) - w = 0. \quad (6.44)$$

The airport chooses τ_0 and K, to maximize profit (6.43) under the constraint of (6.44). From this maximization we derive optimal airport charge and capacity $\tau_0(\overline{p}_1)$ and $K(\overline{p}_1)$. Anticipating the airport's choices, the regulator government maximizes social welfare

$$\begin{aligned} SW^{4.3.2} = & I + u(q_0(\tau_0(\overline{p}_1), \overline{p}_1, K(\overline{p}_1)), x_1(\tau_0(\overline{p}_1), \overline{p}_1, K(\overline{p}_1))) \\ & - (c_0 + t(q_0(\tau_0(\overline{p}_1), \overline{p}_1, K(\overline{p}_1)), K(\overline{p}_1)))q_0(\tau_0(\overline{p}_1), \overline{p}_1, K(\overline{p}_1)) \\ & - C(K(\overline{p}_1)) - c_1 x_1(\tau_0(\overline{p}_1), \overline{p}_1, K(\overline{p}_1)) \end{aligned} \quad (6.45)$$

with respect to price-cap $\overline{p}_1$. From the solutions of these maximizations, we obtain (6.26) and (6.30) in addition to the cost-based regulation constraint, (6.44).

The derivation of (6.26) and (6.30) is shown in Appendix 9. We again have the same condition for determining airport capacity as that under no aeronautical regulation, (6.26). As a result, cost-based regulation with price-cap regulation on non-aeronautical service has no downward effect on airport capacity, just like the no-regulation case.[21] On the other hand, a main difference with the no-regulation case is that in (6.30), the non-aeronautical price can be lower than the marginal cost, depending on the distortions in airport charge and airport capacity, as in the case for no regulation on aeronautical service and price-cap regulation on non-aeronautical service, analyzed in Sect. 6.4.1. This is because the regulator needs to deal with the distortions in airport charge (and the overinvestment in capacity caused by imperfect airline competition) using the non-aeronautical price. Note again that introducing the price cap to non-aeronautical service will attain higher social welfare relative to the no-regulation case. Summing up the analysis in Sect. 6.4.3, we have the following proposition:

Proposition 3 *Under privatization with cost-based regulation on aeronautical service, there won't be an effect for underinvestment in airport capacity as in the case of price-cap regulation. This result holds irrespective of whether*

[21] This result is consistent with Zhang and Zhang et al. (2010).

non-aeronautical service is under price-cap regulation or not. The choice of regulatory forms involves a trade-off between a lower service quality from reduced airport capacity (and hence congestion) under price-cap regulation, and a higher airport charge from additional regulatory wastes under cost-based regulation.

6.5 Numerical Results

This section conducts numerical analysis to elaborate the above analytical results and obtain further insights. Here, in order to have closed-form solutions, we adopt sufficiently simple functional forms: both the sub-utility of aeronautical and non-aeronautical services and the time cost function are quadratic, and the airport capacity cost are linear:

$$U = z + a{q_0}^2 + bq_0 + d{x_1}^2 + ex_1 + fq_0x_1,$$

$$t(q_0, K) = g\left(\frac{q_0}{K}\right)^2, \quad \text{and}$$

$$C(K) = rK.$$

Unfortunately, we do not have a set of reliable empirical parameters that are used to fit our model. Thus, we choose parameters with the purpose to yield closed-form solutions, and then check the sensitivity of results by changing the values of parameters. In our "base case," we adopt the parameters of $a = -1$, $b = 2$, $d = -1$, $e = 2$, $f = 1$, $g = 1$, and $r = 0.1$ in these functions. The other parameters in the base case are: $c_0 = 0.5$, $c_1 = 1$, $N = M = 5$, $w = 0$, $\beta = 0.5$, and $\theta_0 = \theta_1 = \theta_K = 0.3$. These parameters have the following meaning: $a = -1$, $b = 2$, $d = -1$, and $e = 2$ are determined to make the analysis sufficiently simple yet still satisfy the second-order conditions and other regularity conditions. $f = 1$ (>0) guarantees that the air trip demand and the demand for non-aeronautical service are complementary. Larger g, c_0, c_1, r, N, M, and w, respectively, lead to higher time cost, higher marginal cost of aeronautical service, higher marginal cost of non-aeronautical service, higher airport capacity cost, more competition among airlines, more competition among the shops providing non-aeronautical service, and larger regulatory waste. $\theta_0 = \theta_1 = \theta_K = 0.3$ implies that a public airport has 30% higher costs in the marginal costs of aeronautical and non-aeronautical services and airport capacity cost, compared to a private airport. Further, when β is larger, the airport can absorb higher portions of the non-aeronautical profit. Until Sect. 6.5.4.3, we assume that there exists no regulatory waste under cost-based regulation ($w = 0$).

The above specification allows us to obtain the closed-form solutions for all the equilibrium outcomes considered in the text. The base-case results are summarized in Table 6.1 and will be discussed in Sects. 6.5.1–6.5.3. Sensitivity of the base-case results will be examined in Sect. 6.5.4.

6.5.1 Welfare Maximization vs. Public Airport

First, using the base-case results we compare the (equilibrium) outcomes of welfare maximization and public airport. As expected, the public-airport outcomes (Case 2 in Table 6.1) differ significantly from those under welfare maximization (Case 1). Air trip demand q_0, demand for non-aeronautical service x_1, and airport capacity K in the public-airport case range between 69.9% and 76.3% of those under welfare maximization. On the other hand, airport charge τ_0 is almost doubled and the time cost is 19.1% higher, indicating a lower quality of airport service. Social welfare (*SW*) of public airport is only 56.1%, compared to welfare maximization. The comparison suggests that it may not be appropriate to consider a public airport as a welfare-maximizing body.

6.5.2 Privatization

As indicated earlier, our explicit consideration of non-aeronautical service allows us to distinguish the regulation on aeronautical service and that on non-aeronautical service. First, simple privatization *without* any regulation (Case 3.1) is just a pure monopoly, under which airport charge can rise significantly (resulting in a reduced trip demand). Market power in non-aeronautical service, together with the falling trip demand, further suppresses the demand for non-aeronautical service. It is nevertheless worth noting that this monopoly case still attains higher social welfare that the public-airport case (Case 2). When the cost differences between private and public operations are significant, private operation can be better than public operation despite the market power of a pure monopoly.

When the regulator imposes price-cap regulation on non-aeronautical service (Case 3.2), the regulation lowers the non-aeronautical price to counteract market distortions in aeronautical service. As can be seen from Table 6.1, the non-aeronautical price is even lower than the marginal cost in our base case. This result is consistent with Proposition 1. Case 3.2 attains higher social welfare than privatization without any regulation (Case 3.1), because the regulator has one more instrument, price-cap regulation on non-aeronautical service, to maximize social welfare.

Introducing price-cap regulation to aeronautical service (Case 4.1) resolves monopoly aeronautical pricing and reduces airport charge to 63.6% of the monopoly level (Case 3.1). Social welfare is higher than privatization without any regulation (Case 3.1), but this regulation results in higher time costs and, hence, lower service quality, owing to a lower level of investment in airport capacity. If price-cap regulation is additionally introduced to non-aeronautical services (Case 4.2) the non-aeronautical price is made to be less than the marginal cost in order to counteract higher time costs caused by smaller airport capacity, which is consistent with Proposition 2.

Table 6.1 Base case

	Case 1	Case 2	Case 3.1	Case 3.2	Case 4.1	Case 4.2	Case 5.1	Case 5.2
	Welfare maximization	Public airport	Privatization					
Aeronautical service		Public	No regulation		Price-cap regulation		Cost-based regulation	
Non-aeronautical service		Public	No regulation	Price-cap regulation	No regulation	Price-cap regulation	No regulation	Price-cap regulation
q_0	1.062	0.810	0.393	0.415	0.574	0.601	0.737	0.855
x_1	1.031	0.755	0.580	0.771	0.656	0.866	0.724	1.008
K	2.882	2.015	1.193	1.260	1.175	1.236	2.237	2.597
Time cost	0.136	0.162	0.108	0.108	0.238	0.236	0.108	0.108
τ_0	0.292	0.585	1.486	1.624	0.945	1.093	0.804	0.804
p_0	0.771	0.973	1.686	1.833	1.270	1.428	1.142	1.189
p_1	1.000	1.300	1.232	0.873	1.262	0.868	1.289	0.839
SW	1.096	0.615	0.744	0.776	0.879	0.911	0.992	1.053

Finally, if only one sector can be regulated by the price cap under privatization, then regulating aeronautical service is more socially desirable than regulating non-aeronautical service: social welfare is 0.879 (Case 4.1) vs. 0.776 (Case 3.2) in Table 6.1. This is intuitive: Since aeronautical service is, in the present case, provided by a single operator whilst non-aeronautical service by five operators ($M = 5$ as indicated above), the extent of market distortion is greater for aeronautical service than for non-aeronautical service.

6.5.3 Price-Cap vs. Cost-Based Regulation

It is interesting to compare price cap with cost-based regulation, both of which are imposed upon aeronautical service under privatization. In the absence of regulation on non-aeronautical service, the cost-based regulation yields a much smaller time cost than the price cap: 0.108 (Case 5.1) vs. 0.238 (Case 4.1). This has to do with the underinvestment effect in airport capacity under price-cap regulation (but not under cost-based regulation) shown analytically earlier in the text. The same result also holds if non-aeronautical service is additionally regulated: 0.108 (Case 5.2) vs. 0.236 (Case 4.2). In terms of social welfare, cost-based regulation is again superior, with or without price-cap regulation on non-aeronautical service. In effect, cost-based regulation with the non-aeronautical price cap (Case 5.2) attains almost the same *SW* as the welfare-maximization case. We note, nonetheless, that these welfare comparisons stem from the base-case assumption of $w = 0$, i.e. the regulatory waste associated with cost-based regulation is disregarded. As to be seen below, adding the regulatory waste can overturn the result.

6.5.4 Sensitivity Analysis with Respect to the Base Case

This section checks the robustness of our base-case numerical results reported above, using alternative parameter values.[22]

6.5.4.1 Smaller Cost Differences Between Public and Private Operations

Table 6.2 shows the result in which we assume that a public airport has only 10% (rather than 30% in the base case) higher marginal costs in aeronautical service, non-aeronautical service, and airport capacity investment, than a private airport. Thus, we assume smaller cost differences of $\theta_0 = \theta_1 = \theta_K = 0.1$, than the base-case

[22] Note that a change in capacity cost r yields no interesting result. Thus, we do not report the results for a different value of r.

Table 6.2 Smaller cost differences: $\theta_0 = \theta_1 = \theta_K = 0.1$

	Case 1	Case 2	Case 3.1	Case 3.2	Case 4.1	Case 4.2	Case 5.1	Case 5.2
	Welfare maximization	Public airport	Privatization					
Aeronautical service		Public	No regulation		Price-cap regulation		Cost-based regulation	
Non-aeronautical service		Public	No regulation	Price-cap regulation	No regulation	Price-cap regulation	No regulation	Price-cap regulation
q_0	1.062	0.977	0.393	0.415	0.574	0.601	0.737	0.855
x_1	1.031	0.939	0.580	0.771	0.656	0.866	0.724	1.008
K	2.882	2.570	1.193	1.260	1.175	1.236	2.237	2.597
Time cost	0.136	0.145	0.108	0.108	0.238	0.236	0.108	0.108
τ_0	0.292	0.390	1.486	1.624	0.945	1.093	0.804	0.804
p_0	0.771	0.839	1.686	1.833	1.270	1.428	1.142	1.189
p_1	1.000	1.100	1.232	0.873	1.262	0.868	1.289	0.839
SW	1.096	0.919	0.744	0.776	0.879	0.911	0.992	1.053

differences of $\theta_0 = \theta_1 = \theta_K = 0.3$ (while other base-case parameters remain unchanged). Different from the result in the base case, a public airport (Case 2 in Table 6.2) now attains much higher social welfare than a pure monopoly (Case 3.1), which is expected given that the demerit of public operation is now relatively small. It also attains higher social welfare than the other ownership/regulation forms under privatization, except for the two cases of cost-based regulation (Cases 5.1 and 5.2).

6.5.4.2 Higher Time Cost

The results of higher time cost are given in Table 6.3, where $g = 3$, rather than $g = 1$ in the base case. Social welfare becomes smaller, because higher time cost implies higher congestion cost, which results in a higher welfare loss. Higher congestion cost, implied by higher time cost, also means that smaller airport capacity is more harmful. As a consequence, the demerit of price-cap regulation is magnified. Thus, the relative performance of price-cap regulation gets worse. In the base case, social welfare is 80.2% (= 0.879/1.096) of the welfare-maximization benchmark under no regulation on non-aeronautical service (Case 4.1) and 83.1% (= 0.911/1.096) under price-cap regulation on non-aeronautical service (Case 4.2). In Table 6.3, both figures now fall to 78.6% (= 0.720/0.915) and 81.7% (= 0.747/0.915).

6.5.4.3 Higher Regulatory Waste

Tables 6.4 and 6.5 summarize the results in which cost-based regulation accompanies a regulatory waste. As expected, social welfare under cost-based regulation, Cases 5.1 and 5.2 in Table 6.4, falls, in which we use $w = 0.25$ (instead of $w = 0$ in the base case). Furthermore, for regulating the privatized aeronautical service, price-cap regulation is better than cost-based regulation: social welfare is 0.879 in the former (Case 4.1) and 0.813 in the latter (Case 5.1). This result occurs only when non-aeronautical service is unregulated, however. When non-aeronautical service is regulated by price-cap regulation, the cost-based regulation is still better than the price cap: social welfare is 0.975 in the former (Case 5.2) and 0.911 in the latter (Case 4.2).

When the regulatory waste is much larger, $w = 0.5$, in Table 6.5, the problem of the cost-based regulation with no regulation on non-aeronautical service is unsolvable. The regulated airport always obtains a large fixed-amount profit of 0.5 by cost-based regulation, irrespective of its choice of airport charge and airport capacity, and consequently, its behavior is indeterminate. We see that social welfare in Case 5.2 decreases from 0.975 to 0.754, when the regulatory waste rises from 0.25 to 0.50. As a result, even when non-aeronautical service is regulated by price-cap regulation, the price cap is better than the cost-based regulation: social welfare is 0.911 in the former (Case 4.2) and 0.754 in the latter (Case 5.2). This exercise with varying w demonstrates that price-cap regulation is superior to cost-based regulation

Table 6.3 Higher time cost: $g = 3$

	Case 1	Case 2	Case 3.1	Case 3.2	Case 4.1	Case 4.2	Case 5.1	Case 5.2
	Welfare maximization	Public airport	Privatization					
Aeronautical service		Public	No regulation		Price-cap regulation		Cost-based regulation	
Non-aeronautical service		Public	No regulation	Price-cap regulation	No regulation	Price-cap regulation	No regulation	Price-cap regulation
q_0	0.942	0.667	0.341	0.361	0.470	0.494	0.635	0.746
x_1	0.971	0.684	0.559	0.737	0.612	0.808	0.681	0.948
K	3.687	2.393	1.494	1.581	1.487	1.569	2.782	3.269
Time cost	0.196	0.233	0.156	0.156	0.299	0.297	0.156	0.156
τ_0	0.436	0.756	1.521	1.652	1.066	1.206	0.938	0.938
p_0	0.891	1.116	1.720	1.859	1.374	1.523	1.255	1.299
p_1	1.000	1.300	1.224	0.886	1.245	0.877	1.273	0.850
SW	0.915	0.456	0.630	0.656	0.720	0.747	0.822	0.876

Table 6.4 Higher regulatory waste: $w = 0.25$

	Case 1	Case 2	Case 3.1	Case 3.2	Case 4.1	Case 4.2	Case 5.1	Case 5.2
	Welfare maximization	Public airport	Privatization					
Aeronautical service		Public	No regulation		Price-cap regulation		Cost-based regulation	
Non-aeronautical service		Public	No regulation	Price-cap regulation	No regulation	Price-cap regulation	No regulation	Price-cap regulation
q_0	1.062	0.810	0.393	0.415	0.574	0.601	0.467	0.724
x_1	1.031	0.755	0.580	0.771	0.656	0.866	0.611	1.038
K	2.882	2.015	1.193	1.260	1.175	1.236	1.417	2.198
Time cost	0.136	0.162	0.108	0.108	0.238	0.236	0.108	0.108
τ_0	0.292	0.585	1.486	1.624	0.945	1.093	1.339	1.149
p_0	0.771	0.973	1.686	1.833	1.270	1.428	1.570	1.482
p_1	1.000	1.300	1.232	0.873	1.262	0.868	1.244	0.647
SW	1.096	0.615	0.744	0.776	0.879	0.911	0.813	0.975

Table 6.5 Higher regulatory waste: $w = 0.5$

	Case 1	Case 2	Case 3.1	Case 3.2	Case 4.1	Case 4.2	Case 5.1	Case 5.2
	Welfare maximization	Public airport	Privatization					
Aeronautical service		Public	No regulation		Price-cap regulation		Cost-based regulation	
Non-aeronautical service		Public	No regulation	Price-cap regulation	No regulation	Price-cap regulation	No regulation	Price-cap regulation
q_0	1.062	0.810	0.393	0.415	0.574	0.601	n.a.	0.642
x_1	1.031	0.755	0.580	0.771	0.656	0.866	n.a.	1.275
K	2.882	2.015	1.193	1.260	1.175	1.236	n.a.	1.950
Time cost	0.136	0.162	0.108	0.108	0.238	0.236	n.a.	0.108
τ_0	0.292	0.585	1.486	1.624	0.945	1.093	n.a.	1.582
p_0	0.771	0.973	1.686	1.833	1.270	1.428	n.a.	1.882
p_1	1.000	1.300	1.232	0.873	1.262	0.868	n.a.	0.092
SW	1.096	0.615	0.744	0.776	0.879	0.911	n.a.	0.754

when regulatory waste is high, even if we explicitly consider the (undesirable) downward effect on airport capacity.

6.5.4.4 Higher Degrees of Airline Competition and Competition Among Non-Aeronautical Shops

We here focus on the effect of the degree of competition in airlines and non-aeronautical service. Suppose that $N = M = 100$ and hence both the airline market and non-aeronautical service are more competitive than the base case (where $N = M = 5$). The results are in Table 6.6. Compared to the base case (Table 6.1), an increase in social welfare by privatization is larger.

6.5.4.5 Higher Internalization Rate of Profit from Non-Aeronautical Service

Finally, we examine the effect of the degree of internalization of profit from non-aeronautical service. Table 6.7 shows the result in which the privatized airport can absorb all the profit from privatized non-aeronautical service, that is $\beta = 1$ (instead of $\beta = 0.5$ in the base case). The different result from Table 6.1 arises in Cases 3.1–4.2, in which a monopoly airport maximizes its profit taking into account of the profit from non-aeronautical service. No different results are obtained when cost-based regulation is imposed on aeronautical service (Cases 5.1 and 5.2), because larger β has no direct impact on airport charge under cost-based regulation. Under profit maximization, a monopoly airport cares about the profit of non-aeronautical service, and thus, larger β means more importance of such a profit. Consequently, airport charge is reduced more significantly, as compared to that in the base case, so as to increase the profit from non-aeronautical service. Whether this decrease in airport change is desirable socially depends on the regulation on non-aeronautical service. In the absence of regulation on non-aeronautical service (Cases 3.1 and 4.1), social welfare is, respectively, 67.9% (= 0.744/1.096) and 80.2% (= 0.879/1.096) of the base welfare-maximization level in Table 6.1, while the corresponding figures are, respectively, 70.2% (= 0.769/1.096) and 82.8% (= 0.908/1.096) in Table 6.7. This result shows that a decrease in airport charge, caused by an increase in the absorption rate of non-aeronautical profit, has a positive impact on social welfare.

The situation changes however, when the price of non-aeronautical service is subject to price-cap regulation. With the price cap on non-aeronautical service (Cases 3.2 and 4.2), social welfare is, respectively, 70.8% (= 0.776/1.096) and 83.1% (= 0.911/1.096) of the base welfare-maximization level in Table 6.1, while it is 70.4% (= 0.771/1.096) and 82.7% (= 0.906/1.096) in Table 6.7: that is, the figures are slightly decreased. The reason is as follows. If the regulator sets the level of price cap low, it needs to raise airport charge instead. When β is larger, this effect is larger, because an airport considers the profits from non-aeronautical service more

Table 6.6 More competition in airlines and providers of non-aeronautical service: $N = M = 100$

	Case 1	Case 2	Case 3.1	Case 3.2	Case 4.1	Case 4.2	Case 5.1	Case 5.2
	Welfare maximization	Public airport	Privatization					
Aeronautical service		Public	No regulation		Price-cap regulation		Cost-based regulation	
Non-aeronautical service		Public	No regulation	Price-cap regulation	No regulation	Price-cap regulation	No regulation	Price-cap regulation
q_0	1.062	0.810	0.522	0.534	0.729	0.740	1.040	1.050
x_1	1.031	0.755	0.754	0.832	0.856	0.922	1.010	1.031
K	2.882	2.015	1.427	1.459	1.460	1.488	2.840	2.869
Time cost	0.136	0.162	0.134	0.134	0.249	0.247	0.134	0.134
τ_0	0.747	0.954	1.562	1.617	1.130	1.176	0.773	0.773
p_0	0.771	0.973	1.575	1.631	1.149	1.195	0.797	0.797
p_1	1.000	1.300	1.015	0.870	1.017	0.896	1.020	0.988
SW	1.096	0.615	0.877	0.882	0.981	0.985	1.095	1.096

Table 6.7 Higher absorption rate of non-aeronautical profits: $\beta = 1$

	Case 1	Case 2	Case 3.1	Case 3.2	Case 4.1	Case 4.2	Case 5.1	Case 5.2
	Welfare maximization	Public airport	Privatization					
Aeronautical service		Public	No regulation		Price-cap regulation		Cost-based regulation	
Non-aeronautical service		Public	No regulation	Price-cap regulation	No regulation	Price-cap regulation	No regulation	Price-cap regulation
q_0	1.062	0.810	0.418	0.406	0.618	0.588	0.737	0.855
x_1	1.031	0.755	0.591	0.703	0.674	0.794	0.724	1.008
K	2.882	2.015	1.269	1.234	1.268	1.208	2.237	2.597
Time cost	0.136	0.162	0.108	0.108	0.238	0.237	0.108	0.108
τ_0	0.292	0.585	1.436	1.576	0.858	1.052	0.804	0.804
p_0	0.771	0.973	1.646	1.782	1.201	1.381	1.142	1.189
p_1	1.000	1.300	1.236	1.000	1.270	1.000	1.289	0.839
SW	1.096	0.615	0.769	0.771	0.908	0.906	0.992	1.053

seriously. Thus, with a larger β, the regulator is less inclined to set the level of price cap lower. In fact, the price cap is 0.873 and 0.868 in Cases 3.2 and 4.2 in the base-case Table 6.1 ($\beta = 0.5$), while it is 1.000 in both cases in Table 6.7 ($\beta = 1$). This high price cap on non-aeronautical service reduces the demand for non-aeronautical service and welfare, thereby worsening the relative performance of price-cap regulation on non-aeronautical service.

6.6 Concluding Remarks

Our main objective in writing this paper is to have a better understanding of airport privatization, governance, and regulation, taking into account of behavior of public airport administration, and differences in regulatory forms. Our analysis and numerical results showed that, first, the regulator may set the price of non-aeronautical service lower than its marginal cost to counteract a high airport charge, if it can regulate non-aeronautical service. This result stems from our realistic assumption that aeronautical and non-aeronautical services are complementary. Non-aeronautical service may not be profitable anymore, if the regulator can regulate it. Thus, our analysis highlights the importance of interactions between the aeronautical and non-aeronautical services, which is different from the existing studies on airport privatization and regulation that typically consider the aeronautical service only, or treat the non-aeronautical service as a profit center exogenously. One innovation of the present paper is that we included both markets in a consistent way with consumers' and producers' optimization behaviors. An analysis using numerically solvable models has given us several further insights. For instance, we found that if only one sector can be regulated under privatization (and if the extent of market distortion is greater in aeronautical service than in non-aeronautical service), then regulating aeronautical service is more socially desirable than regulating non-aeronautical service. We also found that the welfare gain from privatization is greater under more competitive environments among airlines and/or among non-aeronautical service providers.

Second, privatization with price-cap regulation on aeronautical service could reduce airport charge, but also introduce an underinvestment in airport capacity which could lower social welfare. Whether price-cap regulation or cost-based regulation is socially superior depends on the relative importance of an underinvestment effect in airport capacity under price-cap regulation, versus a regulatory waste associated with cost-based regulation. That is, there exists an efficiency–quality trade-off: Whilst cost-based regulation entails an efficiency loss relative to price-cap regulation, it is associated with higher service quality (lower congestion delay costs). This trade-off has an important implication for assessing airport regulation, as existing empirical studies (e.g., Assaf and Gillen 2012, and others) are concentrated mainly on how economic regulation would affect airport efficiency rather than its quality of service. When an airport has slack capacity, price-cap regulation is better, because we do not need to care about the underinvestment effect but do need to care about the regulatory waste. On the contrary, at a congested airport, the underinvestment effect would be more serious than the regulatory waste, suggesting the superiority of cost-based regulation. This highlight is, to our best knowledge, also a new standpoint in the literature on airport regulation.[23]

The paper has raised a number of other issues and avenues for future research. First, we consider "full" privatization, in which both aeronautical and non-aeronautical services are privatized. However, it is at least theoretically possible that only non-aeronautical service (or only aeronautical service) is privatized. The preliminary result on this "partial" privatization is shown in Kidokoro and Zhang (2017), but we need a more full-fledged analysis on this "partial" privatization. Second, for given price-cap regulation or cost-based regulation, different forms of regulation concerning non-aeronautical service exist. The "single till" regulation, for instance, requires that the airport achieves overall financial breakeven, whilst the "dual till" regulation requires the airport to achieve financial breakeven in aeronautical operation. It would be useful to apply our analysis to single-till and dual-till policies explicitly. Third, the present paper has considered a single monopoly airport. Competition between airports exists and is a growing phenomenon, especially for multiple airport regions (MARs) and for major hubs that compete for connecting passengers. Further work along the lines of, e.g., de Borger and van Dender (2006), Basso and Zhang (2007), Zhang et al. 2010; Mun and Teraji (2012), Yan and Winston (2014), and de Palma et al. (2018) may yield new insights on airport privatization and regulation. Forth, an airport may have various vertical arrangements with its airlines (apart from airport charges) including concession revenue sharing (Yang et al. 2015). Incorporating this feature and related airlines' countervailing power (Haskel et al. 2013; Bottosso et al. 2017) would further improve our understanding of the issues. Finally, we have, as indicated earlier, assumed away the locational-rent that an airport possesses over its non-aeronautical service. As Forsyth (2004a) and Kidokoro et al. (2016) suggested, high profitability of an airport also comes from the locational-rent. Extending our analysis of non-aeronautical service including the locational-rent, as well as imperfect competition between non-aeronautical service providers, is another direction of future research.

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[23] The result on underinvestment in capacity may not be new, but the tradeoff between the regulatory waste and underinvestment is new. Kidokoro (2006) derives this result by simulation for Japanese urban railways.

Appendix 1

Derivation of $q_0(\tau_0, p_1, K)$ and $x_1(\tau_0, p_1, K)$ in Sect. 6.3.

Totally differentiating (6.4) and (6.6), we obtain

$$\begin{pmatrix} dq_0 \\ dx_1 \end{pmatrix} = A^{-1} \begin{pmatrix} d\tau_0 + \left(\dfrac{\partial t}{\partial K} + \dfrac{\partial^2 t}{\partial q_0 \partial K} \dfrac{q_0}{N} \right) dK \\ dp_1 \end{pmatrix} \tag{6.46}$$

where

$$A \equiv \begin{pmatrix} \dfrac{\partial^2 u(q_0,\ x_1)}{\partial q_0{}^2} - \dfrac{\partial t}{\partial q_0} + \left(\dfrac{\partial^2 u(q_0,\ x_1)}{\partial q_0{}^2} - \dfrac{\partial t}{\partial q_0} \right) \dfrac{1}{N} + \left(\dfrac{\partial^3 u(q_0,\ x_1)}{\partial q_0{}^3} - \dfrac{\partial^2 t}{\partial q_0{}^2} \right) \dfrac{q_0}{N} & \dfrac{\partial^2 u(q_0,\ x_1)}{\partial q_0 \partial x_1} + \dfrac{\partial^3 u(q_0,\ x_1)}{\partial q_0{}^2 \partial x_1} \dfrac{q_0}{N} \\ \dfrac{\partial^2 u(q_0,\ x_1)}{\partial x_1 \partial q_0} & \dfrac{\partial^2 u(q_0,\ x_1)}{\partial x_1{}^2} \end{pmatrix}. \tag{6.47}$$

From (6.46) and (6.47) we obtain the equilibrium quantities as functions of airport charge τ_0, price of non-aeronautical service p_1, and capacity K: i.e. $q_0(\tau_0, p_1, K)$ and $x_1(\tau_0, p_1, K)$, which satisfy

$$\frac{dq_0}{dK} = \frac{dq_0}{d\tau_0} \left(\frac{\partial t}{\partial K} + \frac{\partial^2 t}{\partial q_0 \partial K} \frac{q_0}{N} \right), \tag{6.48}$$

$$\frac{dx_1}{dK} = \frac{dx_1}{d\tau_0} \left(\frac{\partial t}{\partial K} + \frac{\partial^2 t}{\partial q_0 \partial K} \frac{q_0}{N} \right). \tag{6.49}$$

From (6.2) and (6.48), we know that $\frac{dq_0}{d\tau_0}$ and $\frac{dq_0}{dK}$ have different signs. Because it is unrealistic that an increase in airport charge (or a decrease in airport capacity) increases the demand for air trip, we assume $\frac{dq_0}{d\tau_0} < 0$ and $\frac{dq_0}{dK} > 0$. From the complementarity between aeronautical and non-aeronautical services, we have $\frac{dx_1}{d\tau_0} < 0$ and $\frac{dx_1}{dK} > 0$.

Appendix 2

Derivation of (6.14)–(6.16) from the maximization of SW, (6.13).

The FOCs are:

$$\frac{\partial SW}{\partial \tau_0} = \frac{\partial u}{\partial q_0} \frac{\partial q_0}{\partial \tau_0} + \frac{\partial u}{\partial x_1} \frac{\partial x_1}{\partial \tau_0} - \left(\frac{\partial t}{\partial q_0} \frac{\partial q_0}{\partial \tau_0} \right) q_0 - (c_0 + t) \frac{\partial q_0}{\partial \tau_0} - c_1 \frac{\partial x_1}{\partial \tau_0} = 0, \tag{6.50}$$

$$\frac{\partial SW}{\partial p_1} = \frac{\partial u}{\partial q_0}\frac{\partial q_0}{\partial p_1} + \frac{\partial u}{\partial x_1}\frac{\partial x_1}{\partial p_1} - \left(\frac{\partial t}{\partial q_0}\frac{\partial q_0}{\partial p_1}\right)q_0 - (c_0 + t)\frac{\partial q_0}{\partial p_1} - c_1\frac{\partial x_1}{\partial p_1} = 0, \quad (6.51)$$

$$\frac{\partial SW}{\partial K} = \frac{\partial u}{\partial q_0}\frac{\partial q_0}{\partial K} + \frac{\partial u}{\partial x_1}\frac{\partial x_1}{\partial K} - \left(\frac{\partial t}{\partial q_0}\frac{\partial q_0}{\partial K} + \frac{\partial t}{\partial K}\right)q_0 - (c_0 + t)\frac{\partial q_0}{\partial K} - \frac{\partial C}{\partial K} - c_1\frac{\partial x_1}{\partial K} = 0. \quad (6.52)$$

Rearranging (6.50) and (6.51), using (6.3) and (6.4), yields

$$p_0 = c_0 + \frac{\partial t}{\partial q_0}q_0 \quad (6.53)$$

and (6.15). Equation (6.14) is derived by substituting (6.7) into (6.53). Rearranging (6.52), using (6.3), (6.4), (6.15), and (6.53) immediately yields (6.16).

Appendix 3

Derivation of (6.18)–(6.20) from the maximization of SW^{Public}, (6.17).

The FOCs are:

$$\frac{\partial SW^{Public}}{\partial \tau_0} = \frac{\partial u}{\partial q_0}\frac{\partial q_0}{\partial \tau_0} + \frac{\partial u}{\partial x_1}\frac{\partial x_1}{\partial \tau_0} - \left(\frac{\partial t}{\partial q_0}\frac{\partial q_0}{\partial \tau_0}\right)q_0 - ((1+\theta_0)c_0 + t) \times \frac{\partial q_0}{\partial \tau_0} - (1+\theta_1)c_1\frac{\partial x_1}{\partial \tau_0} = 0, \quad (6.54)$$

$$\frac{\partial SW^{Public}}{\partial p_1} = \frac{\partial u}{\partial q_0}\frac{\partial q_0}{\partial p_1} + \frac{\partial u}{\partial x_1}\frac{\partial x_1}{\partial p_1} - \left(\frac{\partial t}{\partial q_0}\frac{\partial q_0}{\partial p_1}\right)q_0 - ((1+\theta_0)c_0 + t) \times \frac{\partial q_0}{\partial p_1} - (1+\theta_1)c_1\frac{\partial x_1}{\partial p_1} = 0, \quad (6.55)$$

$$\frac{\partial SW^{Public}}{\partial K} = \frac{\partial u}{\partial q_0}\frac{\partial q_0}{\partial K} + \frac{\partial u}{\partial x_1}\frac{\partial x_1}{\partial K} - \left(\frac{\partial t}{\partial q_0}\frac{\partial q_0}{\partial K} + \frac{\partial t}{\partial K}\right)q_0 - ((1+\theta_0)c_0 + t) \times \frac{\partial q_0}{\partial K} - (1+\theta_K)\frac{\partial C}{\partial K} - (1+\theta_1)c_1\frac{\partial x_1}{\partial K} = 0. \quad (6.56)$$

Rearranging (6.54) and (6.55), using (6.3) and (6.4), yields

$$p_0 = (1 + \theta_0)c_0 + \frac{\partial t}{\partial q_0} q_0 \tag{6.57}$$

and (6.19). Equation (6.18) is derived by substituting (6.7) into (6.57). Rearranging (6.56), using (6.3), (6.4), (6.19), and (6.57), immediately yields (6.20).

Appendix 4

Derivation of (6.25) and (6.26) from the maximization of $\Pi^{Airport4.1.1}$, (6.24).

$q_0(\tau_0, K)$ and $x_1(\tau_0, K)$ are derived in the same way as Appendix 1, and we have (6.48) and (6.49). The FOCs for profit maximization are:

$$\frac{\partial \Pi^{Airport4.1.1}}{\partial \tau_0} = q_0(\tau_0, K) + (\tau_0 - c_0)\frac{\partial q_0}{\partial \tau_0} + \beta \frac{\partial \Pi^{Nonaero}}{\partial \tau_0} = 0, \tag{6.58}$$

$$\frac{\partial \Pi^{Airport4.1.1}}{\partial K} = (\tau_0 - c_0)\frac{\partial q_0}{\partial K} + \beta \frac{\partial \Pi^{Nonaero}}{\partial K} - \frac{\partial C}{\partial K} = 0. \tag{6.59}$$

Rearranging (6.58) immediately yields (6.25). Note that

$$\begin{aligned}
\frac{\partial \Pi^{Nonaero}}{\partial K} &= (p_1 - c_1)\frac{\partial x_1}{\partial K} + \frac{\partial p_1}{\partial K} x_1 \\
&= (p_1 - c_1)\frac{\partial x_1}{\partial K} + \frac{\partial \left(\frac{\partial u(q_0,\ x_1)}{\partial x_1}\right)}{\partial K} x_1 \\
&= (p_1 - c_1)\frac{\partial x_1}{\partial K} + \left(\frac{\partial^2 u}{\partial x_1 \partial q_0}\frac{\partial q_0}{\partial K} + \frac{\partial^2 u}{\partial {x_1}^2}\frac{\partial x_1}{\partial K}\right) x_1 \\
&= \left((p_1 - c_1)\frac{\partial x_1}{\partial \tau_0} + \left(\frac{\partial^2 u}{\partial x_1 \partial q_0}\frac{\partial q_0}{\partial \tau_0} + \frac{\partial^2 u}{\partial {x_1}^2}\frac{\partial x_1}{\partial \tau_0}\right) x_1\right)\left(\frac{\partial t}{\partial K} + \frac{\partial^2 t}{\partial q_0 \partial K}\frac{q_0}{N}\right) \\
&= \frac{\partial \Pi^{Nonaero}}{\partial \tau_0}\left(\frac{\partial t}{\partial K} + \frac{\partial^2 t}{\partial q_0 \partial K}\frac{q_0}{N}\right)
\end{aligned} \tag{6.60}$$

from (6.4), (6.48), and (6.49). Using (6.48) and (6.60), we rearrange (6.59) as

$$\left(\frac{\partial t}{\partial K} + \frac{\partial^2 t}{\partial q_0 \partial K}\frac{q_0}{N}\right)\left((\tau_0 - c_0)\frac{\partial q_0}{\partial \tau_0} + \beta \frac{\partial \Pi^{Nonaero}}{\partial \tau_0}\right) = \frac{\partial C}{\partial K}. \tag{6.61}$$

Substituting (6.58) into (6.61) yields (6.26) by (6.2).

Appendix 5

Derivation of (6.25), (6.26), and (6.30) from the maximization of $\Pi^{Airport4.1.2}$, (6.28), and $SW^{4.1.2}$, (6.29).

$q_0(\tau_0, \overline{p}_1, K)$ and $x_1(\tau_0, \overline{p}_1, K)$are derived in the same way as Appendix 1, and we have (6.48), (6.49), and (6.60). The FOCs for profit maximization are:

$$\frac{\partial \Pi^{Airport4.1.2}}{\partial \tau_0} = q_0(\tau_0, \overline{p}_1, K) + (\tau_0 - c_0)\frac{\partial q_0}{\partial \tau_0} + \beta \frac{\partial \Pi^{Nonaero}}{\partial \tau_0} = 0, \tag{6.62}$$

$$\frac{\partial \Pi^{Airport4.1.2}}{\partial K} = (\tau_0 - c_0)\frac{\partial q_0}{\partial K} + \beta \frac{\partial \Pi^{Nonaero}}{\partial K} - \frac{\partial C}{\partial K} = 0. \tag{6.63}$$

Rearranging (6.62) immediately yields (6.25). Using (6.48), (6.60), and (6.62), (6.63) is rewritten as (6.26) by (6.2).

The FOC for welfare maximization is

$$\frac{\partial SW^{4.1.2}}{\partial \overline{p}_1} = \frac{\partial u}{\partial q_0}\frac{\partial q_0}{\partial \overline{p}_1} + \frac{\partial u}{\partial x_1}\frac{\partial x_1}{\partial \overline{p}_1} - \left(\frac{\partial t}{\partial q_0}\frac{\partial q_0}{\partial \overline{p}_1} + \frac{\partial t}{\partial K}\frac{\partial K}{\partial \overline{p}_1}\right)q_0 - (c_0 + t)$$
$$\times \frac{\partial q_0}{\partial \overline{p}_1} - \frac{\partial C}{\partial K}\frac{\partial K}{\partial \overline{p}_1} - c_1\frac{\partial x_1}{\partial \overline{p}_1} = 0. \tag{6.64}$$

Rearranging (6.64), using (6.3), (6.4), and (6.7), yields (6.30).

Appendix 6

Derivation of (6.35) and (6.36) from the maximization of $\Pi^{Airport4.2.1}$, (6.33), and $SW^{4.2.1}$, (6.34).

$q_0(\overline{\tau}_0, K)$ and $x_1(\overline{\tau}_0, K)$ are derived in the same way as Appendix 1, and we have:

$$\frac{dq_0}{dK} = \frac{dq_0}{d\overline{\tau}_0}\left(\frac{\partial t}{\partial K} + \frac{\partial^2 t}{\partial q_0 \partial K}\frac{q_0}{N}\right), \tag{6.65}$$

$$\frac{dx_1}{dK} = \frac{dx_1}{d\overline{\tau}_0}\left(\frac{\partial t}{\partial K} + \frac{\partial^2 t}{\partial q_0 \partial K}\frac{q_0}{N}\right), \tag{6.66}$$

and (6.60). The FOC for profit maximization is:

$$\frac{\partial \Pi^{Airport4.2.1}}{\partial K} = (\overline{\tau}_0 - c_0)\frac{\partial q_0}{\partial K} + \beta \frac{\partial \Pi^{Nonaero}}{\partial K} - \frac{\partial C}{\partial K} = 0. \tag{6.67}$$

Using (6.60) and (6.65), (6.67) is rearranged as,

$$\left(\frac{\partial t}{\partial K}+\frac{\partial^2 t}{\partial q_0 \partial K}\frac{q_0}{N}\right)\left((\overline{\tau}_0-c_0)\frac{\partial q_0}{\partial \tau_0}+\beta\frac{\partial \Pi^{Nonaero}}{\partial \tau_0}\right)=\frac{\partial C}{\partial K}. \tag{6.68}$$

When $(\overline{\tau}_0-c_0)\frac{\partial q_0}{\partial \tau_0}+\beta\frac{\partial \Pi^{Nonaero}}{\partial \tau_0}>-q_0$, i.e., $\overline{\tau}_0<c_0-\frac{q_0}{\frac{\partial q_0}{\partial \overline{\tau}_0}}-\frac{\beta\frac{\partial \Pi^{Nonaero}}{\partial \tau_0}}{\frac{\partial q_0}{\partial \overline{\tau}_0}}$, from (6.2) we have

$$-\left(\frac{\partial t}{\partial K}+\frac{\partial^2 t}{\partial q_0 \partial K}\frac{q_0}{N}\right)q_0>\frac{\partial C}{\partial K}=\left(\frac{\partial t}{\partial K}+\frac{\partial^2 t}{\partial q_0 \partial K}\frac{q_0}{N}\right) \times\left((\overline{\tau}_0-c_0)\frac{\partial q_0}{\partial \tau_0}+\beta\frac{\partial \Pi^{Nonaero}}{\partial \tau_0}\right) \tag{6.69}$$

which is (6.36).

The FOC for welfare maximization is

$$\frac{\partial SW^{4.2.1}}{\partial \overline{\tau}_0}=\frac{\partial u}{\partial q_0}\frac{\partial q_0}{\partial \overline{\tau}_0}+\frac{\partial u}{\partial x_1}\frac{\partial x_1}{\partial \overline{\tau}_0}-\left(\frac{\partial t}{\partial q_0}\frac{\partial q_0}{\partial \overline{\tau}_0}+\frac{\partial t}{\partial K}\frac{\partial K}{\partial \overline{\tau}_0}\right)q_0-(c_0+t) \times\frac{\partial q_0}{\partial \overline{\tau}_0}-\frac{dC}{dK}\frac{\partial K}{\partial \overline{\tau}_0}-c_1\frac{\partial x_1}{\partial \overline{\tau}_0}=0. \tag{6.70}$$

Rearranging (6.70), using (6.3), (6.4), and (6.7), yields (6.35).

Appendix 7

Derivation of (6.36), (6.39), and (6.40) from the maximization of $\Pi^{Airport4.2.2}$, (6.37), and $SW^{4.2.2}$, (6.38).

$q_0(\overline{\tau}_0, \overline{p}_1, K)$ and $x_1(\overline{\tau}_0, \overline{p}_1, K)$, are derived in the same way as Appendix 1, and we have (6.65) and (6.66), which also yields (6.60). The FOC for profit maximization is:

$$\frac{\partial \Pi^{Airport4.2.2}}{\partial K}=(\overline{\tau}_0-c_0)\frac{\partial q_0}{\partial K}+\beta\frac{\partial \Pi^{Nonaero}}{\partial K}-\frac{\partial C}{\partial K}=0, \tag{6.71}$$

which coincides with (6.67). We derive (6.36) in the same way as Appendix 6.

The FOC for welfare maximization is

$$\frac{\partial SW^{4.2.2}}{\partial \overline{\tau}_0}=\left(\overline{\tau}_0-c_0-\left(\frac{\partial^2 u}{\partial {q_0}^2}-\frac{\partial t}{\partial q_0}\right)\frac{q_0}{N}-\frac{\partial t}{\partial q_0}q_0\right)\frac{\partial q_0}{\partial \overline{\tau}_0}+(\overline{p}_1-c_1) \times\frac{\partial x_1}{\partial \overline{\tau}_0}+\left(-\frac{\partial t}{\partial K}q_0-\frac{\partial C}{\partial K}\right)\frac{\partial K}{\partial \overline{\tau}_0}=0, \tag{6.72}$$

$$\frac{\partial SW^{4.2.2}}{\partial \overline{p}_1} = \left(\overline{\tau}_0 - c_0 - \left(\frac{\partial^2 u}{\partial {q_0}^2} - \frac{\partial t}{\partial q_0}\right)\frac{q_0}{N} - \frac{\partial t}{\partial q_0} q_0\right)\frac{\partial q_0}{\partial \overline{p}_1} + (\overline{p}_1 - c_1)$$
$$\times \frac{\partial x_1}{\partial \overline{p}_1} + \left(-\frac{\partial t}{\partial K} q_0 - \frac{\partial C}{\partial K}\right)\frac{\partial K}{\partial \overline{p}_1} = 0, \tag{6.73}$$

where (6.3), (6.4), and (6.7) are applied. From (6.72) and (6.73), we have

$$\frac{\partial SW^{4.2.2}}{\partial \overline{\tau}_0}\frac{\partial x_1}{\partial \overline{p}_1} - \frac{\partial SW^{4.2.2}}{\partial \overline{p}_1}\frac{\partial x_1}{\partial \overline{\tau}_0} = 0, \tag{6.74}$$

$$\frac{\partial SW^{4.2.2}}{\partial \overline{\tau}_0}\frac{\partial q_0}{\partial \overline{p}_1} - \frac{\partial SW^{4.2.2}}{\partial \overline{p}_1}\frac{\partial q_0}{\partial \overline{\tau}_0} = 0. \tag{6.75}$$

Rearranging (6.74) and (6.75), respectively, yields (6.39) and (6.40).

Appendix 8

Derivation of (6.26) from the maximization of $\Pi^{Airport4.3.1}$, (6.41), under the constraint of (6.42).

$q_0(\tau_0, K)$ and $x_1(\tau_0, K)$ are derived in the same way as Appendix 1, and we have (6.48), (6.49), and (6.60). The Lagrangian for profit maximization can be set up as

$$\Lambda^{4.3.1} = (\tau_0 - c_0)q_0(\tau_0, K) + \beta\Pi^{Nonaero} - C(K)$$
$$+ \lambda[w + c_0 q_0 + C(K) - \tau_0 q_0(\tau_0, K)]. \tag{6.76}$$

The FOCs are

$$\frac{\partial \Lambda^{4.3.1}}{\partial \tau_0} = q_0(\tau_0, K) + (\tau_0 - c_0)\frac{\partial q_0}{\partial \tau_0} + \beta\frac{\partial \Pi^{Nonaero}}{\partial \tau_0}$$
$$+ \lambda\left[c_0\frac{\partial q_0}{\partial \tau_0} - q_0 - \tau_0\frac{\partial q_0}{\partial \tau_0}\right] = 0, \tag{6.77}$$

$$\frac{\partial \Lambda^{4.3.1}}{\partial K} = (\tau_0 - c_0)\frac{\partial q_0}{\partial K} + \beta\frac{\partial \Pi^{Nonaero}}{\partial K} - \frac{\partial C}{\partial K}$$
$$+ \lambda\left[c_0\frac{\partial q_0}{\partial K} + \frac{dC}{dK} - \tau_0\frac{\partial q_0}{\partial K}\right] = 0. \tag{6.78}$$

Rearranging (6.78), using (6.48), (6.60), and (6.77), yields

$$-(1-\lambda)\left(\frac{\partial t}{\partial K}+\frac{\partial^2 t}{\partial q_0 \partial K}\frac{q_0}{N}\right)q_0=(1-\lambda)\frac{\partial C}{\partial K}. \tag{6.79}$$

When $\lambda = 1$, (6.77) and (6.78) can be written as

$$\frac{\partial \Lambda^{4.3.1}}{\partial \tau_0}=\beta\frac{\partial \Pi^{Nonaero}}{\partial \tau_0}=0, \tag{6.80}$$

$$\frac{\partial \Lambda^{4.3.1}}{\partial K}=\beta\frac{\partial \Pi^{Nonaero}}{\partial K}=0. \tag{6.81}$$

However, (6.60) implies that (6.81) can be rearranged as

$$\frac{\partial \Lambda^{4.3.1}}{\partial K}=\beta\frac{\partial \Pi^{Nonaero}}{\partial \tau_0}\left(\frac{\partial t}{\partial K}+\frac{\partial^2 t}{\partial q_0 \partial K}\frac{q_0}{N}\right)=0, \tag{6.82}$$

which yields the same condition as (6.80). Thus, the model degenerates and airport capacity is indeterminate. We then assume $\lambda \neq 1$, which immediately yields (6.26) from (6.79) and (6.2).

Appendix 9

Derivation of (6.26) and (6.30) from the maximization of $\Pi^{Airport4.3.2}$, (6.43), under the constraint of (6.44) and the maximization of $SW^{4.3.2}$, (6.45).

$q_0(\tau_0, \overline{p}_1, K)$ and $x_1(\tau_0, \overline{p}_1, K)$ are derived in the same way as Appendix 1, and we have (6.48), (6.49), and (6.60). The Lagrangian for profit maximization can be set up as

$$\begin{aligned}\Lambda^{4.3.2}=&(\tau_0-c_0)q_0(\tau_0,\overline{p}_1,K)+\beta(\overline{p}_1-c_1)x_1-C(K)\\&+\lambda[w+c_0q_0+C(K)-\tau_0q_0(\tau_0,\overline{p}_1,K)].\end{aligned} \tag{6.83}$$

The FOCs are

$$\begin{aligned}\frac{\partial \Lambda^{4.3.2}}{\partial \tau_0}=&q_0(\tau_0,\overline{p}_1,K)+(\tau_0-c_0)\frac{\partial q_0}{\partial \tau_0}+\beta(\overline{p}_1-c_1)\frac{\partial x_1}{\partial \tau_0}\\&+\lambda\left[c_0\frac{\partial q_0}{\partial \tau_0}-q_0-\tau_0\frac{\partial q_0}{\partial \tau_0}\right]=0,\end{aligned} \tag{6.84}$$

$$\frac{\partial \Lambda^{4.3.2}}{\partial K} = (\tau_0 - c_0)\frac{\partial q_0}{\partial K} + \beta(\overline{p}_1 - c_1)\frac{\partial x_1}{\partial K} - \frac{\partial C}{\partial K} + \lambda\left[c_0\frac{\partial q_0}{\partial K} + \frac{\partial C}{\partial K} - \tau_0\frac{\partial q_0}{\partial K}\right] = 0. \tag{6.85}$$

Rearranging (6.85), using (6.48), (6.49), and (6.84), yields

$$-(1-\lambda)\left(\frac{\partial t}{\partial K} + \frac{\partial^2 t}{\partial q_0 \partial K}\frac{q_0}{N}\right)q_0 = (1-\lambda)\frac{\partial C}{\partial K}. \tag{6.86}$$

By the same argument developed in Appendix 8, we assume $\lambda \neq 1$. Thus, from (6.86) and (6.2), we obtain (6.26).

The FOC for welfare maximization is

$$\frac{\partial SW^{4.3.2}}{\partial \overline{p}_1} = \frac{\partial u}{\partial q_0}\frac{\partial q_0}{\partial \overline{p}_1} + \frac{\partial u}{\partial x_1}\frac{\partial x_1}{\partial \overline{p}_1} - \left(\frac{\partial t}{\partial q_0}\frac{\partial q_0}{\partial \overline{p}_1} + \frac{\partial t}{\partial K}\frac{\partial K}{\partial \overline{p}_1}\right)q_0 - (c_0 + t) \times \frac{\partial q_0}{\partial \overline{p}_1} - \frac{dC}{dK}\frac{\partial K}{\partial \overline{p}_1} - c_1\frac{\partial x_1}{\partial \overline{p}_1} = 0. \tag{6.87}$$

Rearranging (6.87), using (6.3), (6.4), and (6.7), yields (6.30).

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Chapter 7
Light-Handed Regulation of Airports: The Way to Go?

Peter Forsyth

Abstract Traditional regulation of firms with market power, be it cost-plus regulation or incentive regulation, is recognised as having several drawbacks. As a result, some countries have replaced this regulation with light-handed regulation (LHR). This chapter seeks to evaluate LHR in the context of airports. LHR is not a well-defined concept, but the elements which make up LHR can be identified. The potential positive features of LHR can be sketched out, and as can be the way it works. This leads on to a discussion of actual performance under LHR, and especially the Australian experience. There is evidence that LHR works well in several respects, though its performance in some other respects, particularly in terms of its impact on productive efficiency, has not been much tested in a rigorous way. The chapter includes a discussion of how LHR might work if applied to other airports. It concludes with a review of the key findings and questions which remain to be settled.

Keywords Light-Handed Regulation · Incentive regulation · Productive efficiency · Ex post regulation · Airport charges · Airport service quality · Airport investment

7.1 Introduction

This chapter poses the question of to what extent light-handed regulation (LHR) is an option for airports with market power. Many airports, especially smaller airports which face competition, are not regulated at all, particularly in the UK and Australia. However, most airports which are judged to have market power are subject to explicit regulation—the form of this regulation might be that of rate of return (RoR) regulation (as with Amsterdam) or incentive regulation (IR) (as with London Heathrow airport). However, there is also the possibility of LHR.

LHR may be regarded as some sort of looser regulation, though in fact it can be quite formalised (for a discussion of airports, see Arblaster 2017, and, other

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industries, see Bertram and Twaddle 2005; Carpenter and Lapuerta 1999). It is a relatively new concept, and as a result, it is not tightly defined. The system of LHR in airports is synonymous with the Australian airport regulatory system. This has been operating successfully since 2002, though there are critics, most notably, the airlines (see IATA 2006; A4ANZ 2018), though these have been refining their criticisms as time goes on. There have also been other systems of LHR, for example, for New Zealand Airports (InterVISTAS 2014). LHR has particular relevance to the regulation of privately-owned airports, but it can be applied to public and partly private airports (such as Christchurch in New Zealand).

LHR should not be confused with deregulation. If competition is strong, and the airport is judged to have little market power, then no regulation of any sort is needed. LHR is an option for airports which do possess some market power—it can be used in cases where there is quite strong market power (as in Australia). This said, LHR might be regarded as an option where there is some market power, but this power is not very strong. There may be an argument that for some airports exposed to moderate competition (such as London Gatwick), LHR may be preferable to full traditional regulation. The question of whether airports with strong market power warrant traditional regulation, while airports with moderate market power warrant LHR is recognised but not evaluated here.

There are several questions which need to be considered:

- Firstly, what is LHR?
- Secondly, how does it work?
- Then, how well is it working, and what improvements can be made to existing systems? And
- Finally, how good an option might it be for other airports?

7.2 The History of and Rationale for Light-Handed Regulation

LHR grew out of a dissatisfaction with traditional, ex ante, regulation:

- Traditional regulation was regarded as slow and costly and regulatory hearings often take several years. A good example is the (incentive) regulation of the London airports.
- There is a belief that traditional regulation gradually reverts to something like RoR regulation, with all of its problems, even though the regulatory system is formally set up as incentive regulation, with pure price-caps (Productivity Commission 2002). The expectation is that LHR will involve less emphasis on prices tracking (actual) costs, and that there will be a stronger emphasis on promoting productive efficiency.
- Traditional regulation makes it very difficult for sellers and buyers, in this case, the airport and the airlines, to reach mutually advantageous agreements, thus

reducing the regulatory burden. Airlines and the airport may be fundamentally opposed to each other over price, since the airport has, and will seek to use, its market power, but mutually advantageous agreements should be feasible over service quality and investment—after all, the airport should have an incentive to give the airlines what they want. However, under price-cap regulation it is in the interest of the airport to lower quality where this is a means of reducing costs. With LHR, this perverse incentive need not be present (however, it can still be present if the review body interprets high actual operating costs as evidence of poor performance).

These limitations were very much to the fore when Australia moved to LHR in 2002 (Forsyth 2003). Australia privatised its major airports (other than Sydney) in 1997 and 1998, and Sydney was privatised in 2002 (Hooper et al. 2000; Forsyth 2002; A rather pure form of price-cap regulation was instituted when the airports were first privatised in 1996–7. The competition authority, the Australian Competition and Consumer Commission (ACCC) administered the price-caps. Australia took, as its guide, the privatisation and regulation of BAA (then the owner of the main London airports) in the 1980s. The price-caps were tight, and the X was set high, given that it was expected that considerable efficiencies could be wrung out of the system (Forsyth 2004a). In spite of this, some airports almost immediately encountered problems with this form of regulation—for example, for Brisbane airport demand was less than expected due to the Asian Financial Crisis. The situation became much worse at the time of 9/11, because international demand fell, and at the same time the second main domestic carrier, Ansett, collapsed (Forsyth 2004a). In October, the government suspended the price-cap regulation for most airports, and it increased allowed prices for Melbourne, Brisbane, and Perth (at the time, Sydney had not been privatised). At this time the government's main microeconomic adviser, the Productivity Commission, had commenced a review of airport regulation. It recommended LHR, and the government accepted the recommendation (Productivity Commission 2002).

The Productivity Commission Report was thorough, and it covered the main issues to do with airport regulation. It was considered that, over time, price-caps might degenerate into a more cost-plus system. There was a mechanism for airports to raise prices when they invested, but this was closely controlled by the regulator, and airports found it cumbersome. By September 1999??, several airports were finding it difficult to cover costs—the price-cap was tighter than had been intended. The move to LHR was welcomed by the airports, though airlines objected. The greater pricing freedom given by LHR was positive for the sale of Sydney airport—the government received a significantly higher price than had been expected (2008a).

New Zealand also developed a system of LHR at around the same time as Australia (InterVISTAS 2014). Initially, the three major airports subject to LHR were government owned, though two of them (Auckland and Wellington) were privatised (Forsyth 2008a). The impetus for LHR came from a different direction than in Australia. New Zealand had a preference for LHR, and had embodied it in its access regulation, which was based on the Baumol Willig rule.[1]

Over the past 25 years, Australia has had access price regulation for essential services (King and Maddock 1999). There has also been specific telecom and, in the past, airport, access regulation. The basic way in which this has operated has been that initially the parties negotiate, but then if an access seeker is not satisfied with the terms which the facility owner is offering, it can ask the ACCC to set the terms. Clearly, the approach of the arbitrator is critical. With telecommunications, the facility owner initially set high prices for access; as a result, access seekers asked the ACCC to intervene, and usually it set a price well below the initial offer price. It was not long until the negotiated prices converged on levels a little above those which the parties expected the ACCC to determine. There have been problems with this system—it has been very slow, costly to administer, and very complex. There was a case when an airline sought to lower landing charges at Sydney airport. Even though the airline won, it considered that it was not worthwhile using this avenue again (Forsyth 2008a).

LHR is not deregulation. Under the UK and Australia, small- to medium-sized airports are not regulated (often, especially in the UK, competition was sufficient). But how much flexibility does an airport really have over its prices? It may be that it fears a threat of regulation if it were to set prices sufficiently high to attract attention of the government or regulators.[2]

LHR can be used in a wide variety of circumstances. It can be used with small airports, but it can be used in large airports—like Sydney or London Heathrow. It has been used where airports have significant market power (like Sydney) as the major Australian airports face little effective competition, and are many hundreds or thousands of kilometres apart. LHR can be used in busy slot on controlled airports.[3,4]

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[1] There are a number of regulatory forms in other countries which can be described as LHR. Two which are of particular relevance are the Canadian system of pricing of mineral traffic on railways, and the Australian system of access pricing for natural monopoly faculties. With the former, an arbitrator has to determine the price which the railway can change to the shipper. To a large extent, this is a matter of carving up the rents. The Canadian experience would be relevant if Australia were to move to implement a dispute resolution tribunal or arbitrator, as has often been suggested (Littlechild 2012).

[2] Thus, in the case of the BAA Scottish airports after the privatisation of BAA, there was an implicit threat of regulation if prices are high.

[3] Slots are not a significant rationing mechanism in the Australian airports except to a growing extent in Sydney.

[4] There will be questions to do with how slots markets work (in most countries they do not work very well, see Forsyth 2008b), but it is not the normal airport regulatory arrangements which control slot markets.

7.3 What Is Light-Handed Regulation?

There is no generally accepted definition of LHR. Rather, there are various characteristics which are likely to be present is a system of LHR. Some of these are as follows.

7.3.1 The Ex Post Nature

- Often LHR is characterised by ex post regulation. There is no specific requirement that the airport behaves in a specific way. With ex ante regulation, the airport is required to behave in a predetermined way—for example, to keep its charges below a set maximum. With LHR, there will be some review and if behaviour has been contrary to the requirements, there may be a penalty. Typically, with LHR, there will be no set requirements. However, the airport will be subject to review, either by a review body or by an arbitrator. With a review body, there will be a periodic review, and if the airport is not performing well, a sanction will be imposed, such as re-regulation. With an arbitrator, there is no set required behaviour by the airport, but its customers, the airlines, can complain to the arbitrator about some aspects of its performance (e.g., that its charges are too high) and the arbitrator will determine whether the airport will be required to change its behaviour (e.g., lowering its prices).

7.3.2 Upward Price Flexibility

- It is quite possible that a particular system of LHR will build in a degree of upward price flexibility—in other words, allow the airport considerable freedom to set higher prices than those which would normally be allowed under ex ante regulation. Indeed, this may be a defining characteristic of some systems of LHR. This is quite intentional. The idea is to ensure that (expected) prices are relatively high relative compared to costs, minimising the chance that prices will be lower than costs and investment in capacity is facilitated (Cowan 2007; Yang and Fu 2015). The airport will be given some scope to make profits, and productive efficiency will be high, rather than the situation under ex ante regulation where the tendency of regulators is to keep prices close to costs, risking the reversion of the regulation to become cost-plus based. When Australia implemented price-caps at airports, some airports found it very difficult to cover costs with a tight price-cap—and one interpretation of the move to LHR was that productive efficiency was being given priority over keeping prices low.

7.3.3 The Ability of Parties to Negotiate

- One feature of many systems of LHR is the reliance on negotiation rather than regulation. This can result in lowering the administration costs of the system. More particularly, it can lead to more efficient outcomes. This is particularly true with issues to do with service quality and investment, though it will be also so with other aspects of performance. With many aspects of performance (though not performance in terms of price), mutual agreement has the potential to achieve an efficient solution. Thus, airlines might want a higher level of service quality, and the airport may be willing to supply this at a price—both can gain through negotiation. The same would be true with investment to increase quality or capacity. Traditional regulation, of the RoR or price-cap form has many problems in achieving the right quality/price or investment/price mix. Ways around these problems exist, but they are cumbersome and often do not work well (and do the airlines trust the airport to negotiate in good faith?).
- There are some, critical, aspects in which the ability to negotiate does not help. The most important of these concerns price—the two parties have a fundamental conflict of interest in pricing—the airport seeks a high price and the airlines seek lower prices. Pricing has been the central point of disagreement between airports and the airlines in Australia—most other aspects have been resolved by negotiation. This is the core point of regulation. However, there can be a commonality of interest in the price structure, and the airport and airlines can negotiate improved price structures.
- It is quite possible that a contractual approach can be the central element in a system of LHR. A long-term contract specifying prices may be the core of a system, though such a contract could also specify quality investment and other aspects. There might not be any regulation, per se. However, the airport will still have some market power, and there will need to be some way of limiting its use. Thus, there could be a review body which could assess whether the terms of the contract were acceptable, or parties could appeal to an arbitrator/Dispute Resolution Mechanism should they be dissatisfied by the terms of the contract.
- A contractual approach is an ex ante form of regulation—matters such as price will need to be specified in advance.

7.3.4 The Probability of Sanction

- Typically, with most regulatory systems, there is no uncertainty as to whether the firm is regulated—it is. A common feature if LHR is that there is a less than certain chance that (re) regulation, or some other sanction such as a fine, will be imposed. If the review body considers that performance has been poor, then there is the possibility of the sanction being imposed. Thus, an airport might be re-regulated.

- It may seem that making regulation a game of chance would not be a sensible way of proceeding. However, formal regulation is costly, in terms of administrative and efficiency costs, and thus if these costs can be avoided, a better outcome could be achieved. Sanctions work best if they are not needed to be invoked.

7.3.5 Other Characteristics

7.3.5.1 Formal or Informal

- The system of LHR imposed could be formal or informal. With a formal system, there is a specified form of regulation. Thus, with a review/sanction approach, there will be a review of performance at a set time—for example, 5 years after the LHR is set in place. There may be a dispute mechanism or an arbitrator, to which airlines appeal on specified matters if they are not satisfied with the airport's performance.
- By contrast, it is possible to have a looser or more informal system or regulation. The airport may be free to do what it likes, but there is a threat that its performance may be judged unacceptable, and as a result a penalty will be imposed. It could be a regulator imposing the penalty (for example, when some airports are subject to formal regulation while others are only subject to the threat of regulation) or it could be that the government directly imposes the penalty (such as formal regulation). The New Zealand system of LHR is more informal than the Australian system.

7.3.5.2 Independent and Dependent Regulators

- With ex ante regulation, it is possible that the regulator could be independent, such as a regulatory commission, or a dependent regulator, such as a government department. The same is true for LHR. The review body or the arbitrator could be in dependent on the government, or it could be an arm of government. If the system is informal, it is less likely that there would be an independent regulator, since by definition there is no regulatory body charged with operating the system.

7.3.5.3 Monitoring/Benchmarking

- Monitoring and benchmarking take on a major role in a system of LHR. By monitoring we mean that data about some key variable, such as price, are systematically collected and published. By benchmarking we mean that the results of the monitoring exercise for one airport are systematically compared with results for other airports. If a review body or an arbitrator wishes to make meaningful decisions, ultimately benchmarking is essential, since monitoring of its own does not tell us much.

- There are several variables which a review body or arbitrator might pay attention to. Some obvious ones are charges or prices, costs, and profits. Furthermore, quality can be monitored, though doing this is a data intensive and more difficult exercise. The ACCC monitors all of these for the four main airports in Australia (ACCC 2019). With the ACCC data, some benchmarking is feasible—thus it is possible to see if Sydney's charges are highest using the index preferred by the ACCC. This is a rather limited database for a benchmarking exercise—four airports are not many. To make much sense, data for airports on other countries are needed. By combining data from other sources, it is possible to develop a database for useful benchmarking exercises.
- However, data on these variables are insufficient to assess productive efficiency or economic (as distinct from accounting) profit. To measure productive efficiency data on input and output prices, or input and output quantities are needed. With this information one can do a productivity assessment, and determine whether an airport is productively efficient or not. There has been an enormous amount of study of productive efficiency, and there has been much study of airports (see Leibert and Niemeier 2013; Adler et al. 2015). Curiously, these results do not seem to have been much used by review bodies evaluating LHR of airports. The accounting data on profit collected by the ACCC are not sufficient to estimate the economic profit of the airports, and thus estimate whether the airports have been using their market power. This is discussed in Sects. 7.4 and 7.5 below.

7.3.5.4 Review Criteria

With a system of LHR, the review body or arbitrator needs to determine what good performance consists of. Most likely, there will be a range of tests, taking into account prices, profits, quality, stability of prices, and investment. However, perhaps the underlying test will be one of whether:

- Prices are high relative to actual cost; and
- Prices are high relative to what they could be if the airport is productively efficient.

If the review body uses the former as its criterion, it will essentially be acting like a rate of return or cost-plus regulator. The airport will be penalised if prices are high relative to costs, even if the airport has produced very efficiently. As a consequence, poor incentives will be set into the regulatory system.

Alternatively, assessing whether prices are high relative to what they could be requires that the review body is able to assess productive efficiency. To an extent, it can do this by benchmarking. It is necessary that the body determine how well the airport is performing relative to other airports. Benchmarking can only go so far, however, given lack of detailed data, also for other airports. Furthermore, the lesson of the principal–agent literature is that the regulator, or, in this case, the review body, only has imperfect information about how low costs could be. A system of LHR which is conducive to productive efficiency is one in which the review body relies on benchmarking to some extent to determine how low costs can be, but also relies on the natural incentives of the firm.[5]

7.3.6 LHR: Content or Process?

LHR could be regarded as something quite different from normal ex ante regulation. Alternatively, one might see it as being a form of regulation which is not fundamentally different in terms or content, but rather a different process. The review body or arbitrator assesses performance in a similar way to regulator imposing cost-plus or incentive regulation. Thus, one can have "cost plus LHR", where the criterion of good performance is that prices are close to costs, or "incentive LHR", in which case the price/cost ratio is unimportant and the airport is given maximum ability to maximise productive efficiency by maximising profits.

7.4 Models of Light-Handed Regulation

Granted that LHR is a slightly vague concept, much of "loose" regulation might be described as "LHR". Thus, a form of shadow regulation, whereby firms see themselves as being subject to a threat of regulation, could be described as LHR. However, LHR can be a very explicit approach to regulation. Two approaches are discussed here. One is the review/sanction model, while the other is the negotiate/arbitrate model. The former is in place in Australia and has been in place in New Zealand, while the latter has been advocated for Australia.

7.4.1 The Review/Sanction Model

In this model, there is no ex ante regulation. The firm, in this case the airport, is free to behave as it wishes. However, after a set period, its performance will be reviewed, and if performance is judged by the review body to have been inadequate, a sanction or penalty will be imposed. One penalty could be the (re) imposition of ex ante regulation. Alternately, a fine could be imposed (if foreshadowed in the legislation establishing the system), or the airport may be prohibited from undertaking some action.

[5] This is much the same as with ex ante regulation, where the regulator can use benchmarking of similar firms to determine how high the price cap should be set.

The Australian model is in this form. From 2002, there has been no ex ante regulation of airports (except for a price cap for intrastate flights from Sydney). This was recommended by the independent Productivity Commission, the federal government's main microeconomic adviser, when it reviewed the outcomes of price regulation since 1997 (Productivity Commission 2002). It proposed a review in 5 years time—this was actually done in 2006, and there were further reviews in 2011 and 2019 (Productivity Commission 2006, 2011, 2019). The Commission recommended to that government that the system of LHR be kept in place, though with some minor changes (for example, the value of the land which the airports occupy is set at 2006 prices, and the airports subjected to LHR was reduced to five in 2006 and four in 2011).

In New Zealand, there was a review of pricing by the competition regulator, the Commerce Commission, at the three major airports, and it concluded that Auckland airport had an above normal rate of return, and it recommended that the government regulate it; in the end the government did not accept this recommendation (New Zealand Commerce Commission 2002; Forsyth 2008a). The current approach to airports is to improve information about their performance—however it is not clear what use is being made of the information collected.

7.4.2 The Negotiate/Arbitrate Model

A different model of LHR is one in which the airport is free to set terms and conditions for use of the airport, including prices or charges, but where the airlines have the opportunity to negotiate with the airport. Should negotiations fail, the airlines can ask for an arbitrator to resolve the issue. In terms of the basics, this is similar to the Australian general access arrangements which apply to other industries (King and Maddock 1999). Ultimately, the approach of the arbitrator will be very important in determining the outcome. The arbitrator could emphasise keeping prices close to cost (as a rate of return regulator would) or it may emphasise productive efficiency (as an incentive regulator would). The approach of the arbitrator could be very general, or it could be very detailed and specific—if the latter were the case, the arbitrator would become a virtual ex post regulator.

The model in Australia does not have such an arbitrator. However, as mentioned, there has been one use of general access provisions to require Sydney airport to set charges acceptable to the domestic airlines, a process which was regarded as having been very slow and cumbersome, and the airlines have not sought to use it again (Forsyth 2008b). During all of the reviews, several parties (airlines in all cases, and the ACCC) argued for some sort of arbitrator or dispute resolution mechanism to be set up. The Productivity Commission did not support this, and the government accepted the Commission's recommendation. It is a live issue which can be expected to be raised in future reviews.

The two models can be regarded as alternatives or complements. It would be feasible to have both a review body which reviews performance regularly, and a dispute resolution mechanism or tribunal which operates to resolve specific disputes. This is indeed what has been suggested by the airlines and ACCC. This could raise issues of overlap and conflict. The arbitrator could impose decisions which the review body considers will lead to poor performance. It is also possible that one or the other model will become redundant.

7.5 The Working of Light-Handed Regulation

Every 5 years or so, the system of regulation is reviewed in terms of its performance—to date, the reviews have been conducted by the Productivity Commission (Productivity Commission 2002, 2006, 2011, 2019). The reviews look at a wide range of indicators of performance. The data collected by the ACCC on prices, costs, and profits are examined, as are the indicators of quality. The reviews have also assessed performance in terms of investment and the extent to which airlines and airports are solving problems by contract rather than by other means, such as regulation.

Overall, all of the reports so far have concluded that performance has been good—this applies the system and also the performance of the individual airports (though there are some specific criticisms of individual airports). As a result, they have recommended that the system of LHR be continued, albeit with some modifications.

One important property of a review approach to LHR is that the measures of performance being evaluated can be broad. With ex ante regulation, there is a narrow set of measures to be regulated—there will always be price, and occasionally there will be quality or investment. Furthermore, the relationships between the measures will be set in advance precisely, and there are difficulties if a variable has not been specified in advance (for example, problems can emerge if unexpected excess demand emerges). With a review process, additional measures can be brought in—for example, the review body may evaluate environmental performance and the efficiency with which the airport handles excess demand. The review body can evaluate performance in an overall way, and weigh different aspects in ways which have not been specified in advance. It is free to determine that performance of the airport is adequate, considering multiple aspects. Thus, it might conclude that prices are a little too high, but quality has been very good, investment is appropriate, and the airport is environmentally good. This assessment can be done quite simply—this is in contrast to ex ante regulation, where multiple objectives such as price, quality, and investment make for a very complex regulatory system.[6]

One of the core (perhaps the core) aspect of a review of the performance of the system of LHR regulation and in airports covered should be the extent to which productive efficiency is being achieved or fostered. Another aspect is whether or not

[6] As the case of London shows—see Graham in this volume.

market power is being used. In this respect, the Australian reviews have been weak. There is little assessment of productive efficiency (the reviews have tended to argue that measuring productive efficiency is very difficult), and the measure of the use of market power is essentially whether charges are high or not relative to costs and relative to charges at airports in other countries (betraying a distinctly cost-plus mentality). However, given that the market power of the Australian airports is considerable, they do not appear to be exercising this nearly as much as they could. Something seems to be holding them back (perhaps an implicit threat of tighter regulation).

In setting out the ways in which the Productivity Commission should evaluate performance in future reviews, one of the key recommendations was that reviews should assess pricing using the following criterion:

> At airports without significant capacity constraints, efficient prices should broadly generate expected revenue that is not significantly above the long run costs of efficiently providing aeronautical services (on a dual-till basis). Prices should allow a return on (appropriately defined and valued) assets (including land) commensurate with the regulatory and commercial risks involved (Productivity Commission 2002, p. 353).

This criterion was explicitly set out in the Terms of Reference for the 2006 inquiry, though a vaguer statement about efficiency was set out for the 2011 and 2019 inquiries.

There are two aspects embodied in this criterion which are worth mentioning:

- Prices should be not significantly above costs and
- The measure of costs should be the efficient level of costs, not simply the actual level.

Using the ACCCs data on prices, costs, and profits, the Productivity Commission concluded that profits are moderately high, though prices are not significantly higher than costs. The Productivity Commission uses a measure of profits which includes an allowance for the cost of capital, though it is based on historical cost data (Productivity Commission 2019, pp. 178–191). Given that airports are capital intensive, it is important to take the real cost of capital into account. Some submissions to the inquiry, such as that of Airlines for Australia and New Zealand (A4ANZ 2018), have used operating profit margins, which do not allow for the cost of capital, and with substantial investment over the recent years, this produces an exaggerated measure of profitability. A thorough study of economic profit, not based on historical costs, has yet to be done. The 2019 Report (p. 191), however, concludes that the airports have not been systematically exercising their market power.

However, how can one measure whether prices are significantly above the efficient level of costs? This is the incentive regulation problem. The literature identifies two ways in which firms can be motivated keep costs down, keep prices down and produce efficiently. They are:

- Firstly, setting up an environment in which the firm can profit by producing efficiently (it gains a substantial share of the rent) and
- Secondly, by monitoring performance, especially by benchmarking.

The system of LHR as applied to airports in Australia is designed to achieve the first of these.

However, the Productivity Commission has not addressed the second one—it identifies prices close to cost as evidence of efficiency. It relies on evidence on the productivity efficiency of the Australian airports. Much of the chapter and the appendix in the 2011 Report consist of reasons why productivity benchmarking of airports cannot be done (several of those quoted are executives of or consultants employed by airports which have good reasons for not liking the results of benchmarking studies).

In reality, airport benchmarking studies can be, and are, done (for an Australian study, see Assaf 2009; also see Adler et al. 2015). As with all empirical work, there are limitations, and care needs to be exercised in measurement of data and interpretation of results. At one level, it would be worthwhile summarising what studies have said about the efficiency of the Australian airports. At another level, the Commission could have undertaken its own studies—it has very considerable expertise in this area.

The upshot is that the reviews by the Commission are valuable, though they are limited. In particular, they do not show much light on the particular areas of performance on which they set as the question they would answer—whether prices were significantly above the efficient level of costs.

7.6 LHR and Performance

7.6.1 Expectations

7.6.1.1 Use of Market Power

One of the main requirements for a regulatory system is that it moderates the use of market power. With standard regulation, this is achieved through price controls. With LHS, there is no general limit on prices. However, LHR works through the threat of a penalty, such as re-regulation, should the review body being convinced that the airport has used market power excessively, or alternatively, where there is an arbitration body, when the users of the airport's services are able to convince the body that the airport is charging prices which are too high.

Under LHR the review or arbitration body will be the ultimate arbiter of prices and how they are related to costs. If the review body or the arbitrator are slack, and allow the airport to charge high prices, then prices will be high. If the review body or the arbitrator sides with the users, and only allow the airport to charge low prices, then in time, only low prices will emerge. While in the short run, the airport has great freedom in the prices it charges, in the long run it will be the review body or the arbitrator which decides the price. This is much the same as with formal price regulation—prices can be high or low depending on the way the regulator behaves.

As noted before, it is possible that LHR will intentionally allow prices to be above average cost—this is the way it is modelled in some of the literature (Yang and Fu 2015).

7.6.1.2 Productive Efficiency

Another of the hopes for LHR is that it may foster productive efficiency. The issue is whether the airport perceives that it will gain the benefits of cost reductions or not. If it believes that it will gain through being cost efficient, then it will have a strong incentive to be efficient.

However, it is also possible that the airport may not be facing strong incentives to produce efficiently. This will be the case where the review body or the arbitrator takes actual costs of the airport as the efficient level of costs, and does not object to prices as long as they are not much more than actual costs. It is quite easy for an environment of LHR to become one of "cost plus LHR", with all the poor incentive properties of formal cost-plus regulation. It is not enough for the review body or arbitrator to check that the prices are no more than a little above actual costs. A lazy system of LHR is not much better than formal cost-plus regulation.

Thus, it is critical that the system of LHR be more than monitoring of costs and prices. It is essential that there be some form of assessment of productive efficiency. If a review/sanction approach is adopted, the review body will need to have information about what level costs could be achieved for this airport, not just what level costs are at. In other words, there is a need for some sort of benchmarking, possibly by an independent source.

Much the same will be the case when there is an arbitrator and there is a case to arbitrate. However, in this situation, there will automatically be an investigation of costs, since it is in the interests of the users to highlight where they believe that costs are excessive. Here too there will be a need for benchmarking, so that the arbitrator is well informed when it is making its decision on what the allowed prices will be.

7.6.1.3 Service Quality

LHR does have the potential to improve the decisions the airport makes as to what quality of service to offer. How to handle quality is always a difficult one for regulators. The problems of RoR regulation, and the incentives it gives for the firm to provide excessive quality, through gold plating, are well recognised. Incentive regulation, on the other hand, encourages the firm to provide too low a quality, since costs can be reduced, and profits can be made higher, if quality is reduced (Rovizzi and Thompson 1992). Regulators are aware of this, and some provide rewards for higher quality. However, they have difficulties in deciding what level of quality to aim for—regulators tend to be poorly informed about the costs and benefits of quality.

With LHR, the airport and its customers can negotiate about the level of quality to be provided. The airport has an incentive to increase the level of quality if its customers are prepared to pay the additional costs. Assuming that the airlines reflect their passenger's preferences, this will be a good outcome.

There are some problems which can come about. One could be where the airport overinvests in quality—this could happen if the airport is not a profit maximiser or is subject to local pressures. Ideally the review body or arbitrator would recognise this situation, and not approve excessively high prices coming about because costs are excessively high. It is also possible that a non-profit maximising airport will provide too low a quality.

The best way to guard against this problem is to ensure that the review body or arbitrator has good information about what costs should be, not just what they are, along with information about the costs of quality really are. In short, good benchmarking is needed to ensure that LHR works as well as it can (see the chapter by Guiomard in this volume).

7.6.1.4 Non-Aeronautical Revenue

Non-aeronautical revenue often accounts for more than half of an airport's economic activity. If there is a single-till system, as there is with the majority of regulated airports, this source of revenue is effectively regulated, since profits from it go to reduce aeronautical revenues and charges. Sometimes, as was the case in Australia during the regulation period, a dual-till system is operated, meaning that non-aeronautical revenues and prices are not regulated.

With LHR, prices of non-aeronautical services such as retail, restaurants, and car parking may be set by competition. Typically, an airport will have some power which comes about through convenience—off airport car parking and restaurants are cheaper, but less convenient for someone visiting the airport. Since airport land is limited, the higher prices reflect locational rents (Forsyth 2004b). Very often prices at airports are higher than at other locations, even when this cannot be explained by locational reasons. There is a question of whether this exercise of market power is a major efficiency problem. As against this, the airport is likely to be more flexible and innovative than when a single-till system is in operation, and the airport does not have much incentive to increase aeronautical revenues.

7.6.1.5 Investment

With LHR, the airport has the ability to make decisions quickly. If the airport's airline customers and the airport both wish an investment to go ahead, there should be no problem. This is in contrast with investments under regulation, where detailed investigation is needed to determine what change in the allowable price path would be warranted if the airport invests. Achieving investments can be very slow—for example, Heathrow Terminal 5 (though planning requirements, not just regulation, contributed to delays). In Australia, there were provisions for airports to make investments which airlines wanted, but these too were very cumbersome and detailed (Productivity Commission 2002).

There still remains the issue of whether an airport will choose the efficient level of investment, and whether it will invest too little or too much. There is no guarantee that the efficient level of investment will come about. The outcome depends on what the form of LHR is in operation. If the review body is inclined to accept all investments put forward by the airport, there is a risk that there will be excessive investment—if, for example, the airport is a public airport or a private airport with which is not pressured to maximise profits. The outcome will be akin to light-handed rate of return regulation. On the other hand, if the review body or arbitrator is keen to keep costs down, it may underestimate the true costs of additional capacity, and impose or threaten sanctions, or set too low a price for the airport to receive a market rate of return on its investment is it invests. In such a situation, there will be too little investment by the airport. There is no guarantee with LHR that the efficient level of investment will come about.

The situation will be more complex if the airport is slot controlled, which most busy airports, which are likely to wish to invest in additional capacity, are. The slot system is a very effective means of rationing scarce capacity at busy airports. However, not all aspects of it are conducive to efficiency. The system means that the airlines have a strong incentive to oppose additional capacity—it is they who collect the rents from inadequate capacity (Forsyth 2008b). Currently, there is an additional airport being built in Sydney, though Sydney Airport argued that it would not be needed for some decades to come. If airlines are able to share these rents with the airport, (for example, by allowing the airport to allow costs to rise and pass the higher costs on to the airlines), both the airlines and airport can earn higher profits if investment in capacity goes ahead, even where additional capacity is not efficient. In this situation, the airlines do not reflect the interests of the travellers. Travellers gain if the airport makes efficient investments, though both airlines and the airport lose. This is a situation which can arise whether the airport is subject to formal regulation or LHR.

7.6.2 LHR in Practice

7.6.2.1 Use of Market Power

There is some evidence that airports use their market power, though not to a great extent. In Australia, the monitoring body, the ACCC, assesses the prices, costs, and quality of the five main airports. Currently all are profitable, though it is difficult to determine how profitable, given problems in measuring costs and the handling of long-lived assets given the capital structures they have chosen. The Australian airports face very little competition, and, in 2002, the ACCC argued that if unregulated, airports would be able to charge much higher prices than they do. In short, there is some mechanism in play which is restraining prices in the view of the ACCC.

Allowing prices to be set above actual cost is not the only way in which market power can be used—it can be used to enable the airport to produce inefficiently and still achieve a profit, and it can be used to fund inefficient investments. These possibilities are mentioned below. New Zealand airports are also subject to LHR, though their performance is not as well documented in Australia. In 2002, the Commerce Commission investigated the three major airports and concluded that Auckland had a higher than efficient rate of return (the other airports did not) - NZ Commerce Commission 2002). Both Auckland and Wellington have been criticised for having higher than normal profitability, and the form of LHR was changed in 2011 (in particular the measurement of costs was changed).

7.6.2.2 Productive Efficiency

Thus far, there is not much by of detailed analysis of the form of regulation and its effect on productive efficiency, but such analysis as is available suggests that LHR is positive. In a recent benchmarking study, which examined the effects of incentive regulation and LHR, airports subjected to the latter were more efficient than those subjected to RoR regulation, and about as efficient as those subjected to price-caps (see Adler et al. 2015). Unfortunately, most of the benchmarking studies available do not enable us to assess whether LHR is consistent with productive efficiency. With the ATRS Benchmarking Report, the Australian and New Zealand airports are in a group on their own and they cannot be compared with performance in Europe or North America (ATRS 2013). A study of airports in Australia concluded that productivity in Australian airports had improved post privatisation (Assaf 2009). Average costs per passenger for Australian airports are lower than average in the Jacob's study (Jacobs 2010), but this does not allow for other variables which are known to affect productivity. Thus, overall, the productivity efficiency of airports subjected to LHR seems to be good, but there is little rigorous evidence on this.

7.6.2.3 Non-Aeronautical Revenues

There is no generally accepted measure of performance in the non-aeronautical aspects of the airport business. One can measure the non-aeronautical share of revenues, though this does not measure the share relative to what could be achieved. The Australian and New Zealand airports do have a high share, which suggests that they are making good use of their opportunities (ATRS 2013).

However, pricing for car parking has become an issue in Australia. Compared to the pre-privatisation period, the price of car parking has increased sharply, and car parking has become a significant proportion of the cost of using the airports. The evidence is that most of the major airports are making considerable use of their market power in this area. The ACCC, in its annual Monitoring Reports, has been increasingly critical of this—even airports which have moderately low aeronautical charges have substantial car parking charges, and this issue was specifically discussed in the 2011 and 2019 Productivity Commission Inquiries. Passengers, who are widely dispersed, are less able to negotiate with the airport than are the airlines, and thus the airport is better able to use its market power.

7.6.2.4 Investment

An airport which is subjected to LHR can be more flexible with investments, to the advantage of its airline customers. Airlines and airports have been happy with the way LHR has been working in Australia and airlines are glad that the airports are investing to improve quality and expand capacity.

There are no general measures of efficiency in airport investment. However, there are individual examples of problems. One example comes from Adelaide airport. During the period of LHR, Adelaide Airport invested very heavily in a new terminal. This was partly due to pressure from regional authorities. Since then, charges at the airport have been rising—charges at the airport are second to those of Sydney Airport (and airport charges at Sydney were doubled just before privatisation). This suggests that the airport has been using its market power to fund excessive investment. Whether this investment was worthwhile has not been assessed.

Another example comes with Brisbane Airport, which has recently completed a second runway. There has been a Computable General Equilibrium (CGE) modelling study done of this investment, though this study is not very detailed or explicit. What is of interest is that it sought to pre fund this investment, by raising charges to current users, even though it will be some years before the runway is able to be used.[7] For a privately-owned airport with easy access to capital markets there is no need for this (Tretheway 2013). The ability of an airport to do this is a reflection of its market power, as an airport acting in a competitive environment would not be able to raise charges on one group of customers to reduce charges for another group (future users). Current airlines were opposed to this, though Qantas has said that it has reached an agreement with the airport which covers this and other issues.

With LHR, as with formal regulation, when there are major investments under consideration, there will need to be a specific evaluation of the investment which goes beyond the regulated airport. Major investments in the London airport system, Heathrow of which is currently subject to price cap regulation, were assessed by the Airports Commission (Airports Commission 2015). In the same way, additional capacity for the Sydney airport system has been assessed using a CBA and CGE modelling (Forsyth 2013). There are several issues which cannot be handled effectively by the regulatory system, whether it is one of formal or light-handed regulation. For example, it has been noted that both airport and the airlines can have an

[7] Pre funding is a technique used by publicly owned airports or regulated airports which have difficulty in accessing capital markets (Forsyth 2017).

incentive to hold up on investment if there is a slot system in place. By having a broader inquiry, this problem can be analysed and addressed.

Airport charges have been controversial since the move to LHR. At the time of the most recent review, the airlines pointed to increasing operating rates of return (using a measure which did not allow for capital input) (A4ANZ 2018). However, during this period the airports have invested heavily. However, when allowance is made for the cost of capital, the rising charges can mostly be explained, and the rate of return, allowing for the cost of capital, has not changed much.

7.7 Light-Handed Regulation: A Model to Follow?

It seems that Australia and New Zealand are satisfied with the results of LHR, though it needs to be noted that some critical aspects of performance, such as its effect on productive efficiency has not been examined rigorously. The question is does LHR provide an attractive model for other countries when setting up or reviewing the need and form of regulation of airports?

One way of looking at this issue is to choose some other airports and see how they have performed or might perform under LHR. So far there are not many airports subject to LHR, but one example is London Gatwick (another example less documented, is Copenhagen Airport). London Gatwick was regulated by price-caps, though the CAA introduced a light- handed form of price cap for Gatwick (Littlechild 2013; CAA 2013). With Gatwick there is an independent regulator, the UK CAA, though in addition, the Competition and Markets Commission has a role in regulation. With this form of LHR there is still some price regulation: the airport is required not to exceed a “fair price”, with a cap of RPI +1.6 over 5 years, and +0.3 over 7 years. Gatwick is about the same size as Sydney or Melbourne airports. The judgement of the regulators is that the airports have market power and warrant regulation, though there has been some querying of this in the case of Gatwick. Gatwick competes with Heathrow, Stansted, Luton, and London City in the London area.

Gatwick airport is busy and for much of the time, and the slot system is the way demand is rationed, though there is some use of peak pricing. In this situation there will be a rationing price, which consists of the airport charge and the slot value. When charges rise, the slot value will fall. The airlines would not have the ability to pass on the higher charges, and they will suffer a loss of slot rents, and air fares will remain the same.

One of the major hopes for LHR is that it will give the airports a stronger incentive to produce more efficiently. The evidence on the Australian experience is not systematic though there is a belief that the Australian airports are quite productive. (Leibert and Niemeier 2013). The evidence on Gatwick is that it has been a middling to quite good performer (Assaf and Gillen 2012). This remains the case, though it is not clear yet whether there has been any sustained improvement in productivity.

The process of investing has been a slow one for the London airports. Both Gatwick and Heathrow were evaluated by the Airports Commission (Airports Commission 2015) as to their suitability for major runway expansion—in the end, the Commission chose Heathrow over Gatwick. The CAA has been very detailed and slow, and it has required substantial evidence to show that an investment is worthwhile (and thus is worthy of a price increase). Under LHR, Gatwick has been able to undertake an ongoing programme of non-runway investments.

7.8 Summary and Conclusions

Light-handed Regulation (LHR) of airports has developed as a result of perceived limitations with traditional regulation, be it RoR regulation or incentive regulation. Airports may have market power, and thus there is the risk that they may use (or abuse) it, and some restraint on behaviour is justified.

There are several objectives when countries move to LHR. A key objective is one of reducing regulatory costs. Another is reducing the inflexibility of traditional regulation, and lessening the risk of crises in the system, such as those caused by 9/11. LHR is less clearly defined than traditional regulation. Nevertheless, there are several features which tend to be present in LHR regulatory systems, though these are not necessarily always present. Often it is an ex post, rather than ex ante form of regulation, there is often a greater tolerance of higher prices, there is an emphasis on promoting resolving problems by contracts between the airport and the airlines, and there is a threat rather than the actuality of regulation.

There are several models of LHR which have been practised. One model is the review sanction model as practised in Australia. Performance of the airports are reviewed, and if performance is poor, a sanction may be imposed. Another model is the negotiate/arbitrate model, whereby if the airlines are dissatisfied with the terms offered by the airport, they have recourse to an arbitrator. This can become a form of regulation by contract. Whatever the form, the results of LHR depend very much on the criteria of assessment which the review body or arbitrator use.

LHR as it is practised in Australia to regulate airports involves the review body taking a broad view of performance. In spite of this, review bodies have not examined performance in terms of productive efficiency at all rigorously. So far, the results of LHR (in Australia and elsewhere) in terms of promoting productive efficiency are positive but not robust. There are also concerns about the use of market power. Prices are a little higher than costs, though this is, to an extent, intentional. However, use of market power may be masked—the fact that an airport has prices close to cost does not mean that it is not using its market power. The airport may have invested excessively, and costs and prices could be higher than they need to be. This highlights the need for benchmarking, particularly of productive efficiency under LHR.

On a more positive note, LHR seems more conducive to efficient quality and investment choice than traditional regulation. How well LHR performs when airports are busy and facing serious excess demand remains to be seen.

The results of LHR so far suggest that it may be useful as an option where traditional regulation has been applied so far. Some examples have been discussed here, and it has the potential to address the problems in performance identified, as long as it is well designed.

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Chapter 8
Optimising Investment in Regulated Airports

Achim I. Czerny and Peter Forsyth

Abstract Regulation is known to change the incentives a firm faces to invest, inducing some firms to invest too much, and others too little. Regulators must set prices to achieve several conflicting objectives, including providing the incentive to invest. Optimising investment is a particular problem in regulated airports, and many of the inefficiency problems noted with airports can be ascribed to inadequate or excessive investment. Airport regulation is also expected to address issues of congestion, quality of service and productive efficiency, while, in many cases, at the same time achieving distributional objectives. This chapter explores the properties of alternative forms of regulation, including price caps, cost plus and light handed, in achieving the optimal level of investment, along with meeting other objectives. Cost-based regulation can have advantages over price caps in some contexts. The optimisation task is helped considerably by the existence of secondary instruments, including slot controls and conditional price caps.

Keywords Price caps · Cost-based regulation · Light-handed regulation · Congestion · Efficient pricing · Airport slots

8.1 Introduction

Several of the more obvious efficiency problems at airports stem from the difficulties in ensuring that investment in capacity is at the right level. For many regulated airports, investment has been too low, and as a result, quality is poor, output is restricted, and in some cases, delays are excessive. Sometimes, especially in Europe and Japan, it is environmental and planning constraints that are the major cause of limited investment. However, the regulatory arrangements that many airport

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regulators now operate will also be a potent cause of limited and inadequate investment. The model to which many countries are moving their airports is one of privately owned airports subject to a price cap. This model is known to give the regulated firm only weak incentives to invest.

In this paper, we explore how different regulatory arrangements affect investment in airports. The investment problem is complicated because it is part of a more comprehensive optimisation exercise in which the regulator is simultaneously trying to achieve efficiency in the use of existing capacity, deliver the right quality, minimise costs, and also provide incentives for the warranted level of investments in capacity. Typically, regulators rely on a limited range of instruments and the result is that airports perform better in some dimensions than others. Often it is capacity expansion which suffers. We analyse how different instruments, such as cost-based regulation, light-handed regulation and price caps, along with quality rewards, slots, and trigger mechanisms for investment can be used. A mix of instruments can lead to a much more satisfactory solution—for example, if slots are used, prices can be freed from their role in short-run optimisation, and they can be used with conditional triggers to ensure efficient investment in capacity. Some problems remain—notably the problem of giving the airport incentives to minimise the costs of its investments. The complexity of the regulatory problem sometimes leads governments to take the investment assessment task away from the regulators—as happened when the UK government set up an inquiry to evaluate options for increasing capacity at the London airports (Airports Commission 2015).

We begin by discussing the general problem of incentives for investment under regulation and apply this discussion to airports. In the following section, we examine the different efficiency problems which airports pose. We then examine the instruments which regulators can use to influence airport performance. In the next section, we analyse how different regulatory approaches can be combined with these instruments to promote efficiency—use of slots, quality rewards and triggers for investment can be used to improve the performance of price caps as compared to cost-based regulation. Finally, we draw some conclusions and highlight the key results.

8.2 Regulating Airport Investment

Ensuring an efficient level of investment is achieved in a regulated industry is inherently difficult (Guthrie 2006). This is so not just for airports—it has been a problem for UK regulators ensuring investment in rail track, and for Australian regulators supervising export coal loaders. Regulators have a limited number of instruments, and they must balance a range of conflicting objectives, such as protecting the interests of passengers and airlines, ensuring airport cost recovery, encouraging efficient use of available capacity, the meeting of environmental constraints, and ensuring investment is neither excessive nor inadequate. Information asymmetry is typical in a regulatory context, with the regulator knowing less than the regulated firm about feasible minimum cost levels, and the amount of investment which is required. Not surprisingly regulatory gaming takes place—regulators may behave opportunistically to keep prices low, and regulated firms may induce the regulators to set high prices to cover their investments, yet they may not actually deliver on the promised investment—an issue which has been apparent in Australian coal loading infrastructure to European air traffic management investment (Export Infrastructure Task Force 2005) and in the regulation of Dublin's airport (Commission for Aviation Regulation 2019).

8.2.1 *Privatisation and Investments*

Regulation has become much more important for airports over the past three decades. Raising capital for airport expansion can be a major motive for airport privatisation. Before this, most airports were publicly owned, and were rarely subject to direct regulation. Privatisation has changed this. Many airports have now been privatised, either partially or fully, and those which have not been privatised have often been corporatized and instructed to act in a more commercially focussed manner. The UK privatised the BAA airports, including most of the London airports, in the 1980s, New Zealand and Australia privatised their major airports in the 1990s. There have been several privatisations in Europe, with Copenhagen, Budapest, Brussels, Athens, Paris, and Vienna airports being fully or partly privatised (see chapter by Forsyth, Mueller, and Niemeier in this volume). Some airports in Asia are now being privatised.

Whether there is a lack of competition, so that privatised airports would implement excessive prices in the absence of regulation, is controversial (for example, Wiltshire 2018, and Thelle and la Cour Sonne 2018). Some argue that even in the absence of airport competition, airports would avoid charging excessively high prices for aeronautical services to boost their concession businesses (for example, Starkie 2006, 2021). Czerny (2019) and Czerny and Zhang (2020) analyse and illustrate how concession services can be used to boost aeronautical businesses and increase the prices for aeronautical services. Gomes and Tirole (2018) go one step further by proposing lower rather than upper limits on prices associated with airport concession businesses in order to avoid excessive pricing for aeronautical services.[1] Regulatory practice demonstrates that governments are indeed concerned about airport market power and excessive prices for aeronautical services.

Regulation has typically encountered problems with investment. Under the older form of regulation, cost-based rate of return regulation, it was recognised that the regulated firm would have an incentive to invest excessively (the Averch and Johnson effect—see Armstrong et al. 1994). Since the firm was permitted to earn a

[1] Gomes and Tirole (2018) overlook the relevance of their results to airports and airport concession businesses; however, their framework and discussion is general enough so that their results carry over to airport companies.

rate of return on a regulated asset base, it could increase its profits if it could increase its asset base, by investing even if the investment was of little value to airlines and passengers. This was one of the reasons for the move away from rate of return regulation to newer forms of regulation such as incentive regulation (the other main reason was the encouragement given to cost padding under rate of return regulation). Many countries have moved towards some form of incentive regulation, such as price caps and more recently, light-handed regulation, when regulating private or corporatized monopolies, including airports. Pure incentive regulation, whereby the regulator takes no note of the firm's actual cost when setting the price cap is rare—most actual forms of regulation are of a hybrid type, whereby price caps are set for a period, such as 3–5 years, after which the price cap is reset with reference to the firm's actual cost outcomes, along with the firm's projections of capital expenditure.

Price caps give the firm a strong incentive to keep costs low, but they may do this by lowering service quality or by not undertaking sufficient investment. This has been recognised as one of the downsides of incentive regulation (Helm and Thompson 1991). It is a problem which can be overcome if the regulator sets explicit rewards for higher quality or penalties for poor quality, and if it explicitly takes investment into account when setting future price caps. This does mean that the regulator becomes much less "light handed" and becomes more intimately involved with the investment decisions of the firm.

8.2.2 Investment Dynamics

Airport investment typically comes in indivisible lumps, and after a time, substantial programmes of investment are required. If the airport is facing increasing costs of expansion on a constrained site, or if prices were set initially on the basis of historical rather than replacement costs for assets, increases in prices will be required if the airport is to cover its investment costs. Price caps will need to be set with real prices increasing for a period. Price cap changes are a function of the ratio of future cost changes over future traffic growth/changes. Buoyant traffic growth dampens the need for price cap increases even with higher investment; increased investment with modest traffic growth, implies larger price increases.

The experience of London airports, particularly Heathrow, provides a good example of the problems. When the airports were privatised, a price cap (RPI–X) with a positive "X" was set—real prices fell. There was limited investment in the airports, but demand grew and outstripped capacity, leading to a fall in the quality of service, as facilities such as terminals became congested. Capacity extensions were difficult to achieve because of environmental problems and a very slow planning process. (With the presence of a slot system, Heathrow had mixed incentives to invest—see Sect. 8.4). Eventually capacity increases were approved, but these were more expensive than older facilities. The regulator, the CAA, allowed for price increases at Heathrow to fund the new terminal, Terminal 5. Significantly, it used a trigger mechanism, whereby BAA was only permitted to increase prices when it had achieved investment targets (Civil Aviation Authority 2008). A more recent example of such trigger mechanisms is at Dublin airport, where the regulator threatened to reduce the price cap if the airport does not proceed with certain proposed projects (Commission for Aviation Regulation 2019). After paid-for but not built capacity investments, the CAR now routinely uses “triggers” whereby charges rise only when passenger-benefitting capacity is delivered.

In this context, investments have been made. However, it has been extremely difficult to get investment right, in the sense of being neither inadequate nor excessive, and timely (Starkie 2006). The investment process has been slow, and users have been critical of the low quality of service, and of the sharp rises in prices. London’s Heathrow Airport may be exaggerating the need for investment, and it may not have been seeking out the least cost ways of achieving capacity increases—it may have been gold plating its investments. Nevertheless, the CAA was under strong pressure to approve investments and thereby alleviate the quality crisis. There was strong dissatisfaction with the performance of the airports, with many users calling for the breakup of BAA, which did happen afterwards. It also was the case that the regulator had a strong role in determining how much the airports invest—it was not simply setting prices and allowing the airports to determine how much they want to invest. The regulator must rely, to a considerable extent, on the airports’ own claims as to what levels of capital expenditure are required. To manage this problem, the regulator can ask the airport for information about each project’s expected cost and expected additional capacity or improved quality to be delivered. The regulator then has consultants assess the costs to determine the increase in airport charges required to support the investment. Airlines assess the combination of capacity and quality effects and higher airport charges. Finally, the regulator claws back the gains from higher airport charges unless the approved facility is delivered.

8.2.3 Conflicting Goals and Complexities

Thus, the airport regulatory problem is a complex one, especially when significant increases in capacity or quality are required. Airports are congestible facilities, with runways and terminals both becoming congested when demand presses against capacity—this creates a delicate short-run problem of optimising existing capacity. If airports are privately owned and not subsidised, cost recovery is a requirement if the airport is to sustain operations. Airports involve substantial indivisibilities, which means that capacity is more than adequate for some years, and cost recovery is a problem, but when demand is excessive, and creates congestion, capacity becomes a problem in other years (for example, Oum and Zhang 1990). Another controversial issue is the choice between single-till and dual-till regulations. In the case of single-till regulation, where profits from concession businesses are used to reduce the price cap as opposed to dual-till regulation where profits from concession businesses are not used to reduce the price cap (for example, Czerny 2019).

Prices need to be set at a level to induce the airport to undertake efficient levels of investment. Thus, prices need to serve at least three conflicting roles—achieving efficient use of capacity, ensuring operating cost recovery and providing incentives for investment in capacity and service quality. In addition to this, there are two distinct aspects of the principal agent problems. One is the problem of giving the airport an incentive to minimise costs of operation—this can be achieved by setting price caps which are not based on the airport's costs. The second is the problem of achieving the right level of investment. The regulator knows less about the efficient level of investment required than does the firm, but the firm has little incentive to inform the regulator of what this is. This is a more difficult problem to solve than the first.

The complexities of the airport investment assessment problem have meant that governments sometimes take matters out of the hands of the regulator. In Australia, as Sydney Airport became congested, the government evaluated the options for additional capacity itself, and chose to build an additional airport (Australian and NSW Governments 2012). In the UK, the Airports Commission was established to evaluate options for additional capacity in London, bypassing the regulator, the CAA (Airports Commission 2015). Normally, however, governments prefer to leave the airport and the regulator to evaluate and make the investments, especially with smaller investments.

In this paper, we assume that the regulator seeks to promote the public interest, through maximising welfare which includes the passengers' consumer surplus, airline and airport profits (possibly with different weights on different parties). We also assume that investment issues cannot be satisfactorily resolved by direct negotiations between airports and airlines. There are two reasons for this. The first involves the presence of diverse airlines, and the second is the protection of the passengers' interests. The presence of diverse airlines and airline interests such as full service and low-cost airlines with quite distinct demands on airport infrastructure complicating negotiations between airports and airlines seems most relevant at large airports. For small airports serving only a few airlines, negotiations may be more promising. However, even if airport and airline negotiations could be successfully implemented the passengers' interest may not be adequately covered. Altogether, a regulatory approach will have to be resorted to for the implementation of a proper airport investment plan.

8.3 Efficiency and Distributional Objectives in Regulating Airports

When regulating airports, a regulator will seek to achieve a range of objectives. A regulator is bound by statute, but more so in a litigious jurisdiction. Efficiency defined as maximising output for a given input or minimising the input to achieve a given output is an objective, but it is not that simple because there are several distinct aspects to this. For instance, the regulator may have distributional and environmental objectives. Ideally, different objectives should be handled by different regulators, such as an environmental regulator to handle environmental objectives, though we recognised that this does not always occur. We do not analyse these here, though we recognise that they could be an important extra aspect to the regulatory problem for airports.

8.3.1 Short-Run Optimisation: Use of Fixed Capacity

In the short run, an airport will have fixed capacity of several facilities, such as runways, terminals and aprons, and it is desirable that the airport make the most efficient use of the available facilities. Costs will depend on the level of these facilities. Welfare is maximised when prices are set equal to short-run marginal cost. These costs include operating costs of airports and airlines, but also the costs of congestion to airlines and passengers.

Airports are congestible facilities. This is so especially for runways, but also for terminals and other facilities. More utilisation of a facility beyond a certain level means more congestion, in the form of delays, crowding and overall lower service quality. The important aspect of congestion is that it creates an externality. Each user faces some congestion cost, but also imposes costs on other users. Thus, the pricing problem involves setting prices to users which reflect the costs they are imposing on others. As has been noted, some large users of airports internalise some though not all of the congestion costs they create—since one flight by an airline delays other flights of the same airline, some of the congestion externality will be internalised. Given that airlines differ in the extent to which they internalise the congestion externality, different prices will be optimal for different users, with smaller users being charged higher prices than larger users (for example, Brueckner 2002; Zhang and Zhang 2006; Czerny and Zhang 2011, 2015).

Congestion is an aspect of quality of service, but it is also an aspect which is associated with an externality. Investments in capacity lower congestion, and also reduce the externality (on congestion and investment, see Oum and Zhang 1990).

We are taking willingness to pay for airport services as a measure of welfare. This would be appropriate if airlines were perfectly competitive, and the value of the marginal product of an input was equal to its marginal revenue product. If airlines have market power, they will not be pricing competitively, and the value of the marginal product (which is the measure of the welfare gain from using an additional unit of an input) will exceed the marginal revenue product, and the passengers will use less of the service than is optimal. In this case, ideally airports would compensate for this by reducing their prices, thereby offsetting this distortion (Pels and Verhoef 2004). We recognise this problem, but abstract from it in this discussion.

A constraint of short-run optimisation may be that of cost recovery (for example, Basso and Zhang 2010; Czerny and Zhang 2015; Czerny et al. 2017). The regulator will need to allow the airport a high enough price to enable cost recovery—otherwise a private airport would cease to supply. This is an issue for airports which have excess capacity and no congestion, though it is not likely to be a major problem for airports which face high demand and for which investment in additional capacity is warranted. Thus, the regulator's problem is to use price or other instruments to ensure that the efficient utilisation of the airport is achieved.

8.3.2 Regulating Quality

The regulator will seek to achieve an efficient level of quality of service. Many forms of quality at airports are not like congestion, and do not pose any externality issues. Higher quality can be achieved by spending more on operating costs or by investing more. Under price caps, an airport will tend to under-provide quality by cutting costs and not investing sufficiently, since it can add to profits by cutting costs. The regulator can give the airport incentives to provide higher quality, by offering it a higher price conditional on providing a minimum level of quality (Rovizzi and Thompson 1992), otherwise the price cap falls to penalise low service quality, as in the case of Dublin airport. The problem is that the regulator has poor information on the costs and benefits of quality. Since the price is regulated and there is no price/quality trade off facing users, the regulator will not have reliable information on the willingness of users to pay for quality. In addition, it will have to rely on the airport to inform it on what quality costs to provide, and the airport does have the incentive overstate the costs hoping the regulator would impose a higher price cap for cost recovery. In some aspects, there are practical options. Airlines can prescribe certain elements of service quality—e.g. equipment availability, maximum security-queue delay—and these can be incorporated into price cap formula.

Thus, the regulator faces a principal agent problem of setting instruments such as prices such that the airport provides the efficient level of quality. As will be noted below, a valuable feature of light-handed regulation is that it may be used to encourage airport-airline negotiations to determine what level of quality to provide.

8.3.3 Achieving Productive Efficiency in the Short Run

The welfare maximising regulator will seek to achieve a given output with minimum costs. It faces a typical principal agent problem in doing this, since it does not know what the minimum feasible level of costs is, and the airport cannot be assumed to truthfully report it to the regulator. A price cap is a solution to this problem, since by fixing the maximum price that the airport is allowed to charge, the airport has an incentive to minimise costs given any cost savings will add to its profit. A price cap is a blunt instrument, since it imposes risks on the agent airport—its inflexibility can lead to revenue crises for the airport (this happened to regulated airports in Australia in 2001—see Forsyth 2004).

The regulator's problem is to use its instruments in a way consistent with the airport having an incentive to minimise its operating costs.

8.3.4 Long-Run Optimisation: Achieving Efficient Investment in Capacity

The regulator seeks to give the airport incentives to invest in the right level of capacity. Additional capacity is costly, but it leads to lower congestion costs, and enables more output to be catered for, and possibly to lower operating costs. It may also enable higher service quality. More capacity lowers the congestion externality, and when the capacity increase is large and it leaves the airport with ample capacity, it can eliminate the congestion problem entirely, at least until demand catches up. Thus, investment in capacity changes the short-run pricing problem.

The regulator's problem is one of using its instruments such as prices to ensure that the airport has the incentive to actually make the investments which are warranted from the welfare point of view.

8.3.5 Productive Efficiency in the Long Run

The regulator faces another principal agent problem. The airport is likely to have more information than the regulator about the level of capital expenditure that is needed to provide a given level of capacity expansion or quality improvement. Again, the airport does not have an incentive to truthfully inform the regulator—rather it will have the incentive to exaggerate the cost of the investment, since by so doing it can manipulate the regulator to allow it a higher price.

The regulator has several options. It can

- Accept the airport's assessment of the cost of increasing capacity—this is essentially a case of long-run cost plus regulation.
- Employ a monitoring solution, by gathering together its own information about the likely cost of expanding capacity, and essentially do its own cost benefit analysis of the proposals. Some regulators have done this to an extent.
- Allow the airport to negotiate with airlines about the level of investment (the light-handed regulation option)—this has distinct advantages, though in certain situations, there are also risks and there is the problem of a proper representation of the passengers' interests. Or it can
- Attempt to set up instruments which give the airport an incentive to provide the right level of investment at minimum cost. This option has been suggested by Hendriks and Andrew (2004). The regulator could reward the airport according to the outcomes of higher investment—more output, lower congestion higher service quality etc. The airport would have an incentive to invest to improve its

outcomes and revenue, but it would also have a strong incentive to keep the costs of achieving these to a minimum. The regulator would still have the problem of determining at what level these incentives should be put in place—how low congestion should be, how much extra output is warranted, and how much to increase regulated prices. This is not an option which has been applied, though it is an approach which offers the possibility of reducing the regulator's reliance on the airport for information about what level of capital expenditure is needed.

Thus, the regulator's problem is one of using its instruments such that the airport minimises the cost of achieving capacity increases, and actually delivers the investments.

8.3.6 Distributional Objectives

The regulator may seek to achieve efficiency by simply maximising the sum of consumers' surplus and profits. Alternatively, it may seek to pursue distributional objectives by putting different weights on consumers' surplus, airline and airport profits. In the airport case, there are three groups of stakeholders at least. The airport gains profits, and the airline passengers gain consumers' surplus. However, the airline is a user of the airport, and it also gains profits. Lower airport charges may mean higher consumers' surplus, higher airline profits, or both. Lower airport charges do not necessarily lead to lower air fares—in the case where excess demand for airport capacity is rationed by slots, lower airport charges will largely be enjoyed by the airlines. The level of pass through of the benefits of lower charges to their passengers will depend on the market structure at the airline level.

In situations where there is limited capacity and high demand, efficient airport prices would be high, leading to high airport profits. Regulators are often under pressure to ensure that monopoly facilities are not highly profitable (for example, Basso and Zhang 2010, and Czerny and Lang 2019). In the airport case, they may keep regulated prices low and transfer the profits to the airlines and their passengers. Airlines, of course, will pressure the regulator to keep airport prices low.

Here the regulator's task is to determine its distributional weights and seek to use the instruments open to it to maximise the weighted sum of passengers' consumers' surplus, airline profits and airport profits.

8.4 Instruments of Regulation

Regulators of airports have a number of instruments at their disposal. Some have been used extensively, such as price caps. Others, such as conditional triggers, have only been used occasionally.

8.4.1 Price Regulation

For our purposes, three main types of price regulation can be identified:

- Cost-based regulation
- Incentive regulation including hybrid regulation; and
- Light-handed regulation

8.4.2 Cost-Based Regulation

A regulator can set prices such that they are sufficient to cover the costs of the airport (as reported by the airport) and achieve a reasonable return. Cost plus regulation is a general form of regulation, and one variant, rate of return regulation, has been extensively employed in the past, especially in the USA. It is still being implemented in some airports (for example, Schiphol airport in Amsterdam). Under cost plus regulation, costs are the main determinant of allowable prices. Prices are set to cover costs and perhaps earn a reasonable profit. When capital investment is involved, as it invariably is, its costs are shared over the years according to some amortisation formula. Cost-based regulation can involve the regulator setting prices in detail. In practice, regulators were not active in setting price structures which promoted efficiency, such as setting peak and off peak price differentials. The problem with cost-based regulation is that it gives the airport incentives to increase costs (see, Czerny 2019, for an illustration), and it also facilitates excessive investments in capacity.

8.4.3 Incentive Regulation

Incentive regulation was developed in response to the problems observed with cost-based regulation. Allowable prices are set without reference to the airport's actual costs. One form of incentive regulation is the price cap, under which the regulator sets a maximum price path for a number of years—an index or average of the airport's prices is not permitted to exceed the set price. Under CPI-X (RPI-X in the UK) regulation, the price path allows for a fall in real prices each year by a percentage "X". The X may also be negative—i.e. the airport may be permitted to increase real prices each year during the regulation period. Under pure incentive regulation, the regulator sets the price path without reference to the airport's costs—thus the airport has a strong incentive to reduce costs, since any cost reductions add to its profit. Typically, the airport has the freedom to choose its price structure, and under many forms of price caps, it will have the incentive to set prices efficiently.

The most common form of price regulation for airports is now that of hybrid price caps. Price caps are set for a period, say 3–5 years, and after the end of the regulation period, a new cap is set with reference to the airport's actual costs, and expected future costs. These include expected capital expenditure. The airport faces incentives to lower costs, but these are lessened by the inclusion of actual and expected future costs in setting the allowable prices for the future (Baldwin and Cave 1999).

8.4.4 Light-Handed Regulation

As its name suggests, this form of regulation imposes fewer constraints on the firm being regulated. It is a form of ex post regulation, whereby the airport is allowed freedom in pricing, quality choice and investment, though its choices are monitored, and periodically assessed. If its performance is judged to have been poor, it may be sanctioned, possibly by heavier handed regulation being imposed (see chapter by Forsyth in this volume). The system of regulation operating in Australia and New Zealand can be regarded as light handed, and recently London Gatwick, previously subject to a hybrid price cap, has been changed to a light-handed form. The objective of some systems of light-handed regulation is to promote negotiation between the airport and the airlines, especially over quality and investment.

Two mechanisms which can affect airport performance under regulation are slots and trigger mechanisms.

8.4.5 Airport Slots

Slots are now used extensively, except in the USA, to ration demand to capacity (especially for runways) at busy airports. To use the airport during a given period, a flight must possess a slot. Given airport capacity, the maximum number of slots at an airport is declared, and slots are allocated to airlines. This is done by "grandfathering", or allocation on the basis of past use, but other methods, such as auctions could be used (Menaz and Matthews 2008). Airports or slot administrators can allow secondary trading in slots, which should enable allocation of the slots to the flights with the highest willingness to pay (though this does not always mean that welfare is maximised). The main example of slot trading comes with the London airports. An example for slot auctions is Guangzhou Baiyun airport where nine airport slots were sold to airlines via an auction mechanism in 2019. The significance of slots here is that they can be used to solve the short-run optimisation problem—slots are set such that the value of the slot is equal to the marginal external congestion cost of a flight (Forsyth and Niemeier 2008). Slots do the capacity rationing task, and prices do not. Prices can be set lower than at the capacity rationing level (which might imply high airline profits see Starkie 1998) and short-run efficiency is still achieved conditional on slots being allocated to the airlines with the highest welfare contribution via, for example, trading or auctions (Brueckner 2009). There are some long-run aspects of slots which affect the incentives for the airport to invest in extra capacity which are discussed below.

8.4.6 Conditional Triggers

A regulator can alter price caps, in a predetermined way, according to the behaviour of the airport. It can allow higher prices if specified investments are carried out. The critical point is that this is conditional. It is one thing for the regulator to set a price cap high enough for the costs of investment to be recovered. This often happens. However, there is no guarantee that the airport actually makes the investment—and often it does not. Airports will argue for a higher price cap, and when the regulator has obliged, the airport adds to its profits rather than make investments which are to the benefit of its users, through lower congestion. A way around this problem is for the higher price cap to be made conditional on the investment actually taking place. When Australia had price caps for airports there was a conditional trigger, whereby price caps could be raised if (and only if) the airport was undertaking specified investments (Australian Competition and Consumer Commission 2000; Forsyth 2002), and conditional triggers are being used by the UK CAA in its regulation of the London airports (Civil Aviation Authority 2008) and the Irish Commission for Aviation Regulation in its regulation of Dublin airport (2019).

With this instrument, the regulator assesses the airport's actual investment delivery, and allows price increases conditional on meeting investment targets. It allows the cost of investment to be passed on, and to this extent, it is a cost plus element, within a framework of hybrid price caps though perhaps less cost plus if the appropriate budget for the investment is set ex ante. While it is a useful means of resolving the problem of non-delivery on promises for investment, it may not give the airport an incentive to minimise the costs of adding to capacity.

8.5 Regulating Airport Investments: Assessing the Options

In this section, we compare approaches to regulation and their implications for investment in airports. We start with two broad approaches—generic cost plus regulation, price caps and light-handed regulation. We then allow for additional instruments, to see what difference they make. We consider rewards for quality, slots and conditional trigger price caps. This section is partly based on a more detailed analysis of some of the issues (Czerny and Forsyth 2008).

The relative merits of the simple cost plus, price cap and light-handed approaches are summed up in the following Table 8.1.

The Table can be interpreted as follows.

In terms of short-run optimisation, cost plus regulation is only fair. If prices are set according to the airport's operating cost leaving them, for example, unrelated to

Table 8.1 Regulation and efficiency outcomes: base case

Efficiency aspect	Cost plus regulation	Price cap regulation	Light-handed regulation
Short-run optimisation	Fair	Moderately good	Moderately good
Quality choice	Possibly excessive	Quality chosen too low	Moderately good
Short-run productive efficiency	Poor	Good	Good
Long-run investment choice	Good (if no Averch and Johnson effect)	Moderate	Good for small investments, problematic for large investments
Long-run productive efficiency	Poor	Good	Good

the congestion externalities imposed by airport users on other airport users, they cannot ensure efficient use of the available capacity. With a price cap, it is possible for the regulator to optimise the price set taking into account short-run optimisation. If it is not constrained to lower revenues and achieve low profits, it can implement peak pricing so as to price congestion and ration demand. Given the airlines opposition to peak pricing, airport and airline negotiations are unlikely to lead to a peak pricing scheme under light-handed regulation.

Cost-based regulation performs better with the quality dimension. If the airport offers a higher quality, its costs will be higher, but the regulator will allow it higher prices to cover the higher costs. There is, however, a danger that the airport will offer too high a quality. Under a price cap, the airport has only a limited incentive to supply quality, and thus it will under provide it. Under light-handed regulation, the airport negotiates with airlines to deliver the desired quality level. In this case, the airlines' interests may or may not be consistent with the passengers' interests. For instance, airlines may oppose a quality increase desirable from the passengers' viewpoint in an attempt to avoid the corresponding increase in airport prices.

The short-run productive efficiency aspect (keeping operating costs down) is where the cost plus approach falls down badly—it is, after all, the main reason why the price cap alternative was developed. A price cap has strong incentives for the airport to keep its costs down, since it can keep any cost savings it makes (though actual price caps are rarely pure price caps, and the incentive to minimise costs is lessened). An airport subject to light-handed regulation should also have incentives to keep costs down. However, information asymmetry is likely to exist between airports and airlines, which is similar to the information asymmetry between airports and the regulator, and little is known about how airport-airline negotiations are functioning. If the negotiated price between airports and airlines were related to costs, this would provide an opportunity to the airport to manipulate the price via excessive costs also under these circumstances (similar to cost-based regulation).

In terms of the long-run investment choice, cost plus regulation can perform well. Where investment is warranted, the regulator will allow the firm a price sufficient to cover the cost of this investment. Thus, assuming that the regulator is sufficiently well informed about demand and the cost of investment, it can use its instruments to bring about the required investment. Under price caps, the airport will have some incentive to invest, but this incentive is attenuated. More investment means less congestion, and less congestion means higher demand. Depending on how high the price is, the airport can gain from undertaking the investment. The regulator is, however, choosing price to optimise over the short and long run—too high a price will mean that the utilisation of the airport in the optimum will be too low. Thus, while the price cap will work better than cost plus regulation in short-run optimisation, this gain is achieved at the cost of weaker incentives for investment. Light-handed regulation may achieve efficient levels of investment for small to medium investments. The airport has the incentive and scope to negotiate with the airlines to deliver the right level of investments, although the outcome depends, again, on the nature of the negotiations given information asymmetries between airports and airlines. There are additional questions about the ability light-handed regulation to deliver on large investments, such as runways and major terminals. Firms with market power can restrict output to increase prices in order to increase their profits.

Cost plus regulation does not work well when it comes to incentives for the airport to keep the cost of investment down. Price cap and light-handed regulation seem more consistent with incentives to keep the cost of long-run investment down, although information asymmetries between the airports and the regulator as well as the airports and the airlines, respectively, complicate the assessment.

8.6 Improving Regulation Via More Sophisticated Approaches

8.6.1 Introducing Quality Incentives

It is possible to improve the performance of the price cap by introducing rewards for higher quality (and penalties for below target quality). This gives the price capped airport an incentive to increase quality—its performance will rise to good, comparable to that of cost plus regulation. In neither case is the outcome optimal, since the regulator only has limited information about the cost of providing quality and the value that users put on it. Airport and airlines could negotiate mechanisms including rewards for higher to improve the incentives under light-handed regulation.

8.6.2 Introducing Slots

Slots can be used to replace prices as a rationing device, so long as the effective rationing price is above the price that would be chosen by the regulator (e.g. to encourage investment). This is so when demand is high relative to capacity. In such circumstances, it is feasible to achieve short-run optimisation under both cost plus and price cap regulation. By lessening the welfare cost of having inadequate investment in capacity (a risk with price caps) they tilt the balance towards price caps.

There is an asymmetry with slots. They can be used to optimise the use of the airport when the regulated price is below the efficient rationing price, but not when the efficient rationing price is below the regulated price. Thus, if the regulator chooses to allow a high price to encourage investment, slots cannot be used to push utilisation of the airport towards the optimum. However, in the airport case, this may not be much of an efficiency problem. Airports can price discriminate very effectively—their aircraft weight for runway use or passenger-based charges are a form of price discrimination (or a rough form of Ramsey pricing). The deadweight loss from having a regulated average price which exceeds the efficient single price could be quite small (Morrison 1982). In this situation, the average price level may not play a major role in achieving short-run optimisation.

This decoupling of prices from short-run optimisation has implications for regulatory choices—regulated prices *can* be set solely to optimise investment choice, at minimal cost in terms of short-run efficiency. This way slots also increase flexibility for the negotiated prices without affecting quality in terms of congestion.

There are other aspects to the optimisation problem with slots. If an airport is slot controlled, it is unlikely to have an incentive to supply the efficient level of capacity if it internalises shares in the slot rents—it will supply too little capacity (see Forsyth 2008; Gillen and Starkie 2016). Thus, it may be difficult for the regulator to induce the airport to increase capacity—it would be told by the airport that "the time is not right". It may be possible for the regulator to spur more capacity under a tight price cap, though the problem may be more acute with the greater freedom afforded to the airport under light-handed regulation.

8.6.3 Introducing Conditional Triggers

With a trigger, the regulator is able to offer the airport a higher price if and only if it actually undertakes investment to increase capacity or improve quality. This means that a price capped airport now has a strong incentive to undertake the investment. This amounts to an effective way of addressing the main disadvantage of price caps vis a vis cost plus regulation. If slots are not used, such conditional triggers come at a cost. Regulated prices are low when the airport has not invested, and capacity is at a premium, but they are high when there is ample capacity, once the investment has been made. However, as noted above, this short-run efficiency problem is minimised when slots are used. The combination of slots and conditional triggers for investment is a powerful combination.

8.6.4 Systems of Regulation: A Revised Comparison

If use is made of the various mechanisms which have been discussed above, the relative attractiveness of the alternative approaches to regulation changes significantly. The new comparison is summed up in Table 8.2.

The use of the additional mechanisms such as slots has tilted the balance towards price caps. Both price caps and cost plus regulation score better in terms of short-run efficiency—if reliance is made on slots and price discrimination in airport charges, achieving efficient utilisation of available airport capacity is no longer much of a problem. This will also be the case under light-handed regulation. However, with slots, airline incumbents may use their negotiation power to delay capacity expansions in the case of light-handed regulation because such expansions would devaluate their existing slots.

The quality performance of price caps can be improved, though neither form of regulation is without problems. The airport which is subject to cost plus regulation may "gold plate" and offer an inefficiently high quality. The incentive to downgrade quality to reduce costs under price caps can be corrected to some degree by offering incentives for quality—however, this requires the regulator to be well informed on what the users want, and this may not be the case. Similar mechanisms may be used to improve airport quality supply under light-handed regulation.

Conditional triggers make a big difference to the performance of price caps, and possibly cost plus, in terms of providing incentives for efficient levels of investment. This is particularly true of small to medium investments, where there is some concern that regulators will offer price caps based on promised investment only to have the airport fail to deliver on the investment (this is unlikely to be a concern with large investments subject to intense scrutiny). As noted before, the use of slots highlights the disincentive facing the airport to male large investments, particularly under price caps and light-handed regulation. Increasing demand for the airport

Table 8.2 Regulation and efficiency outcomes: revised case

Efficiency aspect	Cost plus regulation	Price cap regulation	Light-handed regulation
Short-run optimisation	Moderate	Good	Good
Quality choice	Possibly excessive	Good	Good
Short-run productive efficiency	Poor	Good	Good
Long-run investment choice	Good (if no Averch and Johnson effect)	Good (only if airports do not share slot rents)	Moderately good (only of airports do not share slot rents)
Long-run productive efficiency	Poor	Good	Good

gives rise to potentially large slot rents, which can be shared by the airport and the airlines. This will mean that both have an incentive to under-supply.

None of the mechanisms discussed will address the last aspect of efficiency, namely that of creating incentives for the airport to be cost efficient when it provides the new capacity. The regulator and airlines still relies and rely, respectively, heavily on the airport for information on what the costs of expanding capacity are. Explicit monitoring of costs and benefits, or introduction of new incentive arrangements such as those discussed by Hendriks and Andrew (2004) may be needed to break the impasse.

8.6.5 Summary

There are various advantages and disadvantages of cost plus and price regulation, though the aspect of short-run productive efficiency is probably the most important determinant of overall efficiency (which is why price caps were developed). Regulation can be improved by the use of slots if peak pricing is not a practical option (and it rarely is) except in the case of light-handed regulation. Price caps can be improved by quality incentives and conditional triggers, though there are still problems with price caps in incentivising the right level of investment in large projects. Similar mechanisms may be part of airport and airline negotiations.

Overall, price cap and light-handed regulations do score well. A limitation of light-handed regulation, which has not been mentioned yet, relates to perceived equity. It gives more freedom to airports which are frequently monopolies and able to use this freedom to raise their charges. This is something which airlines and their trade associations such as IATA are vocal about, though it is an issue which has yet to be analysed in a rigorous manner.

8.7 Conclusions

Regulation of investment in airports is an inherently difficult task. Regulators, with some significant exceptions, have tended to rely on simple regulatory formulae, such as price caps. While these seem to work for a while, problems develop when major investments are required. In particular, it is difficult for the regulator to ensure that adequate but not excessive investments in capacity and quality are made.

The problem is complex because the regulator is seeking to optimise on several fronts: short-run efficiency in the use of congestible capacity; keeping costs low; delivering the right service quality; encouraging the right amount of investment and ensuring that the cost of the additional capacity is minimised. Regulators rely heavily on prices, yet prices are being used to address several conflicting tasks, including optimising use of existing capacity, allowing cost recovery, and providing incentives for investment. For example, when an airport is subject to excess demand and is congested, high prices are warranted for efficiency, but when investments have been made and capacity is ample, prices should be low. On the other hand, the regulator will need to offer high prices when investment is being made to provide the airport with incentives to invest. It is not surprising that simple regulatory solutions are unsatisfactory.

The problem of ensuring efficiency can be lessened if regulators employ additional instruments. These include rewards for quality, slots and trigger mechanisms for investment. Some key points to emerge from this discussion are:

- Slots enable a solution to the short-run optimisation problem which does not rely on the prices being set by the regulator. However, slots may have the effect of discouraging investment especially under light-handed regulation.
- Trigger mechanisms, whereby the regulator sets a higher price cap conditional on investments being made, can be used to get around the problem of price caps leading to under investment.
- The downside of conditional triggers is that they are essentially cost based, and thus they do not provide the airport with incentives to minimise the costs of the investment. Resolving this problem will depend on using additional mechanisms, some of which have been suggested though not operationalised so far.

The airport investment problem is often made more complex by the existence of environmental and planning requirements. Investment in airports, to improve quality or to increase capacity, may be held up for environmental reasons. Airports create noise, and local neighbourhoods frequently oppose expansion. City airports typically have very constrained sites, and expansion ideally requires more land—this will not be feasible where the airport is bordered by built-up areas. Airports also generate surface traffic, putting pressure on land-based infrastructure—this too may be very difficult to expand. In this paper, we did not discuss environmental aspects directly, though they need to be recognised as an important underlying constraint on airport investment.

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Chapter 9
European Airport Reform: Slots and the Implicit Contract Between Airlines and Airports

Hans-Martin Niemeier and Peter Forsyth

Abstract Europe faces some of the most difficult airport environments in the world. Many airports are very busy, are difficult to expand, and several have high charges. In spite of this, in some ways, such as the allocation of scarce capacity without major delays, they perform quite well. This paper examines the interests of the main stakeholders, such airlines, passengers, airports, and governments in these reforms, and the ways key institutions impact on them. A key institution is runway slots—these resolve the delay problem quite effectively. However, they do create large rents which can be used to enable poor efficiency, and enable the airlines and airports to create implicit contracts to underinvest.

Keywords Airport slots · Congestion · Regulation · Privatisation · Allocative efficiency · Cost efficiency · Capacity

9.1 Introduction[1]

Airports have a key role in the transport infrastructure of Europe, and have a major influence on how well air transport performs. In many respects, the performance of the airports in Europe is good. Europe has been able to avoid the chronic congestion which besets the US airports, airports (apart from some smaller airports) are financially viable, and there is moderately strong competition amongst the regional airports. However, there are some serious problems. There are major concerns about slot allocation at the busy airports, there is both overinvestment at less busy airports and underinvestment at airports with excess demand, and cost efficiency is

[1] We are very grateful to David Gillen and Eric Pels for comments on an earlier version. All errors are our own.

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lower than in other regions and costs are high. There is growing criticism that airport charges are higher than they need be.

The problems with the airports have been identified for some time, and solutions have been proposed at a national and at a European level—however, progress on reform has been very slow. This chapter seeks to explain why. To do so, we look at the motivations of the various interests involved, and at the institutions through which they work. While reforms may result in aggregate benefits being greater than aggregate costs, the distribution of costs and benefits is critical. With most reforms, there are some losers, and these will oppose the reforms. If reform imposes costs on interests which are very strong, it is less likely to be implemented.

Particular attention will be paid to institutions such as ownership and regulation. There is, however, an institution which is peculiar to airports-landing slots. Many busy airports are subject to slot limits, and these have a major impact on the way these airports allocate capacity, set prices, fund investment and choose whether to invest or not. As will be shown, the slot system is critical to the operation of busy airports in Europe. On the plus side, slots are an effective means of limiting delays—busy European airports have been able to avoid the chronic delay problems of the US airports. However, the impact of slots does not remain here. Slots create large rents, which go to the airlines, at least in the first instance. Institutions such as cost plus regulation can become an effective means of transferring slot rents from airlines to airports. In a slot-limited airport, there is not much pressure for cost efficiency. Slots can create a strong interest for airlines to oppose capacity expansion—this destroys the slot rents.[2] If airlines can create an implicit contract with the airport to share rents, they will induce the airport to not expand capacity, even when it is economically worthwhile to do so. Thus while the delay problem is addressed, the slot system sets up other inefficiencies which are very difficult to address. Hence performance remains mixed.

We commence by outlining the efficiency problems that can develop at airports, and we outline the various interest groups, their objectives, and the institutions within which they operate. Next, we assess how well the European airports perform in terms of various aspects of efficiency. In Sect. 9.4, we analyze the pressures for good or bad performance at the airports. We suggest that non-busy airports, which are not subject to slot controls, are similar to typical utilities. By contrast, busy airports which are subject to slots, perform very differently. Several situations are possible, but one involves the possibility of an airline–airport implicit contract, which enables the airport to produce inefficiently, and fails to expand capacity when needed. Some concluding remarks are made in Sect. 9.5.

[2] Note that we do not argue that slots, and the slot rents block expansion under all circumstances. The magnitude of the slot rents depends not only on the local market, but also on other markets for which the slots are used. Here, changes might happen which increase the value from additional slots, so that airlines are willing to give up their slot rents and do not oppose airport expansion.

9.2 Outline of the European Airport System

9.2.1 Some Facts about the System

We start by setting out some key facts about the system (Czerny et al. 2008; Forsyth et al. 2010; Gillen and Niemeier 2008):

- European airports vary between the very congested and those which ample capacity. The difference is obvious but important.
- Landing slots are used at most airports other than the very small airports. At some airports slots ration capacity most or all of the day, at others slots are used part of the day (these airports have a peak problem), and at others, slots are used rarely.
- The majority of airports are fully publicly owned, some are fully privately owned, and, significantly, quite a number are partly but not fully privatized. Only in the UK, Portugal, and Hungary (Budapest airport) full privatization has been adopted.
- Airports (typically the larger and medium airports) are regulated, while most of the smaller airports are not regulated. A few airports are regulated by independent bodies, while most airports are regulated by government departments.
- There has been entry into the airport industry on a small scale, particularly through the conversion of military airports to civilian use.
- The larger airports cater for all traffic, while smaller airports may cater for a niche, such as low-cost carriers.
- Some central and local governments subsidize their airports, especially smaller and regional airports.

9.2.2 Aspects of Performance

It will be taken that a key objective for airport policy is that it should promote efficient provision of airport services. This essentially means getting the greatest overall benefit from the operation of the system. There are several dimensions of efficiency which will be discussed in more detail below.

The ways airports operate will also have implications for distribution of the gains from operation. The distributional effects will need to be recognized, even though judgments will not be made here about what are desirable or undesirable distributions of benefits. Different policies will impose gains and losses on various interests—for example, airlines and their passengers will lose from higher airport prices, but airport owners will gain. Part of the task here will be to identify who gains and losses from specific options, with a view to explaining which reforms have and have not been made by reference to the gainers and losers from the reforms and the strength of their influence. Particular reforms may desirable on efficiency grounds, but they may not be undertaken because they impose losses on interests with strong influence (Button 2005).

Airports by their nature pose a number of specific efficiency problems. They are highly capital intensive, involving major investments, which, once made, are mainly sunk. There are considerable indivisibilities—it may not be feasible to increase capacity except in fairly discrete lumps. They are congestible—when demand exceeds capacity, delays to flights and passengers mount. Airports typically have market power, since most cities only have one major airport capable of handling airline traffic—this may because of natural monopoly characteristics, or it may reflect the difficulties of finding new locations for additional airports in a city. They generate significant environmental externalities, which leads to controls on operation and location. Airports produce a range of related outputs, including handling flights and passengers or freight, providing retail services and providing surface access. Efficiency problems can arise with each of these aspects.

9.2.2.1 Allocative Efficiency in the Short Run

This concerns the issue of using existing airport capacity such that the gains from using it are maximized. It is useful to distinguish two cases, the first, where capacity is adequate to handle demand, and the second where demand is in excess of capacity (in addition, for many airports, demand will be in excess of capacity for part but not all of the day).

For airports which have adequate capacity, optimization of use will involve setting prices equal to short-run marginal cost. It is often assumed that the marginal costs of airport operation are very low, perhaps close to zero. This may not be entirely accurate, as some services, such as providing for passengers in terminals, could face significant marginal costs at higher levels of utilization. However, it is likely that pricing at marginal cost will yield revenue which is insufficient to cover the sunk costs of providing the capacity. Thus, if cost recovery is required, a second-best pricing solution, such as Ramsey pricing, would be in order. These raise sufficient revenue at minimum cost in terms of reduction of output. In some cases, there is competition between airports (especially for low-cost carrier traffic). If so, it will still be the case that quasi-Ramsey pricing can be practised, and the price level does not make much difference to allocative efficiency.

For airports which are subject to excess demand relative to capacity, congestion will develop. Up to a point, additional output can be handled, but at the cost of increasing delays. Beyond this, the airport may not be able to handle any more output, and additional demand simply translates into increasing delays. Marginal delay costs are likely to rise sharply as demand presses against the capacity. Solving the congestion problems involves choosing an output level at which the marginal benefit from additional use is equal to the marginal cost, including the marginal costs of delay (Forsyth and Niemeier 2008a, b). Demand can be rationed by congestion, but given the congestion externality (users do not factor into their decisions the delays they cause to other users), this solution will result in excessive utilization of the airport. Two options to determine utilization are prices and slot limits. Pricing solutions involve setting prices for use such that output is limited to the optimum level. Alternatively, an allowable capacity in terms of a number of slots could be declared, and the limited number of slots could be allocated to the airlines—only users with slots would be permitted to use the airport.

If a pricing solution is used, capacity is allocated to the users who are willing to pay the price. If a quantitative solution, such as setting a limit on available slots to use the airport, is chosen, there is firstly, a problem of setting the slot limit efficiently, and secondly, a problem of allocating the slots. Slots can be allocated to airlines on several bases. They can be allocated by "grandfathering", or on the basis of use in previous periods. Regardless of the original allocation, slots might or might not be traded. Slots could also be auctioned. To achieve efficiency in the allocation of slots, it is desirable that the slots go to those users with the highest willingness to pay for them (though this statement needs to be qualified by the recognition that airport use is an intermediate input into airline services, and market power at the airline level could result in willingness to pay for slots being an imperfect indicator of the social value of slots—on this, see Zhang and Czerny (2012). Grandfathering of slots can result in an inefficient allocation of slots, especially if dominant airlines hoard their slots or are otherwise unwilling to trade them. If secondary markets for slots develop, an efficient allocation can come about. Auctions should also give rise to an efficient allocation, though they may be associated with higher transactions costs. The distributional aspects of these two mechanisms will be quite different. Allocated and traded slots will result in the airlines gaining the slot rents, or rents from the limited airport capacity, while auctions will result in the slot rents going to the airport or government (whoever has the rights to receive the auction proceeds).

For many or most contexts where there is a problem of ensuring efficient utilization and allocation of existing capacity, the overall level of prices is an important determinant of efficiency. In the case of airports, the level of prices as set by the airport is not especially important as a determinant of efficiency. Typically, elasticities of demand for airport use are very low, so that when prices are raised above (marginal) costs, the deadweight loss is low (except when prices are many times marginal cost). In addition, airports operate with a quasi-Ramsey pricing structure, whereby larger aircraft, which are likely to be less elastic, pay more than smaller aircraft (which are likely to be the most elastic)—this means that the impact on deadweight losses from increasing prices is even smaller. Thus, doubling prices for an airport which has adequate capacity is unlikely to make an appreciable difference to output, and the efficiency implications will be quite small.[3]

In the case of busy airports which face excess demand, if capacity is allocated by a slot system, this system supplants prices as the primary allocative mechanism. Unless prices are increased to the extent that excess demand is eliminated, increases in price will not have any effect on output. If slots are allocated free to airlines which then do not trade them, price increases will have an effect on the efficiency with which slots are allocated between airlines. Higher airport prices will increase efficiency because they will result in less use of slots by users which have a low

[3] But see Basso (2013); Basso and Ross (2010).

willingness to pay for them. If slots are auctioned or are efficiently traded between airlines, airport prices will not have any impact on the allocation of slots—the effective prices for using the airport are set by the demand for and supply of slot capacity. A rise in airport prices will reduce the value of slots, but will not change the effective price for using the airport.

Thus, except for the qualifications as noted, the level of airport charges will not be an important determinant of the efficiency of the use of the airport. Airport prices will, however, have a major impact on the distribution of the gains from airport operation, or on the distribution of the rents which accrue as the result of limited capacity. Higher prices charged by airports with adequate capacity will raise revenues and profits for the airports, but will result in airlines paying more. Depending on the strength of competition at the airline level, these higher prices will result in lower airline profits, or lower benefits to passengers, or some combination of these two. Higher prices charged by an airport which is subject to excess demand and which is slot limited will result in a shift in the slot rents from airlines to the airport (airline passengers will be unaffected, since the effective price of an airline using the airport, including the airport price plus the slot price, will be unchanged).

9.2.2.2 Cost Efficiency

Airports can combine their factors of production in such a way that they produce less than what is possible. There is some evidence that airports are not producing technically efficiently, for example when they have runways which are too long, larger than needed terminals and when they are overstaffed. Cost efficiency demands airports choose, out of the many technically efficient combinations of inputs, the one combination which minimizes the costs of producing a certain output given the factor prices. While airports are capital intensive, operational costs are still significant. To ensure efficiency, it is necessary that costs of production be minimized for the level of quality which is being provided. Cost inefficiency could well be the most important single source of inefficiency for an airport. Empirical studies suggest that airports differ widely in terms of their cost efficiency, which implies that some are quite inefficient (see Liebert and Niemeier (2013)). An example of cost inefficiency occurs with outsourcing. The degree of outsourcing differs substantially among airports. While some airports produce all services in house and even subsidize internally some loss-making activities, others source out many activities in order to reach the minimum scale of efficiency.

9.2.2.3 Provision of Capacity

Given that airports are capital intensive facilities, the efficiency implications of capacity provision decisions are potentially very large. If provision is inadequate, the costs in terms of delays or of unmet demand could be considerable. Alternatively, provision of capacity may be excessive. Larger facilities than those which are needed will be costly (and often they will be recovered by means of high airport prices to the users). It is also possible that facilities may be provided at a much higher standard than users would like to pay for—given that airports often possess significant market power, they can easily pass on the costs of excessively high standard investments to their users.

In principle, achieving efficient decisions on capacity provision should be straightforward. Cost-benefit analyses of investments can be done, and the gains from lower delays and meeting unmet demand can be set against the costs of additional capacity (a good example is the Airports Commission for London (2015)—in practice, many airport investments have not been rigorously evaluated). With regulated airports, it is possible for a regulator to set up incentives for investment. (For example, the UK Civil Aviation Authority set adjusted price caps for BAA conditional on it achieving specific targets in investment in London Heathrow Terminals—see Starkie (2008), Ch 6). Airport expansion may pose environmental problems, such as an increase in noise, but the costs of these can be factored into the cost-benefit assessment. In practice, the presence of indivisibilities and substantial time lags add to the difficulty of assessment. Perhaps the most severe hindrance to investment efficiency comes from the institutional aspects—do decision makers face strong incentives to get investment decisions right? For example, when airports are slot rationed, it is possible that both the airlines, and the airport, may have an incentive to underinvest, to increase prices and profits.

When airports need to expand capacity, locational problems arise. Additional capacity might be provided at the existing site, but this could be quite expensive. It might also impose substantial environmental costs. Alternatively, capacity can be provided at a new site. Land and environmental costs of this option will typically be less, but other costs will be present. New sites may be less conveniently located, and surface access costs can be large. In addition, traffic will be split between two or more sites, and this limits the scope of the airports to serve connecting traffic efficiently. Where to locate additional airport capacity usually becomes an issue for governments and communities, not just the airport and its users. Again, the options can be assessed using cost-benefit techniques.

9.2.2.4 Options for Commercial Activities

Airports have the ability to develop commercial facilities, some of which are related to the operation of the core business and some of which may not be. Thus, airports can gain revenue from provision of complementary[4] retail, office, and parking services. One aspect of efficiency is that airports make effective use of their options, such as by providing parking and retail facilities when passengers are willing to pay for them.

[4] On the complementarity see the chapter by Zhang and Kidokoro.

9.2.2.5 Connectivity and Regional Aspects

Another aspect of capacity provision which is of special relevance to Europe concerns investment in regional airports. Smaller (and some larger) communities are seeking to attract flights to their airports—airports are seen as "job machines". By investment may attract more flights and thus increase economic activity within the region. Recently there has been considerable interest in airports as a means of increasing the "connectivity" of a city or region (Airports Commission 2014). Improved connectivity can be regarded as a "wider economic benefit" of air transport (Forsyth 2020). From the region's perspective, this may be a worthwhile investment. However, if much of this increase in traffic is traffic which attracted from other regions, there need be no gain to the economy as a whole.

9.2.2.6 Quality

Service quality has become a major issue among airports and their users. As Graham (2018) has pointed out overall service quality of an airport is a product of many parties such as airlines and airports but also customs and immigration officials of which the airport has no direct control and which have different interests. Low-cost carrier and legacy carrier demand different qualities. Furthermore, passengers differ in their attitudes between those who just want to get as quickly to the gate and those who wish to shop. This implies that service quality should be differentiated and reflects the demands of the users. With crowded terminals and passenger delays, quality has become more and more and issue. IATA and the airport industry group ACI have jointly developed quality standards to measure service quality and regularly monitor quality.

9.2.2.7 Environmental Externalities

Airports are generators of a range on environmental externalities, such as noise, local emissions and greenhouse emissions. Internalization of local externalities poses a number of problems. Noise surcharges could be, in principle, an efficient instrument, but very often they are constrained to be revenue neutral. This limits incentives for airports to use noise surcharges effectively, and the shadow price of noise might be higher than a revenue neutral level of charges. Furthermore, it is rational for individual airports to let other airports penalize louder aircraft and benefit from a less noisy fleet. Even at Zürich Airport, an airport which is regarded as having one of the most stringent noise charges, noise and emission charges lead to hardly any substitution effects towards environmentally friendly aircraft (Evangelinos et al. 2020). Air transport is a major generator of greenhouse gasses. Airlines, rather than airports, have the main role in determining these emissions, but airports also have some role. Airports are not normally subject to formal regulation of emissions

Table 9.1 Aspects of Efficiency

Aspect of efficiency	
Allocative	Output choice and choice of slot limits
	Allocation of capacity
	Pricing
Costs	Minimum cost production
Provision of capacity	Investment in capacity
	Location of additional capacity
Other efficiency aspects	Commercial activities
	Regional impact and accessibility
	Service quality
	Environmental

outputs, but they are under pressure to do what they can to lessen them. Many are seeking to become "carbon neutral". One stage in which they are under pressure is the investment stage. Airports are often opposed because they are seen as generators of emissions. The London Airports Commission paid considerable attention to the carbon implications of the options which they evaluated (Airports Commission 2015).

Table 9.1 sums up the key efficiency aspects of airports.

9.2.3 Institutions

There are several sets of institutional arrangements which will affect how interests influence performance. Some of the key ones are as follows.

9.2.3.1 Ownership

Most of the airlines in Europe are privately owned, and subject to capital market disciplines. Thus a working hypothesizes that they seek profit as their primary objective. Airports are subject to a range of different ownership forms, from pure public ownership, mixed public—private ownership, and fully private ownership. Publicly and partly privatized owned airports are likely to be less oriented towards profit and may have size or quality maximization objectives. They may also seek to promote development in their region by attracting traffic.

9.2.3.2 Competition

Many of the major airports in Europe have an effective monopoly, in that they are the only airport in a city, and alternative airports are distant. However, competition has been developing for some large airports and between smaller, regional airports, especially for low-cost carrier traffic. The scope for competition has been influenced by ownership arrangements. Thus, some cities which have more than one airport (Berlin, Paris), but only one owner of the airports—hence the potential for competition has not been taken up. Airlines are mainly oligopolistic or competitive.

9.2.3.3 Regulation

Most larger privately owned airports, and some publicly owned airports are subject to explicit price regulation. Many smaller airports are not directly regulated—for some there is a threat of regulation, and for others, competition limits the market power they might have. Regulation of airports in Europe takes several forms. Some airports are subjected to old style rate of return regulation, or essentially cost-based regulation. There has been some use of price caps, especially with fully privatized airports (Gillen and Niemeier 2008). Price caps can be regarded as a form of incentive regulation, though the strength of the incentives varies (Adler et al. 2015). Some price-capped airports are subject to regular cost-based resets typically at the beginning of each regulatory period, and this form of regulation can be seen as a combination of cost-based and incentive regulation (or hybrid regulation). Arguably, there are no airports in Europe which are subject to strong forms of incentive regulation. Apart from this, regulation can be more or less light handed. Light-handed regulation is less prescriptive, and it allows the airport more freedom in setting charges, subject to conforming to some broad limits. Thus, Copenhagen or London Gatwick airport could be considered to be less tightly regulated than London Heathrow airport. Airports can be regulated by an independent regulator, with an open and transparent consultation process with the stakeholders represented or they can be regulated by a more or less dependent government regulator with a less open consultation process. The latter form of regulation has been criticized by airport users.

9.2.3.4 The Slot System

The slot system an institution which has grown up organically and which has a major impact on the ways airports operate (see Czerny et al. 2008). Most countries around the world use a slot system—the main exception being the USA, which uses a queuing system with first come, first served allocation. Europe and Japan are the main areas with busy airports and slot systems. The slot system embodies particular rules of allocation for scarce slots. It is now partly regulated by the EU, and it has been a system which has allowed little scope for formal slot trading.

9.2.3.5 The Planning Environment

Airports can rarely undertake major investments without obtaining planning permission from governments, local regional and national. Planning arrangements seek to balance the interests of the airports and their users, along with the interests of the local communities. They will also often be used to control or limit environmental externalities, such as noise. In addition to planning authorities, airports may be subject to environmental regulators, which will have an influence on major investments, as well as operational aspects. Thus, noise taxes may be levied on an airport, or it may be subject to a noise curfew.

Table 9.2 sums up a range of institutional aspects of airports.

9.2.4 Interest Groups

Many distinct groups have an interest in what happens at airports and how airports operate. These include users, owners, and local communities. These groups work and advance their interests within an institutional framework. For present purposes, the notion of institution is a broad one, and it encompasses forms of ownership, regulatory arrangements, including economic and environmental regulation, and operating arrangements, such as the slot system. We start by considering the different interest groups, and how they are affected by airport operation and policies.

Table 9.2 Institutions and Interests

Institutions	Interests and motives
Ownership	
– State	Ideally welfare maximization but very often distorted by special interests and rent seeking. For airports owned by local municipalities, maximizing regional benefits dominates
– Private	Bankruptcy constraint enforces profit maximizing behaviour
– Mixed	No bankruptcy constraint and mixture of commercial and regional interests
Regulation	
– Cost-based	No interest in cost efficiency and no interest in optimal capacity utilization
– Incentive	With pure incentive caps strong incentives for cost efficiency and revenue generation
– Independent regulator:	Avoids rent seeking and regulatory capture behaviour of airports and airlines
Competition	
– Blocked or not	Interest of airport managers to block competition
Slots	
– IATA system	Slot owner has the interest to maximize the value of its slot by keeping slots scarce and by blocking others to acquire slots

9.2.4.1 Passengers and Shippers

Passengers and shippers of freight prefer to see lower airport charges, which may be passed on to them by airlines. In addition, they prefer to see low delays, which they experience themselves, and which also increase the costs of airlines, which may be passed on to them. They wish to see the right level of quality of service—for example, they may not wish to pay for a very high level of service which they do not value. Different users have different quality requirements. Thus, it may be desirable to offer different levels of service to different passengers (passengers on low-cost carriers will be willing to use lower quality facilities if they save them money).

9.2.4.2 Airlines

Most airlines these days are privately owned and can be regarded as normally focused on profit (especially since their viability depends on achieving profits). Airline interests also include airline workforces, who are interested in wages, employment conditions and jobs. The interests of airlines do not necessarily coincide with those of their passengers or freight customers—for example, depending on competitive conditions, airlines might or might not pass on an increase in airport charges. Airlines have an interest in airport charges being low. In addition, they prefer to see low delays, and seek a level of quality of services which matches their willingness to pay for quality.

9.2.4.3 Airports

Airports may be publicly or privately owned, and as well, they may have hybrid ownership forms. Typically, privately owned airports will be oriented towards profit, and they will seek high airport prices.[5] While they will not be directly affected, they will prefer lower levels of delay (however, if an airport is regulated, it may allow delays to be high rather than incur costs to itself, and lower profits, in reducing delays). Publicly owned airports could be corporatized and be given incentives to make profits. More likely however, such airports will be set cost recovery requirements, and will not be expected to maximize profits. Publicly owned airports may seek to maximize size, or quality, or may seek a quiet life.

[5] Though sometimes they prefer enjoy the quiet life of a monopolist.

9.2.4.4 Governments and Regulators

A public interest approach would suggest that governments, such as national governments in Europe or the EC, would seek to advance the public interest. They would do this by promoting maximum welfare (such a measure of welfare would take environmental costs into account). In reality, governments may be more populist. They will also be influenced by interest groups, some of which, like airlines or airports, may have more direct access than others, such as passengers. Some governments may have some broad objectives which impinge on their approaches to airports—for example, parts of the EU seem ambivalent towards air travel and are keen to encourage people to travel by surface modes rather than by air. Governments may seek to attract economic activity and may see airports as a means of doing this. Finally, governments can be interested in the revenue consequences of airport policy (especially at the time of privatization). With the Green Paper on Fair and Efficient pricing in 1995, the European Union viewed airports as part of the general infrastructure that should be priced according to social marginal cost principles (Rothengatter 2003). Member states such as, e.g. Germany have also adopted these principles in their policy papers (Nash 2000).

Local and regional governments can have similar objectives to those of higher level governments. However, they may be particularly interested in promoting economic activity and jobs in their area,[6] and may seek to use airports to achieve such objectives. They may also be more reflective than higher level governments of the views of residents in their area who live around the airport.

The interests of regulators depend on what their government masters expect of them. The public interest theory of regulation would suggest that regulators seek to maximize the efficiency of the firms that they are regulating. Certainly, efficiency objectives can be paramount in a regulator's objectives. However, regulators need not always seek to advance the public interest. Regulators may be captured by the firms they are regulating, and see issues in a very similar way to the ways the firms see them. Regulators will also reflect the government's political objectives. Thus, they may be under strong pressure to ensure that profits of the regulated firms are at moderate or "reasonable" levels, and that revenues are close to cost. High profits can be embarrassing to governments, even when they espouse incentive regulation. Regulators also may seek to avoid crises, such as setting conditions such that the regulated firm encounters a cash crisis.

9.2.4.5 Local Communities

Local communities around an airport are likely to be particularly concerned about any negative externalities, such as noise, generated by the airport. They may also be

[6] Regions might depict themselves as being under some form of regional competition.

Table 9.3 Interests at (a) busy airports, (b) non-busy airports

	PAX	Airlines	Airports	Government	Community
(a) Interests at busy airport					
Delay	S	S	–	–	–
Cost efficiency	–	S	W unless private airport can keep part of the efficiency gains	W	–
Add. capacity	S	N	N	S	W/N
Price	–	S	N	–	–
(b) Interests at non-busy airport					
Delay	–	–	–	–	–
Cost efficiency	S	W	W	W	–
Add. Capacity	S	S	S if size maximizer	W	N/W
Price	S	W	N	–	–

Code: S strong interest, W weak interest, N negative interest

interested in positive effects such as the promotion of economic activity and creation of jobs, and the gains from increased connectivity with other centres.

Table 9.3 sums up the different interests affecting airports.

The strengths of these differing interests differ widely, though not always systematically. Ultimately, governments are the most powerful, and governments will be the final arbiter of issues to do with airport policy. Governments are not all powerful, however, and they need to seek support for their policies from other interests (Stigler 1971). Other airlines and airports can be regarded as having strong influence. Airlines are often large corporations which have multiple points of contact with government. Airports will also have direct contact with regulators and possibly governments (who may be their owners). Both airlines and airports are well organized in their respective associations at a national and European level (Kyrou 2000). Lower level governments may have some direct controls over airports (construction may require local government planning permission), though they are less likely to be interested in the detailed operation of airports in their area. Local communities may or may not have political power—this will depend on how effectively they are able to organize and also if and to what extent they own the airport. Finally, the customers of the airlines, passengers, and shippers are likely to have only limited influence. Most would not have direct access to governments or regulators. Furthermore, for most passengers or shippers, the prices that they indirectly pay to airports or delays they face are not likely to be a high proportion of their real incomes. Thus, for individual passengers or firms, they are unlikely to have a strong incentive to lobby governments or regulators on airport prices and policies. Interests and influence are not constants—they can change over time. A group which has little influence over airport policy may gain considerable clout at a key point of time. For example, a local community which is well organized may be able to lobby quite effectively over a specific airport expansion proposal.

There has been change in the ways in which the airports in Europe have been owned, regulated and operated (Gillen and Niemeier 2008; Forsyth et al. 2016). This, there have been changes within the EU concerning slot trading—the restrictions on such trading are due to be eased. There have been institutional changes, notably privatization. Accompanying this has been the introduction of explicit regulation, mostly of a hybrid (mixed incentive and cost based) form (Adler et al. 2015). Attempts have been made to make existing regulation more incentive based, and to handle investment issues more efficiently. This said, there has been little progress on several issues. There has been little interest in reforming price structures. While privatization may sharpen incentives to pursue cost efficiency, there is not much evidence of progress so far. With the exception of a few cases, the problem of securing adequate, but not excessive investment in capacity and quality has not been given much explicit attention (see Forsyth et al. 2022).

One aspect of airports on which change does seem to be occurring concerns the level of airport prices—these appear to be increasing, for some airports, quite significantly (Bel and Fageda 2010). One possibility is that airports may have been making more use of their market power, increasing their profits by doing so. Another possibility is that many airports are difficult to expand to cater for growing traffic, especially since many are land constrained. Additional capacity is expensive, and this necessitates higher prices. The causes of higher prices at airports have yet to be analysed rigorously. The distributional consequences of these price increases can be very large—higher prices lead to airlines and their passengers losing out to airports and their owners, (which may include governments).

While the nature of the changes needed to improve airport efficiency can be straightforward, the ways in which they can be achieved are not. There are uncertainties as to which institutional arrangements are most effective in facilitating and promoting reform. Different interests have different views on reform. What happens depends on the interplay between these interests and the institutions they work with.

9.3 How Well Are European Airports Performing?

9.3.1 Allocative Efficiency

With airports which have adequate capacity, utilization is efficient. The price structure, which is of a quasi-Ramsey form, results in achievement of cost recovery with little impact on output (Martin-Cejas 1997).[7]

[7]Ramsey pricing would result in low charges for small planes on short flights and high charges for large planes on long flights.

In Europe, most airports which face excess demand have capacity rationed by a slot system, in contrast to the USA where demand is rationed by delays at most busy airports. Authorities choose slot limits which are close to the theoretical capacity of the airport, and which are consistent with a modest level of delays. While this slot limit is not usually set very scientifically, by balancing the costs of extra delays against the benefits of additional output, it might turn out that the choice of slot limits is quite efficient. However, this need not be the case (Forsyth and Niemeier 2008a). Morisset and Odoni (2011) have argued that a typical US airport sets a substantial higher movement constraint than their Europeans counterpart.[8] This has been further analysed by Adler and Yazhemsky (2018) showing that increasing the number of slots would lead to substantial welfare gains in Europe.

The allocation of capacity at busy European airports is well short of the ideal. This is for two reasons.

Firstly, slots are allocated by grandfathering, and slot trading is limited. Grandfathering, per se is not the problem—if an original allocation is changed by airlines freely trading, an efficient allocation, with slots going to the airlines with the highest willingness to pay for them, an efficient allocation will result. However, in Europe trading is quite limited. There is some trading in UK airport slots, but the market is very thin. Trading has been effectively prohibited in the rest of Europe, though this is now changing. Major airlines with many slots at busy airports may allocate their slots internally in an efficient manner, but they still may be unwilling to put low-valued slots on the market and enable their competitors to buy them. It is difficult for airlines to obtain slots when they are prepared to pay high prices for them (Czerny et al. 2008).

Secondly, the allocation of capacity depends on just on slot availability but also on price structures, and these promote inefficient allocation. The price structure for most airports is one in which large or heavy aircraft pay much more than small or light aircraft. Granted a correlation with demand elasticity, this structure works well to encourage the use of capacity which is in ample supply. However, for busy airports, the problem is one of rationing demand for capacity which is in short supply. Small and large aircraft use the same scarce facilities, but one pays much less than the other. To allocate scarce capacity, the efficient price structure would be uniform one, in which all users pay the same to use the constrained facility. In some busy European airports, large aircraft may pay more than ten times as much as small aircraft. While large aircraft and passenger loads are costlier to handle than small aircraft in terminals, this cannot explain the divergence in prices. Small aircraft are given an artificial incentive to use busy airports, and this results in a potentially large inefficiency in the allocation of scarce capacity (Forsyth and Niemeier 2008a, b).

Another factor which lessens the efficiency of capacity allocation is the almost complete absence of peak/off peak price differentials in European airports.[9] Peak pricing is relevant for airports which are busy for part of the day, but which have

[8] Odoni (2017) showed also that the existing slot allocation rules can be improved.

[9] London City and Rome Airport are among the few exceptions.

adequate capacity for the rest of the day. The slot system takes on part of the role of peak prices. Slots during the peak are in high demand, and their effective price is high—this rations capacity at the peak, and encourages greater use of the off peak. However, peak / off peak price differentials could improve the allocation still further. Lower off peak prices would encourage the use of available off peak capacity, and airport revenues could be kept constant by increasing peak prices (which would not affect the use of the airport since peak prices are below market clearing levels).

9.3.2 Cost Efficiency

Productivity benchmarking studies have indicated that European airports, as a group, have relatively low productivity as compared with Australia or the USA.[10] These results can be used to shed some light on the European performance. There is evidence that fully privatized Australian airports and public US airports with a relatively high degree of outsourcing outperform European continental airports, in particular, partially privatized German and Austrian airports (Oum et al. 2006; Adler and Liebert 2014). The latter seem to suffer from a range of issues, in particular labour intensive and unionized ground handling, complexities of partial privatization, a lack of incentive regulation and airport competition, which is generally less intense than in the UK.[11]

[10] Comparisons with airports of other regions can be difficult because airports in different regions provide a different mix of services- many European airports provide ground handling, which is less common elsewhere. Even when corrections are made for the different output mixes, the European airports have lower productivity and higher per passenger costs (Oum et al. 2006).

[11] Performance analysis has focused on the various factors influencing efficiency (Liebert and Niemeier 2013). In Europe there are roughly three different types of airport models including governance. In the UK we find fully privatized airports with a large degree of outsourcing facing competition, the threat to be regulated or direct incentive regulation from an independent regulator. In Europe we find public utilities or partially privatized airports facing more or less intense competition. Some are regulated by incentive schemes but with a few exceptions by a dependent regulator. The degree of outsourcing is especially low in Austria and Germany where airports operate in particular labour intensive ground handling. The characteristics of these models have been analysed in terms of their efficiency implications. Full privatization leads to a better performance than partial privatization and not necessarily to more cost efficient production than public airports (Oum et al. 2006; Adler and Liebert 2014). Intense competition forces airports to become efficient. Competition if effective has stronger effects than regulation (Assaf et al. 2012; Adler and Liebert 2014). Incentive regulation is superior to cost-based regulation and increases efficiency (Adler and Liebert 2014; Adler et al. 2015). Outsourcing in particular of ground handling increases cost efficiency (Oum et al. 2006; Adler and Liebert 2014; Adler et al. 2013).

9.3.3 Provision of Capacity

In Europe there has been abundant capacity in areas with lack of demand, and underinvestment in those with excess demand over the last 30 years (Button and Reynolds-Feighan 1999). We can observe some tendencies, namely that

- At busy airports, the slot constraints for the period 1990–2018 were steadily increased. The airports of Amsterdam, Barcelona, Frankfurt, Manchester, Madrid, Charles de Gaulle built new runways, lessening excess demand. Some busy airports have not increased capacity and some airports, like Düsseldorf or Paris Orly, are unlikely to be expanded due to environmental and planning restrictions.
- At non-busy airports, there is evidence of excessive investment in runways for intercontinental flights at secondary European airports. According to Maertens (2000), investment was not profitable for about 80 airports out of 115 airports and 55 airports had no long-distance flight at all in 2007.

In general, these investments were not assessed by cost-benefit analysis, although noise and pollution are a major policy concern. Investment in capacity was very often assessed by economic impact analysis (EIA), which is a flawed technique which always measures positive effects on GDP and employment by ignoring substitution and price effects and treating costs as benefits. This leads to a lack of rigorous assessment and a bias towards overstating the benefits and underestimating the costs of providing additional capacity (Forsyth et al. 2020).

9.3.4 Other Aspects

Evidence on the extent to which European airports are making good use of their options for commercial activities is not systematic or extensive. European airports have developed these activities more intensively than the US airports, but there seems to be a large variance among European airports indicating scope for further business gains (Graham 2018). There is some evidence that privatization makes them more willing to increase their non-aeronautical revenues, but this incentive depends also on the regulatory system.

It is challenging to make a general assessment of the efficiency with which decisions about the location of additional capacity have been made. Such decisions tend to be made ultimately by governments, which balance community pressures, environmental factors and airport capacity requirements against one another. However, there are examples of decisions which pose questions firstly, in regard to the rationality of choice reflected largely in the absence or disregard of cost-benefit studies and secondly, in the results, that is where new airports have been built. Three are listed here.

Firstly. whether or not, and if so, when and where to add capacity in the London area has been a controversial issue for more than five decades. In the 1980s, the UK government determined to expand runway capacity at London Stansted airport rather than at London Heathrow, where the capacity was needed. Starkie (2004, p. 410) criticized this as “a mistake and one that might well have been foreseen”. Policy begun to change in 2003 with the White Paper on the Future of Air Transport in the UK and the decision of the Labour Government in 2008 to add a third runway in Heathrow and a second runway in Stansted. This decision was reversed by the government in 2010 which decided to add new capacity. The Mayor of London, then Boris Johnson, favoured then the construction of a new airport in the Thames Estuary. In September 2012 the government established the Airports Commission, an independent commission which in 2013 rejected Johnson proposal and evaluated the three options: either to build a new north-west third runway at Heathrow, or extend an existing runway at Heathrow, or a second runway at Gatwick Airport. These options were evaluated by a Cost-Benefit study and a Computable general equilibrium (CGE) model. In 2015 the Airport Commission recommended a new northwest runway at Heathrow Airport with a package of measures to address its negative environmental and community impacts (Airports Commission 2015). In 2018 the government and the Parliament approved this plan. While the Airports Commission has in many respects set new standards on how to evaluate the different options with CBA and CGE, the decision raises some concern that after the break-up of BAA Gatwick airport has not been allowed to compete with a new runway with Heathrow. Furthermore, as Starkie (2018) pointed out, the option of a shorter, less costly to build runway, which would have been delivered earlier, has not been assessed.

Secondly, in contrast to the UK approach, Germany has expanded its capacity without assessing these major investments in terms of economic welfare. In the year 2000, the decision on the additional runway at Frankfurt Airport was taken without a cost-benefit analysis, although the external costs were calculated in a study. Similarly, the decision to locate the new Berlin airport near Berlin-Schoenefeld airport, and to close two other airports was taken without valuing the benefits and costs, although transport infrastructure projects are generally assessed by this method in the national transport plan. Instead these decisions were rationalized by economic impact studies which claimed implausibly large employment effects, with the intention to persuade the general public that the benefits (new jobs) outweigh the negative effects of noise (Niemeier 2013).

Thirdly, with strong growth and expected capacity shortages, it would be efficient to expand existing airports and to build new airports in those markets with excess demand. While the former has happened in some cases like Frankfurt, Heathrow (terminal 5) and Madrid, the latter has not happened. Quite the opposite has happened: in the period 1995–2005 21 new airports entered the market in 14 countries out of 25 European countries, but largely in rural regions with low demand (Müller-Rostin et al. 2010). Very often these were military fields converted into civil aviation airports and managed by the public sector. Only in the UK has a privately managed airport (Robin Hood Doncaster Airport) entered the market. Very few airports were greenfield airports. The most notable exceptions to this are two Spanish airports[12] and one German airport[13] though all of these were complete and costly failures.

Table 9.4 sums up the efficiency performance of the airports.

9.4 Implicit Airline–Airport Contracts

9.4.1 Airports with Adequate Capacity

It is easiest to commence with airports with adequate capacity. These are airports which are likely to have least problems, and which are likely to resemble traditional utility industries. Some, especially, the smaller ones, may be quite competitive. The group of these airports covers a broad range, from very small airports, perhaps with one airline customer, to medium-sized airports which have adequate capacity. Overall, they are the much larger part of the air transport infrastructure.

There is unlikely to be a problem with allocative efficiency at these airports. There is no problem of delays at these airports (other than non-capacity related delays). The quasi-Ramsey nature of price structures means that there is unlikely to be large gains from changing price structures.

[12] Don Quijote International Airport is located about 200 kilometers (45 min) south of Madrid and 45 min north of Córdoba by high speed train. It cost about 1.1 Billion €, but operated only the first 3 months of 2011. It was auctioned in 2015 and was purchased by Tzaneen International for 10.000 € (Niemeier 2016). Since then, regular commercial flights have not been reported. Another international airport Aeropuerto de Castellón was built in the province of Castellón. Castellón is the only province on the Spanish coast that does not yet have an international airport. It is in close proximity to the airport of Valencia which is a non-busy airport. The project was delayed and has been regarded as public/ private scandal. Today the airport is fully privatized. It is an airport with a capacity of two million passenger and operates with a few flights per week by Low-Cost-Carriers (Poole 2012, Aeroporto Castello 2019).

[13] Kassel Calden is a newly built airport planned in 2000 and opened 2013. It is surrounded by small regional and international airports like Paderborn and Hannover and city of Kassel is well connected via High Speed train to Frankfurt Airport. 260 M € was invested, but compared to the worst-case scenario, passenger numbers grew much slower. In 2015 passenger numbers reached only 20% of the forecast passengers (Niemeier 2016) and after a strong increase in 2018 passenger numbers have reached in 2019 40%. The yearly financial deficit is reported to be the range of five to six million € (Süddeutsche Zeitung 2019).

Table 9.4 Airport performance

	Assessment	Evidence	Relative to US
Busy airports			
Allocative inefficiency	Reasonably efficient in London due to secondary trading, otherwise less effective, but superior to the USA. Slot constraints tighter than in the USA, congestion lower than USA. Rents reaped by airlines are higher	Morisset and Odoni (2011)	Less costly than USA, which relies on queuing.
Cost efficiency	Low in Europe due to various factors including ground handling and partial privatization	Oum et al. (2006) and Adler and Liebert (2014),	European airports have higher costs than USA due to lack of outsourcing and complex public–private partnerships
Efficient investment	Increase in capacity at some busy airports, but often too slow and blocked, e.g. in London and Düsseldorf area. No new entry at airport regions with excess demand	Müller-Rostin et al. (2010)	
Other aspects	Choice of location not done by CBA		
Non-busy airports			
Allocative inefficiency	Welfare losses limited by weight-based charges. Ramsey pricing would result in decreased fees for small planes on short flights and increased fees for large planes on long flights	Martin-Cejas (1997) Hogan and Starkie (2003)	Similar Morrison (1982)
Cost efficiency	Low in Europe due to ground handling and other factors	Oum et al. 2006 and Adler and Liebert 2014, Adler et al. 2013	Continental airports have higher costs than the USA, e.g. due to lack of outsourcing and complex public–private partnerships
Efficient investment	Excess of intercontinental runway capacity at non-busy secondary airports New entry in rural areas increasing over capacity	Maertens (2000), Müller-Rostin et al. (2010) Niemeier (2013)	
Other aspects	New airports in regions with low demand and examples of white elephants	Müller-Rostin et al. (2010) and Poole (2012)	

The situation could be different with cost efficiency, however evidence on smaller airports is not as extensive as that on large airports. Small airports which face competition and demanding customers (LCCs) have strong pressure to be efficient. On the other hand, small to medium-sized airports, which do not face strong competition, are not regulated in a way which gives them the incentives to be efficient, and which are publicly or partly publicly owned, are likely to be questionable in terms of cost efficiency. Some smaller airports are effectively cross subsidized by their government owners. Indeed, the larger ones, for which there do exist measurements of cost efficiency, tend to be poor performers in this regard. They have invested in costly capacity for intercontinental flights which they hardly use, and have very often "gold plated" their terminals.

In terms of investment efficiency in the long term, this group would also be mixed. There are many factors affecting efficiency of investment, such as location and subsidies. Where competition is present, there are pressures for good investment decisions. But the mechanism of entry and exit hardly works and even leads to cases of white elephant airports, particularly amongst government-owned airports or where local and national governments have been attempting to boost demand in an attempt to raise economic activity.

Thus, airports in this group are similar to other industries in that they are likely to respond similarly to the usual incentives for efficiency. Competition, incentive regulation and private ownership will put pressure on the airports to be efficient, whereas lack of competition, cost-based regulation and part or full public ownership will do the reverse. While there is no guarantee that a particular airport will perform efficiently, we do know the environment which is likely to stimulate good performance.

Connectivity and Regional Aspects

While airports are often viewed as noisy but necessary evils, particularly in larger cities, there is a growing appreciation of their roles in a wider context. There has been a greater recognition of the impacts and benefits of connectivity. With larger cities, connectivity with other cities around the world is valued—well-connected cities are seen as attracting greater economic activity (the Airports Commission (2015) for London put a strong emphasis on connectivity for London). With smaller cities in regional areas, connectivity with the capital of the nation is important. In addition, a region will be keen to have direct airline services to the main inbound or outbound tourist destinations. Some regions have been prepared to subsidize their airports to bring traffic in and enable better connections.

The economic impacts of connectivity can be documented relatively well, though the benefits they bring are much more difficult to quantify (Forsyth 2020). Regions and their airports have often used questionable techniques, especially economic impact analysis (Forsyth et al. 2020), to claim large "benefits", such as impacts on GDP and jobs, for the region. These have not really helped further the analysis of these real effects, and more rigorous approaches, such as computable general equilibrium modelling, are better at estimating the impacts of airport policies.

9.4.2 Busy Airports

With busy airports the presence of slots makes a fundamental difference to the interests of the different stakeholders. Outcomes will differ according to whether the airport is privatized or not, and what form of regulation it faces.

In terms of allocative efficiency, the delay aspect is handled reasonably efficiently in Europe, and the main allocative efficiency problem stems from the allocation of slots. Slot allocation may be a moderate though not severe source of inefficiency (e.g. see NERA 2004). Thus it is in contrast to the US, where there is a major source of inefficiency in that delays not handled well (Morrison and Winston 2008). Thus, allocative efficiency is low in the USA, but moderately or very high in Europe.

In principle, the three aspects of efficiency are independent—airports can perform well in one aspect though poorly in another. However, in Europe they are interconnected. The institutions (slots) which give rise to good performance in one aspect set up incentives for poor performance in others. It is not by accident that European airports perform poorly in cost efficiency while they perform well in allocatively. In some cases, European airports may also be performing poorly in investment. Two cases can be considered.

Well-Regulated Private Airports
Suppose that an airport is private and subjected to incentive or hybrid regulation. An example of this is London Heathrow which is subjected to hybrid regulation. Airlines would like to see prices being as low as possible, to maximize their slot rents. The airport will like to see prices as high as possible, and it will tend to be productively efficient. In reality, regulation will be less than perfect, and the incentives for the airport to be productively efficient will be only modest. In this environment, the airport will tend to be maximally productively efficient. As Starkie (2012) has noted, the role of the regulator of Heathrow has little to do with allocative efficiency—rather it is to carve up the slot rents between airport and airlines. The airport will take advantage of this to gain rents but use them in being less efficient. In the short run, the airport may have some remaining incentive to be efficient.

Turning to long-run aspects of efficiency, these are not independent of what is happening with short-run efficiency. In the long run, it is in the airlines' interest that the airport does not invest in adequate capacity, even when there is a clear economic case to do so (Forsyth 2008; Gillen and Starkie 2016). Investment in capacity will reduce prices and slot rents. The airport's interest is mixed. If the airport is well regulated, it may gain higher profits if it invests in additional capacity. However, it is also possible that the airport can do better by not expanding (and not achieving the higher profits which will be regulated away from it).

In fact, there may be an implicit contract which leads both the airport and the airlines to oppose and block expansion, even when expansion is the economic option. The airlines allow the airport to capture some of their slot rents, by not putting much pressure on the regulator to keep prices low. The airport can enjoy higher profits and/or less efficiency. The travellers/shippers will suffer from prices being higher than they need be. In the case of London Heathrow, both the airlines and the airport for many years said that they would like to see it expanded—but is this their real view? Certainly, there does not seem to be a reason why the airlines would destroy their slot rents. When the Report of the Airports Commission (Airport Commission 2015) was published, recommending a new runway for London Heathrow, airlines such as British Airways became significantly less in favour of it. Some regulators, especially the UK CAA, have been promoting the use of contracts between airlines and airports to improve efficiency. In the short run, this may be desirable—however, in the long run, it may make it easier for airlines and airports to develop deals which lessen efficiency by inhibiting expansion (Forsyth and Niemeier 2010).

Thus, in the case of busy airports, the reliance on slots solves the delay problem very neatly. However, the other aspects of efficiency are not independent of what is going on with slots. Slots create very large rents, and these rents can be used quite inefficiently. Even in the most efficient institutional arrangement, with private ownership and good regulation, the combination of slots and other institutions can give rise to poor performance in terms of productive and long-run investment efficiency.

Cost Plus Regulated, Partly Private and Public Airports

This type of airport is quite a large group in Europe. Incentives and interests are mixed. Cost plus regulation allows productive inefficiency to develop—thus it is not surprising that European airports tend to be productively inefficient. One would expect that airlines, at least from a short-run perspective, would oppose cost plus regulation, since the airlines rents are being dissipated in inefficiency. On the other hand, the airlines are gaining significant rents, and pressure to cut costs is less. As before, however, short-run efficiency is not necessarily the whole story.

Is it possible for an implicit contract to be formed by the airlines and airport to block expansion? Airports are not indifferent to profit—after all, they have some private shareholders, who would approve a contract like the one discussed above. Furthermore, the owners may prefer a Hicksian quiet life, and prefer to see the airport not expand, even though it is economic to do so. On the other hand, the airport may behave as an Averch/ Johnson cost-regulated firm, and invest too much rather than too little since they are able to pass on much of the cost of excess capacity to passengers. Normally, customers of the regulated firm have only a mild aversion to the firm investing. In the airport case, they have a strong incentive to dissuade the airport from investing—thus they will be very keen to develop a deal whereby the airlines share some of the slot rents in return for the airport not investing.

The case of the public airports is similar to that of the regulated private airports. As always, there are several different motivations for public firms. Some seek a quiet life, while others are empire builders. The implicit contact will be attractive for the former but not the latter.

To sum up on performance, allocative efficiency should be similar to the well-regulated airports. These airports have the scope to be productively inefficient, and often they use this scope. In the long run, there is a strong chance that the airport will come to a deal with the airlines to not invest. Even when the airports own preferences are to invest, it will come under pressure from the airlines to go slow on its investments. In this environment, it is much less likely that the airport will make worthwhile investments, and overinvest, as some regulated and public firms do, than the typical regulated and public firms do.

9.4.3 Options for Reform

There are no easy solutions to the dilemmas outlined here, but there are some ways in which efficiency can be increased. We discuss some of these here.

Secondary Trading of Slots
This is an option which has been widely discussed. It should lead to better slot allocation and higher efficiency.

Privatization
There is evidence that full privatization is positive for cost efficiency, though partial privatization is not. Other aspects of efficiency may suffer from privatization—allocative efficiency may suffer, since privatized airports which have market power may seek to use to increase profits. To a degree, regulation may be effective in limiting the use of market power, though regulation itself has its problems.

Deregulating Airports
Deregulation may be positive in the short run, especially where airports have limited market power. If airports have more scope to make and keep profits, they have a stronger incentive to produce efficiently. They will also have an incentive to raise prices. If the distribution between airports, airlines, and passengers is not a concern, there will be a net gain. In a slot-controlled situation, this will mean that airports gain at the expense of airlines. Deregulation is a stronger option when competition is present. The limitation of deregulation is that does not handle the long-run investment aspect well, for busy airports. Deregulation makes it easy for the airport to enter an implicit contract with the airlines to limit investment in capacity. A combination of deregulation and slot auctions could be a strong option.

Slot Auctions
Slot auctions have the advantage that they would allocate slots efficiently—more so than the current arrangements such as secondary trading. Airlines will not gain from slot rents, and thus they will put pressure on airports to be productively efficient. However, there is a further advantage of auctions which has not been discussed—they destroy the incentive for airlines to pressure the airport to not invest in capacity expansion. Thus, they score well on all aspects of efficiency. Their main problem is that they would be very difficult to bring them about, particularly on a widespread basis (e.g., rather than on a basis of a 10% slot auction).

Strong Incentive Regulation
Most or all of regulation or airports falls short of full incentive regulation. If airports were subject to strong incentive regulation, and if private firms own the airports, cost efficiency will be enhanced. Furthermore, there are strong incentives to change the price structure towards allocative efficiency. Unfortunately, this would not do anything to remedy the third aspect of efficiency, namely that of investment in capacity. A very strong regulator might be able to set up good incentives for the airport to invest, but this seems to be some way in the future.

Airline–Airport Contracts
Starkie (2008, 2012) and Littlechild (2012) have advocated airline–airport contracts. In our view, they can make a useful but not fundamental contribution. Thus, for example, and airline wanted to upgrade terminal quality, and was prepared to fund the airport to do this, there can be gains for both parties. However, short or long-term contracts do not address the central issue of how prices should be set or rents divided (and presumable there is an arbitrator who is the key decider). Contracts will not help the investment problem—the airlines and airports will inhibit efficient investment to the detriment of other parties, such as passengers.

Government Involvement
Even when a government privatises an airport, and sets up a regulatory environment, it does not necessarily leave all decisions to the airport and the regulator. The sorts of problems which come about as a result of the lack of the incentive for airlines and airports to invest might be resolved by government intervention. In fact, this happens from time to time. The government becomes frustrated by the unwillingness of airlines and airport to invest. Passengers, shippers and businesses pressure the government to act. Ideally, a Cost-Benefit Analysis will be done (as has been the case with London—see Airports Commission 2015) and the government can create incentives (perhaps operating through the regulator) for the airport to invest, if worthwhile. While this is not a light-handed solution, it may be the only way through the impasse, if the government is unwilling to use slot auctions.

9.5 Conclusions

In this paper, we analyse progress in airport reform in Europe. While in some aspect's airports perform well, while in others they are poor. This is not surprising; however we argue that performance in the different aspects is not unconnected. The same institution which gives European airports good performance in moderating delays is also the one which gives them the ability to produce at high cost, and is linked to the unwillingness of some airports to invest in much needed capacity.

We make a critical distinction between busy and airports with adequate capacity. The latter can be regarded as typical utilities, though with some particular aspects. The former are rather different. Demand for them is not rationed by price, as a result of the workings of the slot system. This system has worked well, though not perfectly, and there is a strong case for the reforms that have been suggested, such as slot trading. European airports perform poorly in terms of cost efficiency. In the short run, airlines have an interest in airports producing efficiently and keeping costs low. Also, airlines have an interest in keeping capacity low, since they enjoy the rents from scarce capacity. This suggests an implicit contract between the airlines and the airport is possible. If the airlines can share some of the slot rents with the airport, perhaps enabling them to produce inefficiently, they will dampen the interest of the airport to invest in capacity, even when it is economically justified. The combination of all of these will perpetuate poor performance and aversion to reform.

There are ways to resolve these problems, though they are not straightforward to implement, because it is not in the interest of airlines and airports to change the implicit contract of sharing rents. Both groups have in the past and would in future oppose reforms at European level which eliminate these rents. In the current discussion about a reform of the EU Directive on airport charges (Florence School of Regulation 2018) the airlines demanded a price cap on single till regulated airports, while airports oppose regulation in principle, and favour the status quo of ineffective regulation based on dual till. Both groups disagree fundamentally on the level of charges and about the distribution of rents, including the rents from commercial activities. They both do not want to enter into a discussion of allocative efficiency because a combination of strong incentive regulation with peak pricing and slot auctions would have the negative effects that airports would be pressured to produce efficiently, and airports would lose their share of the slot rents. How to design policy measures which are not only efficient, but are also feasible to be implemented by policies which do not simply follow the demands of airlines and airports is a difficult political economy problem, as Stigler (1971) envisaged.

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Part II
Benchmarking

Chapter 10
Efficiency Assessment of Airports and the Impact of Regulation on Performance

Nicole Adler and Shravan Kumar

Abstract This paper reviews the methods used to measure airport performance and the impact of regulation on airport performance. We find that the most commonly used methods are index number based total factor productivity measures, stochastic frontier analysis and data envelopment analysis. Our review of airport regulation reveals that different market structures and regulatory environments have varying impacts on efficiency. Our review further reveals that a majority of the studies find that airport regulation has proven to encourage technical, financial and cost efficiency; a couple of papers argue that regulation has no noticeable impact on efficiency levels; and a minority of the papers suggest that regulation tends to decrease technical and cost efficiency. We finally give some suggestions regarding directions for future research on the impact of regulation on airport performance.

Keywords Efficiency · Benchmarking · Performance · Regulation · Data envelopment analysis · Stochastic frontier analysis · Total factor productivity · Market structure

10.1 Introduction

Historically, airports were mostly deemed state-owned entities with the objective to provide and operate infrastructure on behalf of airlines. These airports were often poor performers and faced problems related to underinvestment. However, the nature of the airport industry has changed over the last four decades. Moving away from viewing the airport as a public utility, airports have begun to operate as

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modern enterprises pursuing commercial objectives. Privatization processes have been actively promoted by governments around the globe with the proclaimed intention of reducing government involvement and increasing airport productivity and innovation. However, given the assumed profit-maximizing behaviour of private companies working in a natural monopolistic environment, many commercialized airports around the globe remain subject to economic regulation (Gillen 2011; Adler et al. 2015).

The general theoretical literature discussing the impact of privatization on efficiency and social welfare has led to an interesting debate. Sappington and Stiglitz (1987) argue that the transaction costs of government intervention are lower under public ownership. The government is better informed and more capable of regulating state-owned firms. With respect to cost efficiency, Armstrong and Sappington (2006) argue that regulated public enterprises facing monopolistic conditions tend to fail to stay within budget constraints in the knowledge that the government is likely to cover their losses. This was tested by Martín and Socorro (2009) who conclude that public airports not subject to budget restrictions tend to charge prices below their marginal costs hence resulting in lower aeronautical charges. Additionally, Boycko et al. (1996) argue that public ownership may lead to excessive employment. Hence, there appears to be a trade-off between efficiency and welfare optimization: whereas public companies reduce the problem of information asymmetry thereby lowering costs, they also face weaker budget constraints resulting in less cost-efficient operations. Under competitive conditions, Caves and Christensen (1980) show empirically that public and private companies could operate equally efficiently. They argue that ownership per se does not cause cost inefficiency rather the lack of effective competition. On the other hand, Shapiro and Willig (1990) argue that managers of public firms pursue personal targets rather than maximizing social welfare. Moreover, Kikeri and Nellis (2004) review the empirical evidence on privatization and argue that under competitive conditions, privatization leads to better performance of firms. They also argue that privatization in infrastructure sectors maximizes social welfare. They suggest that in order for privatization to be effective, policy should focus on promoting competition, establishing the right regulatory framework, enforcing transparency and introducing mechanisms in order for all consumer groups to have affordable access.

The emergence of partially privatized business models further complicates the debate as to the effects of ownership on productivity. Boardman and Vining (1989) review the effects of mixed ownership structures based on theory and empirical studies. They conclude that large, industrial, partly privatized firms perform in a less productive and profitable manner than their fully private counterparts, which may be caused by the public and private shareholders' differing objectives. Empirical studies that attempt to assess the effects of ownership on the efficiency of airports have frequently arrived at opposing conclusions. Parker (1999) estimates the technical efficiency of the British Airport Authority (BAA) pre and post privatization. No evidence is found that complete privatization led to improved technical efficiency which suggests that the UK government's golden share limited the impact of capital market pressures. Furthermore, Parker argues that BAA remained subject to economic regulation hence incentives to operate more efficiently are distorted as a result of government intervention. Finally, although BAA's London airports face competition for international traffic from hubs such as Frankfurt, Schiphol and Paris, they are almost a localized monopoly facing only limited competition from airports such as Luton, London City and Southend. The lack of effective competition may be another factor influencing Parker's results. In contrast, Yokomi (2005) finds that the BAA airports exhibited positive changes in efficiency and technology as a result of the privatization. It should be noted that commercial growth after privatization was substantial; however, this activity was not considered in Parker's analysis. As non-aeronautical revenues are a major source of income for many airports, the exclusion of this relevant output may be another reason influencing Parker's results.

The effects of different ownership forms on efficiency were also analysed but again the results have not arrived at clear conclusions. Barros and Dieke (2007) analyse Italian airports and reveal that private airports operate more efficiently than their partially private counterparts. Lin and Hong (2006) find no connection between ownership form and efficiency. Oum et al. (2006, 2008) distinguish between public airports owned by public corporations and those owned by more than one public shareholder (multilevel). Oum et al. (2006) reach the conclusion that the productivity of a public corporation is not statistically different from that of a majority owned private airport. However, airports owned by a minority private shareholding or multiple government involvement operate significantly less efficiently than other ownership forms. Oum et al. (2008) conclude that airports with a majority of private shareholders are more efficient than public airports, particularly those with a major public ownership structure. Adler and Liebert (2014) analyse European and Australian airports over a 10-year timeframe and reveal that under relatively non-competitive conditions, public airports operate less cost efficiently than fully private airports. Under relatively non-competitive conditions, irrespective of ownership form, regulation is necessary to emulate competitive forces thus pushing airport management towards cost efficiency and reasonable pricing policies. Under potential regional or hub competition, economic regulation inhibits airports of any ownership form from operating and pricing efficiently. Although public and fully private airports operate equally efficiently in a competitive setting, private airports still set higher aeronautical charges. Furthermore, mixed ownership forms with a majority public holding are neither cost efficient nor low price, irrespective of the level of competition.

The assessment of airport facilities is necessary from multiple perspectives. Privately owned firms often benchmark themselves for purposes of continuous improvement. Competition authorities may choose to assess performance in order to search for abuse of market power. Transportation authorities may need to set prices or price caps, in which case measurement of efficiency is an important element of such a process. Three well-documented quantitative methods have been frequently applied to analyse the productivity and efficiency of government and private enterprises. An index number approach estimates total factor productivity (Caves et al. 1982; Hooper and Hensher 1997; Oum and Yu 2004; Vasigh and Gorjidooz 2006), based on input and output prices and quantities. Parametric stochastic frontier analysis (SFA) assesses efficiency utilizing econometrics which disentangles unobservable random error from technical inefficiency (Aigner et al. 1977; Meeusen and van den Broeck 1977; Pels et al. 2003; Oum et al. 2008) based on assumptions as to the distributional forms of the production function and efficiency distribution. Non-parametric data envelopment analysis (DEA), based on linear programming, categorizes observations into relatively efficient and inefficient groups hence produces weaker results than those of SFA, but does not require assumptions with respect to the functional form of production or efficiency. Airport studies of efficiency utilizing all three approaches are reviewed in Liebert and Niemeier (2010).

In this chapter, we first describe the three main methods for estimating airport performance and then discuss the literature assessing the impact of regulation on airport performance. In the final section, we draw conclusions based on the literature to date and discuss the remaining disagreements and potential ways forward.

10.2 Airport Efficiency Estimation

In this section, we first discuss total factor productivity, followed by the two frontier approaches, namely stochastic frontier analysis based on regression and data envelopment analysis based on mathematical programs.

10.2.1 Total Factor Productivity

Hooper and Hensher (1997) were among the first to estimate the total factor productivity (TFP) of airports. They argue that the TFP approach distinguishes productivity differences that arise from scale effects as opposed to those resulting from managerial performance. TFP is an aggregate productivity measure which can be estimated in several ways including parametric approaches, assuming production functions and non-parametric index number approaches. In this section, we discuss two index number approaches proposed by Caves et al. (1982) and O'Donnell (2012) and their application to the airport sector (Hooper and Hensher 1997; Nyshadham and Rao 2000; See and Li 2015). The method proposed by Caves et al. (1982) is a multilateral, parametric TFP index which constructs a ratio of a revenue share weighted output index to a cost share weighted input index. This allows for the comparison of a firm over time and also cross-firm comparisons, whilst meeting both circularity and characteristicity criteria. The weights in such an index have economic meaning, the index does not suffer from the curse of dimensionality and the changes in TFP are attributable to the changes in inputs and outputs of a respective firm.

From Caves et al. (1982), a translog multilateral measure of TFP is defined as follows:

$$\ln\left(\frac{TFP_k}{TFP_l}\right) = \frac{1}{2}\sum_i \left(R_i^k + \overline{R_i}\right)\left(\ln Y_i^k - \overline{\ln Y_i}\right) - \frac{1}{2}\sum_i \left(R_i^l + \overline{R_i}\right) \times \left(\ln Y_i^l - \overline{\ln Y_i}\right) - \frac{1}{2}\sum_n \left(W_n^k + \overline{W_n}\right)\left(\ln X_n^k - \overline{\ln X_n}\right) + \frac{1}{2}\sum_n \left(W_n^l + \overline{W_n}\right)\left(\ln X_n^l - \overline{\ln X_n}\right) \tag{10.1}$$

where k is an individual observation, 1 is a base observation, R_i denotes revenue shares, $\overline{R_i}$ denotes the mean of the revenue shares over all airport-year observations, W_n denotes cost shares, $\overline{W_n}$ denotes the mean of the cost shares over all airport-year observations, Y_i are the outputs, $\overline{\ln Y_i}$ is the geometric mean of outputs over all airport-year observations, X_n are the inputs and $\overline{\ln X_n}$ is the geometric mean of inputs over all airport-year observations.

Hooper and Hensher (1997) construct such TFP indices for six Australian airports for a time duration of 4 years ranging from 1988/89 to 1991/92. The authors include two outputs, namely the aeronautical and non-aeronautical revenues. The inputs include capital which has been measured using the perpetual inventory method, labour which is measured by including the expenditure on salaries and wages and a third operating cost input which is measured by including the residual expenditures. All inputs and outputs have been deflated using appropriate price deflators. Nyshadham and Rao (2000) construct these indices for 25 European airports using the same outputs as in Hooper and Hensher (1997) but the inputs include the cost of capital, operating costs and other costs.

Another measure of TFP is the Hicks–Moorsteen TFP index which is a multiplicative index formulated as the ratio of Malmquist output and input quantity indices. The advantage of this index is that it requires only information on quantity, does not require any assumptions to be made with respect to a firm's returns-to-scale and behaviour and does not assume a specific production function. Another advantage of this index number approach is that the derived measure of TFP can be disaggregated into multiple components such as technical change and measures of efficiency change including technical efficiency, scale efficiency, mix efficiency and residual scale efficiency. From O'Donnell (2012), the Hicks–Moorsteen TFP index is defined as follows:

$$TFP_{st} = \left(\frac{D_O^s(x_s,\ q_t)D_O^t(x_t,\ q_t)}{D_O^s(x_s,\ q_s)D_O^t(x_t,\ q_s)}\ \frac{D_I^s(x_s,\ q_s)D_I^t(x_s,\ q_t)}{D_I^s(x_t,\ q_s)D_I^t(x_t,\ q_t)}\right)^{\frac{1}{2}} \tag{10.2}$$

where $D_O(.)$ and $D_I(.)$ are output and input distance functions, respectively, measured during the base period s and the comparison period t and the xs and qs represent the input and output quantity vectors measured for a firm during a specific time period. See and Li (2015) apply an input-oriented Hicks–Moorsteen TFP index number approach to measure the productivity of 22 UK airports over a 9-year timeframe. The inputs include the number of employees, capital stock and cost of other inputs. The outputs include both aeronautical and non-aeronautical revenues. All monetary measures are deflated by appropriate price deflators.

10.2.2 Stochastic Frontier Analysis

Estimation of the production function of a given output and the efficiency with which each firm operates is of interest in order to estimate performance at the firm and aggregate levels. Such analyses are also of use for the implementation of economic regulation. A popular framework for carrying out such estimation is the stochastic frontier analysis (SFA) model, in which the output is composed of three terms. The first term estimates the underlying production function, which expresses the relationship between the inputs and the outputs. The second term is a random effect term, u, asymmetrically distributed, which reflects the efficiency of the individual firm. The third term is a random error component, v, typically assumed to be symmetrically distributed, which accounts for the combined effects of various types of errors such as the inadvertent omission of relevant variables from the production function, errors of measurement in inputs and approximation errors.

Suppose we have a cross-sectional dataset with I producers, K inputs and a single output. Let X_i^o denote the vector of inputs and Y_i^o the output. A traditional production frontier model can then be written as $Y_i^o = P_i.TE_i$, where i indexes the producer, $P_i = g\left(X_i^o;\beta\right)$ is the production frontier, β a vector of parameters to be estimated and TE_i expresses the output-oriented technical efficiency of producer i. If $TE_i = 1$, the output Y_i^o achieves its maximum feasible value P_i , otherwise $TE_i < 1$ which provides a measure of the shortfall of observed output compared to the maximum feasible output.

Aigner et al. (1977) and Meeusen and van den Broeck (1977) introduced the concept of a stochastic frontier, aimed at incorporating producer-specific random shocks into the analysis. In SFA, the output Y_i is modelled as $Y_i = g\left(X_i^o;\beta\right).e^{v_i}.TE_i$, whereby $g\left(X_i^o;\beta\right).e^{v_i}$ represents the stochastic production frontier including a deterministic production function $g\left(X_i^o;\beta\right)$ common to all producers and a producer-specific part e^{v_i} which captures the effect of random shocks experienced by the producer. Defining $Y_i = ln\, Y_i^o$ and $u_i = -\ ln\, TE_i$, we subsequently obtain $Y_i = \ln g\left(X_i^o;\beta\right) - u_i + v_i$. Assumptions include $TE_i \leq 1$, $u_i \geq 0$, u_i and v_i are independent and identically distributed across the firms and the noise component v_i is assumed to be symmetrically distributed and independent of u_i. Consequently, the error term $\varepsilon_i = v_i - u_i$ is asymmetric, since $u_i \geq 0$. Another standard assumption is that u_i and v_i are independent of X_i^o. Parametric forms are assumed for u_i and v_i. Distributions commonly used for u_i include the half-normal, truncated normal, exponential and gamma. Usually it is assumed that $v_i \sim N(0, \sigma_v^2)$. Early papers on the SFA model assumed that $g\left(X_i^o;\beta\right)$ is a log-linear Cobb and Douglas (1928) function. Assuming $X_{ik} = ln\, X_{ik}^o$ and $Y_i = ln\, Y_i^o$ leads to $Y_i = \beta_0 + \sum_{k=1}^{K} \beta_k X_{ik} - u_i + v_i$. Diana (2010) assesses three New York airports for technical efficiency using a stochastic production function approach. Assaf (2009) applies a meta stochastic frontier with a Cobb-Douglas production function in order to compare a set of British airports as a function of their size.

More recent papers often assume $g\left(X_i^o;\beta\right)$ follows the translog function $Y_i = \beta_0 + \sum_{k=1}^{K} \beta_k X_{ik} + \sum_{k=1}^{K} \sum_{m=1}^{k} \gamma_{km} X_{ik} X_{ik} - u_i + v_i$. Of all the flexible forms, the translog functional form is the most frequently used because it provides a second-order approximation to any structure and allows a large variety of substitution patterns. Regularity conditions are imposed by linear restrictions to the parameters. Scotti et al. (2012) estimate the stochastic translog distance function for a set of Italian airports, in order to evaluate the impact of competition. The stochastic directional distance function permits an analysis of multiple inputs and multiple outputs simultaneously (Coelli and Perelman 2000). In all cases, the parameters of the models are estimated by maximum likelihood techniques.

An estimate of u_i is then obtained using the conditional density which is given by:

$$f_{u_i|\varepsilon_i}(u|\varepsilon) = \frac{f_{u_i}(u) f_{v_i}(\varepsilon_i + u)}{\int_0^\infty f_{u_i}(\widetilde{u}) f_{v_i}(\varepsilon_i + \widetilde{u}) d\widetilde{u}} \tag{10.3}$$

As a point estimate of u_i, we normally utilize the posterior mean, median or mode (Jondrow et al. (1982), Stevenson (1980), Greene (1990)). Additional, prominent models include Battese and Coelli (1995) and Greene (2005) in which the distribution of u_i depends on firm-specific variables, including those defined in the production function or additional, exogenous variables. Parmeter and Kumbhakar (2014) provide a survey of models of this type.

Given a panel dataset, the input vector consists of X_{it}^o observations and output Y_{it}^o over a time series $t = 1,\ldots,T$. The simplest formulation assumes each producer's technical efficiency to be constant over time. One approach to working with this model is a fixed effects approach, in which $a_i = \beta_0 - u_i$ represents a fixed parameter and the model is fit by ordinary least squares. This approach allows efficiency comparisons across producers but not an absolute estimate of efficiency for a given producer. Furthermore, the variance of $\widehat{a_i}$ will decrease as T increases, but so will the plausibility of the assumption of time-independent efficiency. Alternatively, a random effects approach could be assumed, whereby u_i is regarded as random with a specific distribution. Moving a step further, the technical efficiency could be dependent on time and the literature includes both fixed effect and random effect approaches (Kumbhakar (1990), Battese and Coelli (1992)). One of the most useful approaches is based on Battese and Coelli (1995) in which the inefficiency is assumed to be both time varying and a function of environmental variables, namely $u_{it} \sim N^+\left(\mu_{it}, \sigma_u^2\right); \mu_{it} = \sum_m \delta_m z_{mit}$ such that:

$$E(\ln y_{it}) = \beta_0 + \sum_n \beta_n \ln x_{nit} + E(v_{it}) - E(u_{it})$$
$$= \beta_0 + \sum_n \beta_n \ln x_{nit} - \left\{ z'_{it}\delta + \frac{\phi\left(\frac{z'_{it}\delta}{\sigma_u}\right)}{\Phi\left(\frac{z'_{it}\delta}{\sigma_u}\right)} \right\} \tag{10.4}$$

where $y_{it,}$ x_{nit} and z_{mit} represent the output, n multiple inputs and m multiple exogenous explanatory variables, respectively, for firm i in year t. The inefficiency term u_{it} is half-normal distributed and positive with mean $z'_{it}\delta$. The noise term is v_{it} and $\varnothing(\cdot)$ and $\Phi(\cdot)$ are the density and cumulative distribution functions of the standard normal variable, respectively. In Colombi et al. (2014), a four random-component stochastic frontier approach estimates random-firm effects, long-run (persistent) inefficiency, time-varying short-run inefficiency and random stochastic shocks, which is subsequently applied to an analysis of Italian airports.

An alternative model estimates a stochastic cost frontier in which $C_i = f(y_i; w_i) - u_i + v_i$ whereby w_i represents the vector of input prices. Oum et al. (2008) study the effects of ownership forms on airport cost efficiency by applying stochastic frontier analysis to a panel data of the major airports globally. Martín et al. (2009) estimate a long-run, multi-product, cost function for Spanish airports over a 7-year timeframe, finding that economic inefficiencies range from 15 to 26% for the average airport.

For those interested in greater depth, we refer you to the book of Kumbhakar and Lovell (2003) and for panel data applications, the surveys of Cornwell and Schmidt (2008) and Kumbhakar et al. (2020).

10.2.3 Data Envelopment Analysis

Data Envelopment Analysis (DEA) is a non-parametric method of frontier estimation that measures the relative efficiency of firms, often denoted as decision-making units, utilizing multiple inputs and outputs. DEA accounts for multiple objectives simultaneously without attaching ex ante weights to each indicator and compares each decision-making unit (DMU) to the efficient set of observations, with similar input and output ratios, assuming neither a specific functional form for the production function nor the inefficiency distribution. DEA was first published in Charnes et al. (1978) under the assumption of constant returns-to-scale[1] and was extended by Banker et al. (1984) to include variable returns-to-scale. This non-parametric approach solves a linear program per DMU and the weights assigned to each linear aggregation are the decision variables of the mathematical program. The weights are chosen optimally in order to show the specific DMU in as positive a light as possible,

[1] Constant returns-to-scale means that the producers are able to linearly scale the inputs and outputs without increasing or decreasing efficiency.

provided that no other DMU is more than 100% efficient with the same set of weights. This approach allows each firm to set its own priorities, whether input minimizing given the outputs to be served or output maximizing given a set of inputs available. Consequently, a Pareto frontier is estimated, marked by specific DMUs on the boundary envelope of input–output variable space. Formulation (10.5) presents an input-oriented model assuming variable returns-to-scale.

$$\begin{aligned} & Min_{\lambda,\theta}\theta \\ s.t. \quad & \sum_{n=1}^{N} X^n \lambda^n \leq \theta X^a \\ & \sum_{n=1}^{N} Y^n \lambda^n \geq Y^a \\ & \sum_{n=1}^{N} \lambda^n = 1 \\ & \lambda^n, \theta \geq 0 \end{aligned} \tag{10.5}$$

where superscript a is the index of DMU^a, the unit under investigation; X^a represents the input values of DMU^a; Y^a the output values of DMU^a and the intensity variable describing the benchmarks. θ represents the relative efficiency score, where a value of 1 indicates relative efficiency and a value smaller than 1 indicates the level by which the relevant inputs ought to be decreased in order for DMU^a to improve. Removing the last constraint changes the assumption to constant returns-to-scale and either orientation may be considered reasonable when benchmarking airports depending on the long-run or short-run nature of the analysis (Gillen and Lall 1997; Pels et al. 2003).

Basic DEA benchmarking may lead to inappropriate targets for improvement in a dataset in which there are substantial differences in size among the DMUs under analysis. Sarkis and Talluri (2004) propose second-stage clustering to identify appropriate benchmarks for poor performers, after applying DEA to determine the relative efficiencies of airports. An alternative, dynamic clustering approach was first proposed by Golany and Thore (1997) in which the selection of best practice DMUs is restricted according to predefined boundaries within the DEA framework in a single-stage process. The boundaries of the cluster are defined in relative terms, limiting the efficient reference set[2] to those DMUs whose input–output values are within the distance defined by the proportions. Adler et al. (2013) identify appropriate peers for a case study of 43 European airports over 10 years, using a restricted reference mechanism according to predefined characteristics. Compared to basic DEA models, the results of the proposed structure provide more meaningful benchmarks with comparable peer units and target values that are potentially achievable in

[2] A reference set, or peer group, is defined by a subset of units “closest” to the unit under evaluation, i.e. with similar mixes of inputs and outputs (Banker and Morey 1986).

the medium term. By identifying each unit's individual reference set, unique outliers influence the performance measurement less severely than occurs under basic DEA. In addition, the formulations produce an implementation path that moves the airport towards the Pareto frontier gradually, taking into account the regulatory and business environment in which the unit is located.

Network DEA models were first introduced by Färe (1991) and Färe and Grosskopf (1996, 2000) and subsequently extended by Lewis and Sexton (2004), Golany et al. (2006) and Tone and Tsutsui (2009) among others. Opening the black box permits an analysis of the preferable production structure of DMUs and their priorities, to determine both efficient subsystems and overall efficiency in order to allocate resources efficiently and determine appropriate targets. Castelli et al. (2010) provide a classification of DEA models accounting for the internal structure of DMUs, depending on the assumptions of the modelling approach and then present mathematical formulations, extensions and applications. In the transportation literature, network DEA has been applied by Yu and Lin (2008) in order to simultaneously estimate passenger and freight technical and service efficiency for 20 selected European railways and by Yu (2004) in order to analyse the operational framework of 15 domestic airports in Taiwan. Since the liberalization of the aviation industry in Europe in the late eighties, airports have focused on both aeronautical and commercial landside activities. The network DEA approach recognizes the fact that generalized and fixed costs connected to the two sets of activities can only be split in an artificial manner and that while aeronautical revenues draw from passengers, cargo and air traffic movements, the non-aeronautical revenue is more closely tied to passenger throughput. Although airports may have limited control over traffic volume, non-aeronautical revenues drawn from non-airport related activities, such as airport cities, are indeed within the purview of airport management. In Adler et al. (2013), a DEA modelling approach is developed in order to measure the relative cost and revenue performance of airports with respect to aeronautical and commercial activities, whereby activities are connected via passengers as the common intermediate product.

Productivity growth models within the non-parametric DEA literature have also been developed, starting with Färe et al. (1992). The Malmquist index covers two periods, t and $t + 1$, and is defined as described in Eq. (10.6) in which $D_O(x,y)$ represents the distance from the observation to the Pareto frontier.

$$M_0^{t+1}\left(x^{t+1}, y^{t+1}, x^t, y^t\right) = \left[\frac{D_0^t(x^{t+1}, y^{t+1}) D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t) D_0^{t+1}(x^t, y^t)}\right]^{1/2}$$

$$= \underbrace{\frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)}}_{E} \underbrace{\left[\frac{D_0^t(x^{t+1}, y^{t+1}) D_0^{t+1}(x^t, y^t)}{D_0^{t+q}(x^{t+1}, y^{t+1}) D_0^{t+1}(x^t, y^t)}\right]^{1/2}}_{P} \tag{10.6}$$

The first ratio of the Malquist index estimates the change in technical inefficiency and the ratios inside the bracket measure the shift in the frontier between periods

t and $t + 1$. Assaf (2011) applies a Malmquist bootstrapped approach in order to assess the level of productivity, efficiency, scale and technological change at the major Australian airports between 2002 and 2007. The analysis focuses on the post-privatization period of Australian airports, using panel data with three outputs and three inputs. Results suggest that most Australian airports experienced significant total factor productivity increases although a few suffered declines over the same period. Gitto and Mancuso (2012) apply a similar methodology to assess the operational performance of 28 Italian airports over a similar timeframe. They found that the Italian airport industry experienced significant technological regress.

For those interested in reading in greater depth, we refer you to Cooper et al. (2000) and Zhu and Cook (2007), the review papers of Liu et al. (2016) and Emrouznejad and Yang (2018) and the discussion of how to apply the modelling approach in Cook et al. (2014).

10.2.4 Comparing Index Number TFP, SFA and DEA

Index number TFP, SFA and DEA have been used quite extensively to measure the performance of airports as can be seen from the previous three sub-sections. It is interesting to compare the three methodologies and to highlight their advantages and disadvantages. While SFA is a parametric method that accounts for statistical noise, index number TFP and DEA do not have these attributes. DEA and SFA can be used to estimate technical efficiency, allocative efficiency, technical change and scale effects while index number TFP cannot be used for these purposes. Meanwhile, all three methods can be used to estimate the change in TFP. While time series data can be used with index number TFP methods, SFA and DEA can only make use of cross-sectional and panel datasets. Finally, index number TFP methods require input and output prices along with input and output quantities while input and output quantities are sufficient in order to estimate efficiency using SFA and DEA. The principal advantage of index number TFP in comparison to SFA and DEA is that an index number TFP model can be estimated with only two data points while SFA and DEA require multiple data points either of many firms in one time period or of many firms over multiple time periods. The advantages of SFA and DEA over index number TFP methods are that SFA and DEA do not require price information; firms are not assumed to exhibit technical, cost and allocative efficiency with SFA and DEA models; firms are not assumed to be cost minimizers and revenue maximizers with SFA and DEA; and whenever SFA and DEA are used to estimate TFP, the index can be decomposed into technical change and technical efficiency change. In comparing SFA and DEA, the principal advantages of SFA over DEA are that SFA accounts for statistical noise and can be used to conduct hypotheses tests. The principal advantages of DEA over SFA are that DEA does not need the specification of a distributional form for the inefficiency term and it also does not need the specification of a functional form for the estimated production or cost frontier (Coelli et al. 2005). Several authors have attempted to combine SFA and DEA, starting with a paper by

Banker and Maindiratta in Banker and Maindiratta 1992 and summarized in a review by Olesen and Peterson (2016) but none have yet been applied to airports.

10.3 Impact of Regulation on Airport Performance

Neoclassical theory states that under monopolistic conditions, firms generally seek to maximize their profits by limiting output and increasing prices, hence when economies of scale exist, they may not be fully exploited. In addition, monopolies might fail to produce efficiently and the managerial slack could lead to Leibenstein *X*-inefficiency. Consequently, the introduction of competition may lead to increased productive and allocative efficiency as a result of lower prices and higher outputs such that social welfare may increase when market conditions exist (Leibenstein 1966). On the other hand, network utilities providing substantial infrastructure may be natural monopolies in that a single large firm might produce at lower costs in which case the introduction of competition is not desirable. In order to encourage efficiency and avoid abuse of market power, the natural monopolist ought to be subject to economic regulation whereas in a potentially competitive environment, regulation may not be desirable as it could distort efficiency.

In Europe, airport charges have traditionally been regulated according to a rate-of-return or cost-plus principle as is true for the majority of German airports (Gillen and Niemeier 2008; Forsyth et al. 2021). Rate-of-return regulation is expected to lower the charges and increase output in comparison to an unregulated monopolistic market. However, this positive effect on efficiency might be reduced by over-investment by gold plating and cost padding, as described by Averch and Johnson (1962) and Sherman (1989). The problematic incentives are one of the motives that led Littlechild (1983) to propose an incentive based, price-cap regulation as an alternative. At congested airports, rate-of-return regulation provides little incentive to pursue peak pricing,[3] which is not the case with incentive regulation. This is because incentive regulation regulates the price level and not the price structure. As the demand for the utilization of airport facilities fluctuates, incentive regulation could lead to the rebalancing of the price structure by the airport in order to increase profits, incentivizing airport management to charge a higher peak price in comparison to the off-peak price. As a result, incentive regulation should encourage higher allocative efficiency and improved cost efficiency but may also lead to under-investment[4] and deterioration in the quality of service. These could be prevented

[3]Starkie (2005) identifies four reasons why incentive regulation has not led to many airports pursuing peak pricing: (1) airports may not be maximizing profits; (2) airport charges have traditionally been based on aircraft weight; (3) airlines oppose peak pricing; and (4) airport managers appear to prefer long-run output maximization which leads to larger capital expenditure programmes hence the decision not to pursue peak pricing.

[4]Starkie (2008) argues the opposite, claiming that incentive regulation could lead to excessive investment because under-investment could add additional costs to the firm due to the resultant

by appointing a committed regulator (Gillen and Niemeier 2008) and by monitoring service quality with a bonus and penalty system (Forsyth et al. 2021).

Both cost-based and incentive-based pricing mechanisms may be applied according to a single-till or dual-till approach. Under the single-till approach, both aeronautical (landing, passenger and aircraft parking charges, etc.) and non-aeronautical (food, retail and car parking services, etc.) revenues are constrained simultaneously. For example, London Heathrow is single-till price-capped and Brussels airport is single-till, rate-of-return regulated, similar to the North American system in which airports are constrained to not-for-profit business models. The advantage of this form of regulation is that the charges are lower and the output is higher in comparison to dual-till rate-of-return regulation (Adler and Liebert 2014). However, as the single-till approach taxes commercial revenues, the airport management may be less incentivized to search for alternative commercial revenues. In contrast, the dual-till approach regulates aeronautical revenues alone in order to constrain only those activities with a monopolistic server. Regulators of Vienna and Hamburg airports changed the rules from cost-based to incentive-based regulation via a price-cap approach, following a dual-till mechanism (Gillen and Niemeier 2008). Under this form of regulation, airport management are incentivized to innovate thus earn non-aeronautical revenues which are unconstrained.[5]

Shleifer (1985) proposes yardstick competition as an alternative approach to stimulate efficiency based on a benchmarking process. The policy has yet to be applied to the airport industry although an attempt was made at Dublin airport only to be thwarted by arguments over the relevant comparators (Reinhold et al. 2010). Another form of regulation is light-handed regulation or price monitoring which does not regulate charges directly rather evaluates the performance on a regular basis, as occurs in Australia. Light-handed regulation is more flexible, involving lower regulatory burden which may be effective provided the threat of re-regulation is credible (Forsyth 2004).

In the case of excess demand relative to airport capacity, the charges may be set below the market clearing price. In this case, regulation might only play a distributional role by shifting scarcity rents from the airport to the airlines. The structure of charges is important in the case of excess demand and regulation could impact allocative efficiency. Rate-of-return regulation is based on book-keeping computations rather than opportunity costs, hence does not incentivize peak pricing, unlike price-cap regulation. Alternatively, we note that a profit-maximizing monopolist may optimize the price structure in order to reap benefits from non-aeronautical revenues. Starkie (2002) obviates the need for economic regulation arguing that demand complementarities across aeronautical and terminal activities will prevent

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congestion and delays and excess capacity could be used to pre-empt entry from the competitive fringe.

[5] However, given the significant common costs between aeronautical and non-aeronautical activities, dual-till regulation may pose significant difficulties due to the cost allocation game that is played between the airport and the regulator.

Table 10.1 Market structure, regulatory environment and impact on efficiency

Market structure/ regulatory environment	Description	Impact on efficiency
Monopoly	Restriction of output and unexploited economies of scale	–
	Leads to *X*-inefficiency	–
Competitive market	Regulated airports may distort efficiency	–
Rate-of-return regulation	Lower charges increase output in comparison to monopolist	+
	Congested airports have no incentive to set peak prices	–
	Averch–Johnson effect and gold plating	–
Single-till rate-of-return regulation	Restricts potentially competitive commercial activities	–
Dual-till rate-of-return regulation	Higher charges decrease output in comparison to single-till rate-of-return regulation	–
Price-cap regulation	Peak pricing promotes allocative efficiency	+
	Encourages cost efficiency	+
	Under-investment leads to deterioration in quality of service	–
Single-till price-cap regulation	Leads ceteris paribus to lower caps compared to dual till	+
	Creates weak incentives to earn commercial revenues	–
Dual-till price-cap regulation	Encourages airports to lower aeronautical charges thus increase passenger throughput, but ceteris paribus less than single till	+
	Commercial revenues are unrestricted	+
Light-handed regulation	With credible threat, may encourage cost efficiency	+
	Flexible with a low amount of regulatory burden	+

airports from abusing market power.[6] Specifically, airports generating additional revenues from non-aeronautical activities are more likely to lower their charges in order to attract airlines and higher passenger throughput, thus maximizing their commercial revenues. If airports are subject to regulation, he suggests that dual-till regulation is preferable irrespective of the level of congestion (Starkie 2001). However, Czerny (2006) and Yang and Zhang (2011) argue that single-till regulation is preferable for non-congested airports, whereas dual-till regulation is more relevant for congested hubs. Specifically, Czerny (2006) shows that single-till price-cap dominates dual-till price-cap regulation from a welfare perspective at uncongested airports and Yang and Zhang (2011) show that dual-till price caps lead to higher welfare in comparison to single-till price caps when the airport charges cover costs related to aeronautical services at congested airports. Table 10.1

[6]Even though Starkie (2002) shows that a monopoly airport generating commercial profits as a by-product will set aeronautical charges lower than if there are no commercial profits, he does not compare a monopoly airport with a competitive airport in the same circumstances, which would still show the monopoly airport levying excessive aeronautical charges (Adler and Liebert 2014).

summarizes the different market structures and regulatory environments and their likely impact on efficiency.

Multiple papers have been published applying the benchmarking methodologies described in Sect. 10.2 to the airport industry in an attempt to answer open questions. The papers published on the topic are summarized in Table 10.2. The research jointly analyses airports around the globe and the variables most frequently collected for this purpose draw from the KLEMS model (O'Mahony and Timmer 2009). Capital (K) has been accounted for by including the value of fixed assets (Barros and Weber 2009) and capital stock (Bottasso and Conti 2012; See and Li 2015). Other studies collected declared runway capacity as a proxy for capital because this value accounts for the most frequent bottlenecks in the system and limits throughput at slot capacitated airports (Adler and Liebert 2014; Adler et al. 2015). Alternative capital proxies include the airport area, number of runways, apron area and total size of the passenger terminal (Assaf and Gillen 2012; Assaf et al. 2014; Curi et al. 2011). All cost efficiency studies use the price of capital as a factor input (Assaf 2010; Assaf et al. 2012). Although the measurement of capital inputs is essential, due to the difficulty in estimating this input, most studies often use proxies to measure capital. Labour (L) generally is measured by full-time equivalent employees (Barros and Weber 2009; Assaf and Gillen 2012; Adler et al. 2015; Randrianarisoa et al. 2015; See and Li 2015) or staff costs (Adler and Liebert 2014). All cost efficiency studies include the price of labour as a factor price input (Assaf 2010; Assaf et al. 2012). Variable costs generally include energy (E), materials (M) and supplies (S) in an aggregated form (Barros and Weber 2009; Curi et al. 2011; Assaf and Gillen 2012; Adler and Liebert 2014; Adler et al. 2015; Randrianarisoa et al. 2015; See and Li 2015). In the cost efficiency models, the price of materials, the materials and contracted services index and the purchasing power parity index are applied (Assaf et al. 2012, 2014). The airport production process is characterized by the presence of multiple outputs, including passengers, aircraft movements, cargo, aeronautical revenues and commercial revenues. Sometimes work load units, a function of passengers and cargo, are utilized in order to address the curse of dimensionality.

Seven of the twelve applied papers detailed in Table 10.2 argue that regulation has been statistically proven to encourage technical, financial and cost efficiency. Assaf (2010) analyses the cost efficiency of 13 major Australian airports from 2002 to 2007, approximately 5 years after the Federal Airport Corporation facilitated the privatization of these airports. The results suggest that cost efficiency increased over time, which he hypothesizes is due to the privatization process and light-handed monitoring regulatory effects. Assaf et al. (2012) estimate the impact of price-cap regulation and the level of the price cap on the cost efficiency of 27 large UK airports from 1998 to 2008. The results suggest that average cost efficiency was relatively high and improved over time. Factors found to be important determinants of efficiency include airport size, level of competition, the existence of single-till price-cap regulation and the price-cap value. The authors note that the lower efficiency found at airports with a higher price cap does not necessarily imply cost inefficiency rather may reflect the need for an investment programme. Bottasso and

Table 10.2 Overview of research on airport performance estimation

Reference	Region	Timeframe	Method	Performance measure	Inputs	Outputs	Results
Regulation impacts positively on estimated levels of efficiency							
Assaf (2010)	Australia	2002–2007	Bayesian random effects SFA	Cost efficiency	Price of labour and capital	Passengers, cargo, aircraft movements	Light-handed regulation leads to cost efficiency
Assaf et al. (2012)	UK	1998–2008	Bayesian dynamic SFA	Cost efficiency	Price of labour, capital and materials	Total revenues	Price-cap regulated airports are more cost efficient but level of price-cap is important
Bottasso and Conti (2012)	UK	1994–2005	SURE and 3SLS	Variable cost function	Capital stock, price of labour and variable inputs	Work load units, aircraft movements, non-aeronautical revenues	Technical efficiency increased over time but regulation causes overcapitalization at larger airports suffering diseconomies of scale
Curi et al. (2011)	Italy	2000–2004	Output-oriented CRS bootstrapped DEA	Operational and financial efficiency	Operational efficiency—Labour, number of runways, apron size Financial efficiency—Labour costs, other costs, airport area	Operational efficiency—Passengers, cargo, aircraft movements Financial efficiency—Aeronautical and non-aeronautical revenues	Dual-till price-cap regulation improved financial efficiency but was introduced in 2001, alongside terrorist attacks which reduced demand globally, hence operational efficiency dropped
Adler et al. (2015)	Europe and Australia	1990–2010	Non-oriented VRS bound adjusted DEA	Technical efficiency	Labour, other operating costs, runway capacity	Non-aeronautical revenues, passengers, aircraft movements, cargo	Incentive regulation leads to higher productive efficiency in comparison to cost-plus regulation

Adler and Liebert (2014)	Europe and Australia	1998–2007	Input-oriented VRS weighted additive DEA	Cost efficiency	Staff costs, other operating costs, declared runway capacity	Passengers, cargo, aircraft movements, non-aeronautical revenues	Under weak competition, private owned, dual-till price-cap regulated airports more efficient than unregulated counterparts In competitive environment, purely public and purely private unregulated airports operate equally cost efficiently but private airports set higher aeronautical charges
Karanki and Lim (2020)	United States	2009–2016	Bootstrapped output-oriented DEA	Technical efficiency	Labour, effective number of runways, land area, gates, variable costs	Work load units, non-aeronautical revenues	Compensatory and hybrid agreements positively and significantly impact efficiency
Regulation does not impact efficiency estimates							
Barros and Weber (2009)	UK	2000/01–2004/05	Input-oriented CRS Malmquist DEA	Total factor productivity	Labour, fixed assets, other costs	Passengers, cargo, aircraft movements	No clear relationship between regulation and gains in total factor productivity
Randrianarisoa et al. (2015)	Europe	2003–2009	Residual variable factor productivity	Technical efficiency	Labour, soft costs	Passengers, aircraft movements, non-aeronautical revenues	No significant difference in operating efficiency of airports whether regulated or not
Regulation impacts efficiency estimates negatively							
Assaf and Gillen (2012)	Europe, North	2003–2008	Semiparametric Bayesian	Technical efficiency	Labour, soft costs, number of runways, total	Passengers, aircraft movements,	Private airport subject to minimal economic

(continued)

Table 10.2 (continued)

Reference	Region	Timeframe	Method	Performance measure	Inputs	Outputs	Results
	America and Australia		stochastic distance function		size of passenger terminal	non-aeronautical revenues	regulation most efficient Government owned, single-till, cost-based regulation least efficient
Assaf et al. (2014)	Europe, North America and Australia	2003–2008	Random effects Bayesian dynamic SFA	Technical, cost and allocative efficiency	Employees, materials and contracted services, runways, passenger terminal area, price of labour, purchasing power parity index	International passengers, other passengers, aircraft movements, non-aeronautical revenues	Economic regulation leads to reduced short-run technical efficiency
See and Li (2015)	UK	2001–2009	Input-oriented Hicks–Moorsteen index number approach	Total factor productivity	Labour, capital stock, other operating expenses	Aeronautical & non-aeronautical revenue	Regulated airports attain lower productivity growth rates than unregulated

Conti (2012) estimate short- and long-run translog variable cost functions for 25 airports located in the UK covering the years 1994–2005. The results suggest a positive technical change of around 2% annually but equally over-capitalization among the larger airports. The long-run average cost functions suggest that airports with under five million passengers enjoy increasing economies of scale and those with over 15 million passengers suffer from diseconomies of scale. The authors argue that the UK Civil Aviation Authority sets prices which match average costs and that these suboptimal prices lead to allocative inefficiencies. Consequently, although regulation impacts technical change positively, it leads to some negative impacts such as over-capitalization and allocative inefficiency.

Curi et al. (2011) analyse the operational and financial efficiency of 18 Italian airports from 2000 to 2004. The results of the financial analysis suggest a net increase in efficiency over the time duration considered after dual-till price caps were introduced in 2001. However, operational efficiency declined, likely due to the large decrease in traffic as a result of the terrorist attacks in the United States on September 11th, 2001. Adler et al. (2015) analyse the impact of regulation on the short-term productive efficiency of 58 European and Australian airports from 1990 to 2010, using a two-stage benchmarking and regression analysis. For the second-stage fixed effects and truncated regressions, they categorize incentive regulation as high-powered pure price caps, medium-powered hybrid price caps and light-handed monitoring and low-powered revenue caps. After controlling for the share of revenues from non-aeronautical activities and capacity utilization by including a dummy if the airport earns at least 50% of revenues from non-aeronautical sources and two additional dummies if the airport utilizes between 50% and 80% of its declared runway capacity on an annual basis and if the airport utilizes above 80% of its declared runway capacity, they find that incentive regulation leads to higher productive efficiency in comparison to cost-plus regulation. Their categorization of whether the regulator is dependent or independent was not proven to significantly impact productive efficiency.

The sixth paper analyses the combined impact of competition, ownership form and regulation on the cost efficiency and prices of an unbalanced panel dataset of 48 European and Australian airports from 1998 to 2007 (Adler and Liebert 2014). Their results suggest that cost-plus regulation creates disincentives for efficiency, whereas dual-till incentive regulated airports are more cost efficient than their single-till incentive regulated counterparts because the former leads to higher non-aeronautical revenues. In weakly competitive markets, majority privately owned and regulated airports are more efficient than their unregulated counterparts whereas publicly owned and regulated airports perform worse than those that are unregulated. In a potentially competitive environment, the results suggest that both purely public and purely private airports operate in an equally cost-efficient manner. Furthermore, the private and unregulated airports perform better than their regulated counterparts, suggesting that regulation creates costs to both the regulators and the regulated firms. However, it is also noted that the aeronautical prices of unregulated private airports are significantly higher than their unregulated public counterparts. Consequently, Adler and Liebert conclude that fully private, dual-till, price-cap regulated airports are the most cost efficient under weak competition. Under potential competition, both ownership forms are equally cost efficient, but unregulated private airports charge a higher price than their unregulated public counterparts.

Finally, Karanki and Lim (2020) analyse 59 of the large- and medium-sized US airports from 2009 to 2016. The results suggest that state government-owned airports are less efficient than those operated by a port or airport authority. With respect to regulation, the results suggest that airports operating under compensatory or hybrid methods are more efficient than those with residual agreements signed with a signatory airline. Whilst the signatory airlines may enjoy lower charges, the airport is less incentivized to achieve operational efficiency goals.

Two papers in the literature argue that regulation has little to no noticeable impact on efficiency levels. Barros and Weber (2009) estimate the total factor productivity of 27 UK airports from 2000 to 2004 of which three private airports were subject to price-cap regulation. They hypothesize that there is no clear relationship between regulation and productivity since two experienced lower levels of efficiency and one improved, out of a general technological regress during this period. Randrianarisoa et al. (2015) evaluate the impact of corruption on the technical efficiency of 47 airports from 27 European countries from 2003 to 2009. Wren-Lewis (2013) argues that an independent regulator may reduce the effect of corruption on efficiency, hence Randrianarisoa et al. (2015) include a regulation variable as a control. The results with respect to regulation are statistically insignificant in a random effects models but are significant in a pooled OLS model, which suggests that cost-plus, single-till regulated airports are more efficient than unregulated airports which in turn are more efficient than incentive, dual-till regulation.

Three papers suggest that regulation tends to decrease technical and cost efficiency. Assaf and Gillen (2012) estimate the combined impact of governance form and regulation on the productive efficiency of 73 international airports from Europe, North America and Australia between 2003 and 2008. Their results suggest that fully private airports with light-handed regulation and government-owned airports without regulation are the most technically efficient. The least efficient are those airports which are government owned and subject to cost-based, single-till regulation. Assaf and Gillen argue that the more restrictive the form of regulation, the lower the productive efficiency, regardless of the ownership form. Moreover, government-owned airports subject to single-till cost-based regulation may be the least efficient because they may have an objective other than the maximization of economic efficiency. Assaf et al. (2014) analyse the joint impact of ownership and regulation on the short- and long-run technical and allocative efficiency of airports for the same dataset. They conclude that economic regulation leads to reduced short-run technical efficiency except in the case of light-hand regulated, privately owned airports found in Australia and New Zealand. Regardless of governance type, they argue that removing single-till price-cap regulation will always improve economic efficiency and the expected gains are highest for fully or partially publicly owned airports. See and Li (2015) estimate the impact of size, regulation and ownership form on the total factor productivity of 22 UK airports from 2001 to 2009. The results indicate that the majority of the sample experience TFP growth but technical regress explains a reduction in TFP for the minority. The results also show lower TFP growth rates for regulated airports as compared to those that are unregulated.

In summary, the applied literature draws a rich and varied picture as to the impact of regulation on efficiency, arguing that levels of competition and ownership form jointly impact airport efficiency. One explanation for the variation in the results is an argument over whether the US airports are regulated or not. Whilst Assaf and Gillen (2012) and Assaf et al. (2014) classify US airports as unregulated public airports, Graham (2004) describes them as residual, compensatory and hybrid regulatory approaches, which are assessed in Karanki and Lim (2020). The latter estimate that compensatory (dual-till) US airports are more technically efficient than those with residual (single-till) use agreements. Moreover, the Federal Aviation Administration and US Department of Transport pose a credible threat of regulation and airports have been taken to court due to airline complaints. Management at Logan Airport in Boston introduced movement and weight-based charges, which led to higher landing charges for smaller aircraft. The airlines took the airport to court and won, forcing the airport to resort to its former pricing structure. Consequently, we hypothesize that light-handed and incentive-based regulation are the most conducive to improving performance based on the majority of the applied literature. Moreover, dual-till price-cap regulation is preferred over single-till regulation, provided airports are congested and geographical monopolies.

10.4 Conclusions and Future Directions

In conclusion, we argue that regulation most likely impacts airport efficiency and for the most part, appears to positively encourage technical and cost efficiency. However, the question should not be divorced from the impact of governance form and competition levels. In other words, small, spoke airports located in regions with little to no competition from either alternative airports or transport modes, will require a form of regulation in order to ensure reasonable charge levels. The general consensus appears to be that dual-till, incentive-based regulation is the most promising, with the proviso that this may lead to underinvestment in capital projects, hence may require some corrections over time. For large airports located in a region with little competition, there is a need to regulate charges alone in order to optimize overall social welfare. Light-handed regulation with the credible threat of re-regulation may also be sufficient in such cases, ensuring reasonable charges and maximizing overall social welfare. In competitive markets, regulation is unnecessary and simply leads to additional, unnecessary costs.

As most of the applied results are derived from studies which have been conducted on airports located in developed economies such as Australia, Europe and the USA, it may be of interest to test whether these results also hold true for airports in developing economies. With regard to the institutional aspect, further research will be needed to confirm the performance impact of an independent regulator as opposed to a partly or fully dependent regulator. This is of significance because the number of independent regulators has increased in Europe over the years and the European Commission is trying to establish independent airport regulators in the Member States. Further research will need to focus on whether yardstick competition and benchmarking could be used for the regulation of airports. If such models are adopted, the performance impact of yardstick competition and benchmarking will also need to be measured. Benchmarking is in fact an integral part of price-cap regulation but creating a regulatory mechanism based on yardstick competition which relies entirely on benchmarking is proving to be more problematic. At the moment, this may be possible only within a country, for example Germany, and the problem here is the lack of sufficient data because of the limited number of large airports within the country. Once the issues pertaining to data have been solved for a larger geographical region such as Europe, yardstick competition could be applied as a regulatory mechanism in this region.

We also note that not all theoretical results that have been listed in Table 10.1 have been tested in the applied literature, probably due to the relatively large, diverse yet comparable dataset required. For example, the case of peak pricing, allocative efficiency and the regulation of airports with excess demand has yet to be analysed in the literature. Finally, as Bottasso and Conti (2012) argue, the single-till price-cap system in the UK leads to gold plating and over-capitalization hence the correct form of investment regulation ought to be of focus and the performance impact of investment regulation will need to be measured.

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Chapter 11
Methodology Choices for Benchmarking Airports

Ian Kincaid, Michael W. Tretheway, and Jody Kositsky

Abstract This chapter discusses the ways benchmarking has been used in the airport industry, including assessing managerial performance, price regulation and informing national policy. The chapter examines issues including difficulties in providing meaningful comparisons and the approaches developed to improve the benchmarking comparisons, especially residual benchmarking. While benchmarking has many issues and limitations, it is not without value. Provided it is well designed and executed, it is a useful tool to identify deficiencies and excellence in performance. It can spur competitive forces and shake up conventional thinking. The answer to whether benchmarking with limitations is better than no benchmarking depends on how it is to be used. If used to calculate the price cap applied to an airport, then the limitations of benchmarking can have major implications, as even minor errors in the benchmarking analysis could result in a price cap costing the airport or its users millions of dollars. If used to assess the impact of policy reforms, then a broad, but imprecise measure may be sufficient, as it is not dependent on the outcome of a single airport. Benchmarking can serve as an effective decision-aid tool, but decision makers must be aware of the limitation of the analysis, and the analysis itself must demonstrate sufficient robustness.

Keywords Benchmarking · Performance · Efficiency · Policy · Residual benchmarking · Total factor productivity · Variable factor productivity

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11.1 Introduction

Benchmarking is a means by which to assess the performance of a firm, industry or sector by comparing its performance with other, similar firms, industries or sectors. A benefit of benchmarking is that it can be a fairly straightforward means to identify performance deficiencies or exceptional performance, without detailed and complex examination of processes. For example, it can be used to determine whether a firm has achieved high productivity levels by comparing its productivity with that of peer firms. Without this comparison it would be a difficult and complex process to determine whether the firm was in fact productive.

Benchmarking has become an increasingly popular tool used in the management, regulation and review of both private and public organisations. Like many other industries within the transportation sector, the airport industry, its stakeholder and researchers have used benchmarking in a number of different ways to assess and improve its performance. Examples include annual studies by the Transport Research Laboratory (TRL)[1] and the Air Transport Research Society (ATRS), benchmarking studies commissioned by the management of individual airports,[2] benchmarking of performance and customer service by the Airports Council International (ACI) and benchmarking for possible use in the regulation of Aer Rianta.[3] In this chapter, we examine the purposes for which benchmarking has been used (and purposes for which it could be used) and the impact this has on benchmarking approach used. We also consider many of the issues associated with benchmarking. To illustrate this discussion, our chapter draws on examples from the airport industry, from other transportation modes and from other sectors of the economy.

11.2 The Link Between the Use and Format of Benchmarking

This section provides an overview of the ways in which benchmarking has been used, how this affects the choice of performance measures, the level of aggregation applied and the selection of comparators or peer firms. Benchmarking has been used in a number of ways:

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[1] Airport Performance Indicators and Review of Airport Charges, Department of Air Transport, Transport Research Laboratory, Wokingham. This report is now published by Leigh Fisher.

[2] As an example, Inter*VISTAS* Consulting undertakes benchmarking for Canada's Level II airports, with the benchmarking studies commissioned by the airports.

[3] Now the Dublin Airport Authority. The Irish Aviation Regulator considered, although ultimately did not adopt, the use of benchmarking as a factor in regulating airport terminal charges. See, for example, Commission Paper CP5/2001, section 3.4.2.3. Also see Irish Commission for Aviation Regulation (2001).

- **Assess managerial or firm performance**. Benchmarking has been used as an internal management tool to assess an organisation's performance and to instigate change. Benchmarking has also been used by governments and other organisations to assess the performance of a company contracted to provide a particular service.
- **Collaborative benchmarking**. While similar to the item above, this approach tends to be a more collaborative process between airport operators or countries to assess their relative performance and identify areas of improvement.
- **Price regulation**. A notable example of this is the past use of benchmarking in the regulation of Aer Rianta in Ireland.
- **National policy**. Benchmarking has been used to inform policy decisions and to subsequently assess the impact of changes in policy.
- **Supply chain or value chain efficiency**. Here, benchmarking would not be applied solely to a firm and its peers. Instead, benchmarking would be applied to the entire supply or value chain. For example, in the case of airports, it may be that a particular hub airport is inefficient when measured against its peers, perhaps due to a higher level of infrastructure investment, but enables much greater efficiency in other supply/value chain members. A congested airport will often be assessed as efficient among its peers (less investment for a given number of movements) but at the cost of increasing airline operating costs and reducing airline capital productivity. Value chain benchmarking would attempt to sort out the contribution of airport investment on value chain efficiency.

Each of these approaches is described in more detail below along with their implications in terms of methodology and effectiveness.

11.2.1 Assess Managerial or Firm Performance

Benchmarking has become an established management tool, used to identify best practices, to challenge established thinking and encourage organisations to consider and adopt new methods and ideas. Early benchmarking focussed on manufacturing processes. (Xerox Corporation is widely credited with initiating benchmarking in the 1970s, which it used to improve its manufacturing and distribution processes by benchmarking against its major, generally Japanese, competitors.[4]) Benchmarking has since been used in sales, marketing, pricing, product development, customer satisfaction and in the public sector and non-profit organisations.

[4] Another famous example of a benchmarking study is the MIT study of the automobile manufacturing (*The Machine That Changed the World*) which analysed in-depth automobile manufacturing processes at plants across the world and lead ultimately to significant changes in production processes in North America and elsewhere, by enabling managers to recognise what they had to do to achieve world class standards.

There are also instances of benchmarking being used to assess the performance of a company contracted to provide a particular service, albeit outside of the airport industry. For example, the provincial government of Ontario Canada used benchmarking to assess the performance of private companies contracted to operate correctional facilities, comparing their performance with similar facilities operated within the public sector.[5] If the private operator fails to perform at a level equal to or higher than the public sector equivalents, the company could be subjected to financial penalties. To date, however, the Ontario government has yet to publish the results of this benchmarking analysis, so it is unclear how the benchmarking has progressed and what impact it has had.

As many airports have transformed from public utilities to commercial enterprises, there has been an increased interest in utilising benchmarking to improve performance. Benchmarking has been used by airport managers to examine a number of different aspects of the airport business:

- Pricing: benchmarking landing fees and other charges.
- Service quality: customer satisfaction levels, average queue times, incidences of delays.
- Cost: unit cost, such as operating or total cost per Work Load Unit (WLU).[6]
- Productivity or efficiency: Total Factor Productivity (TFP), Variable Factor Productivity (VFP) or Single Factor Productivity measures (SFP, e.g., WLU per labour hour). Arguably, TFP should become a key indicator by which airport performance is measured, as it provides a more comprehensive picture of the overall efficiency of the airport.[7]

The comparator airports will generally be made of natural competitors to the airport or "best in class" airports whose performance the airport management may wish to emulate. For example, Heathrow Airport may wish to benchmark itself against Frankfurt, Paris, Amsterdam (competitors for European hub traffic) or Hong Kong, Singapore, Dubai (best in class global hub airports). An airport catering to largely Low Cost Carrier airlines may wish to benchmark itself against airports serving similar airlines, rather than a major international hub.

While most airport benchmarking has focussed on overall airport performance, it is possible for airports to benchmark specific services. For example, an airport could benchmark the unit cost or productivity of its ground handling service or cargo facilities against those provided at other airports. Airports can also benchmark

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[5] The performance indicators include incidences of violent disturbances, incidences of escape, incidences of unnatural death, as well as more mundane measures related to cost efficiency and productivity.

[6] WLUs are measures that aggregate different measures of airport activity, specifically numbers of passengers and number of runway movements.

[7] VFP is more comprehensive than SFP, as it considers all variable inputs, but by ignoring the cost and contribution of capital resources, it is not a comprehensive measure of efficiency. E.g., an airport might achieve a high level of VFP by overinvesting in capital assets, resulting in lower overall productivity.

against non-airport businesses. An obvious example would be retail, where an airport could benchmark the price and service quality of its retail facilities against equivalents on High Street.[8]

As with all forms of benchmarking, the development of meaningful performance indicators that reflect managerial performance is critical. For example, the unit operating cost of airports can differ depending on the degree of outsourcing undertaken by the airport. Some airports operate a number of activities themselves, such as ground handling, car parking and retailing, which many other airports outsource. Thus, one airport's operating costs may be higher simply because it provides a wider range of services than other airports, and so may not be a suitable reflection of managerial performance.

Approaches have been developed to overcome these kinds of problems. For example, TRL "normalizes" the data so that performance indicators are based on a uniform set of activities. Another approach is to use statistical or econometric analysis to adjust the performance indicators for outside factors, an approach known as residual benchmarking, as is done for the ATRS reports. There are significant issues associated with both of these approaches, as discussed in Sect. 11.3.

11.2.2 Collaborative Benchmarking

Benchmarking started as a process conducted by individual firms to improve their processes and competitive position. Since then, benchmarking has also been being carried out in a collaborative manner by groups of firms or organisations in a given economic sector.

Benchmarking Customer Satisfaction

An example of collaborative benchmarking is the former IATA Global Airport Monitor, now rebranded as the Air Service Quality (ASQ) Programme, which is conducted by ACI. This programme benchmarks (passenger) customer satisfaction for a variety of airport services and facilities on a quarterly basis. The ASQ benchmarking programme originated with stakeholders (airlines), rather than with the airports themselves, although the initiative is now supervised by the entities being benchmarked. Airports participate in the study on a voluntary basis; currently around 130 airports worldwide participate. In addition to assessing relative performance, the results of this benchmarking are also used for promotional purposes: *Number 1 Airport in the World/North America/Europe*, etc.

Similarly, Inter*VISTAS* Consulting Inc. has conducted annual customer satisfaction benchmarking for a number of Canadian small airports. The programme benchmarks overall satisfaction with the airports as well as satisfaction with specific

[8] High Street is a term used in the airport retail sector for retail businesses off airport, typically at full service outlets, rather than at low service discount retailers.

services—baggage delivery, ground transportation, retail, etc. The study also benchmarks other metrics such as average passenger retail/food/beverage spend rates and queue times.

Collaborative Benchmarking of European Air Navigation

Another example of collaborative benchmarking is that conducted by the Performance Review Commission (PRC) of EUROCONTROL, the European Organisation for Safety of Air Navigation.[9] Since 1997, the PRC has used air navigation data from all the member states to produce annual reports benchmarking the following performance indicators related to:

- Capacity and Delays: e.g., Delay Minutes per Flight, total cost of delays, average delay duration
- Cost Effectiveness: e.g., Cost per Km Flown Enroute, Cost per Composite Flight-hour.[10], Flight-hours per ATCO hour (Air Traffic Control Officer)[11]
- Safety: the PRC has also attempted to benchmark safety but with limited success as there has been no agreement among member states on a set of key indicators for safety

The PRC has struggled to make progress in using the data to determine the reasons for performance differences between member states. Many of the reports produced include "health warnings" regarding comparison between performance of member states, as many external factors can impact on performance (weather, traffic mix, economies of scale, etc.). This has severely limited the stated aims of the benchmarking exercise, which are to identify areas of best practice to be emulated and provide guidance on economic regulation of air navigation. The PRC has carried out some econometric analysis to adjust for these external factors (i.e. forms of residual benchmarking) but, to date, the analysis has been largely experimental and the PRC has stated that more rigorous analysis needs to be undertaken before any conclusions can be drawn.

[9]EUROCONTROL is a civil and military organisation established in 1963 to facilitate a safe, seamless pan-European Air Traffic Management (ATM) system. While the initial focus of the organisation was on safety and operations, its remit has expanded over time to include capacity management and development, operating costs, and fees and charges. EUROCONTROL is not an EU institution, but includes nearly all the EU members, as well as countries outside of the EU such as Switzerland, Turkey and Norway.

[10]*Enroute* refers to the high altitude, cruising part of the flight as opposed to the decent/landing and take-off/climb parts of the flight. The *composite flight hour* is a weighted average of the time spent enroute and the time spent in decent/landing and take-off/climb.

[11]The PRC has examined the possibility of developing a TFP indicator, but concluded that insufficient data was available to develop such an indicator.

11.2.3 Price Regulation

Performance benchmarking is of interest to regulators as it potentially enables them to overcome some of the problems associated with information asymmetry. The regulator may have difficulty in obtaining adequate information on the regulated firm's operations and costs in order to determine the most economically efficient price cap. One approach by which to overcome this information asymmetry is to compare the regulated firm against other similar firms. In doing so, the regulator no longer needs detailed cost information to determine whether a company is efficient; instead, the regulator simply benchmarks the firm's unit cost or TFP against similar peer companies.

Regulation of Aer Rianta

An example of the use of benchmarking to determine a price cap is that by the Irish regulator, the Commission for Aviation Regulation.[12] The Commission was established in 2001 to regulate airport charges and aviation terminal service charges at three airports owned by Aer Rianta—Dublin, Cork and Shannon.[13] The price regulation used the common RPI –X formulation to determine the price cap applied to the airport. The Commission investigated using benchmarking to the guide the determination of the X value.[14] The benchmarking study was commissioned in 2001 and compared the operational efficiency of the three Irish airports with comparator airports elsewhere in the world.

A total of 11 performance indicators were estimated related to cost efficiency (e.g. operating cost per WLU), revenue effectiveness (operating revenue per WLU) and service efficiency (WLU per employee). However, the primary indicator used by the Commission in formulating the price cap was *operating cost per WLU*.[15] The three Irish airports were each compared against a small selection of "peer" airports that handled similar volumes of passengers and that had similar operating requirements. In addition, Dublin Airport and the Aer Rianta group as a whole were benchmarked against a "best in class" group of European airports, generally larger in scope than Dublin and recognised as innovators in their field. The "best in class" comparator group for Dublin Airport included Brussels, Copenhagen and Stansted.

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[12] Benchmarking has also been used in the price regulation of non-transportation sectors. For example, benchmarking has been used by regulators of the electricity sector in the UK, Ontario (Canada), Chile, Sweden and elsewhere. Regulators of the rail, water and telecoms industry in the UK have also used benchmarking to inform their economic regulation.

[13] In 2004, the Irish government split Aer Rianta into three separate airport authorities. In addition, the legislation narrowed the role of the Commission to regulate airport charges at Dublin Airport only (Cork and Shannon are no longer subject to price regulation).

[14] The "X" factor is typically viewed as comprising a productivity factor. It is actually more complex than this as it also includes a factor for the difference between an input cost index versus the retail price index, and allowances for higher costs due to new safety, security or capital investments.

[15] As discussed in Annex, if estimated correctly, this measure is generally equivalent to VFP.

The benchmarking analysis found that while Dublin's operating cost per WLU was in line with its peer group, it was considerably higher than its "best in class" comparators. The Commission determined that Dublin Airport should be able to considerably reduce this efficiency gap and proposed setting an X that would require achieving such as result. A similar approach was used to determine the X for Shannon and Aer Rianta as a whole. Cork was found to be more efficient than its peers and so had no specific price cap adjustment applied.

The approach used to benchmark the Aer Rianta airports came under criticism, particularly from Aer Rianta itself. The major complaint was that the benchmarking study did not compare "like with like". As mentioned previously, the costs of the airports can differ depending on the degree of outsourcing undertaken by the airports. In addition, other external factors may have distorted the assessment of cost efficiency. One airport may face higher labour costs if it operates in a higher labour cost country. Equally, service quality, traffic mix, traffic volume and traffic "peakiness" can also impact costs. The prime indicator used, operating cost per WLU, was also criticised as it is a partial productivity measure that does not consider investment, and its use of WLU as a measure of output may be too narrow and not capture the full range and quality of outputs provided by the airports. In later price cap determinations for Dublin Airport, the Irish regulator itself noted the potential issues with benchmarking and uses it more to judge general levels of comparison, rather than as an underlying regulatory method (Commission for Aviation Regulation 2020). It instead adopted an incentive approach in the price cap, rewarding the airport with a higher revenue cap for achieving targeted efficiency goals.

Also, while the Commission did review the price cap approximately once a year to assess compliance and to adjust the cap for inflation and other factors, no additional benchmarking was undertaken since the initial study. It can be argued that, as a result, the Commission may not have a correct picture of the operational efficiency improvements achieved by the regulated airports. While an airport may indeed be achieving its efficiency targets, this may simply be because of technological and other factors which are benefiting the industry as a whole, rather than specific actions taken by the airport itself. Arguably, ongoing benchmarking would be required to truly assess the efficiency improvements achieved by the airport. To date though, the Commission has not indicated that it will conduct any further benchmarking analysis.

The use of benchmarking in the price regulation of airports remains controversial. As part of its quinquennial review of its regulated airports in 2000–02, the UK CAA explored the possibility of using benchmarking as part of the formulation of the price cap. After consulting with industry and undertaking a "test" benchmarking review of Manchester Airport, the CAA concluded that issues associated with data quality and the methodologies for adjusting the data precluded the use of benchmarking in the near future. However, the CAA takes the view that benchmarking may be able to play a part in setting price caps in the future, once some of these issues have been resolved.

11.2.4 National Policy

The use of benchmarking in a policy context has considerable attraction. In the same way that firms can learn from the activities of other firms, governments can enhance policy by examining the relative performance of other countries. Benchmarking can be used to determine what sectors of the economies are lagging behind international competitors and what sort of policy changes have been effective in improving sectoral performance.[16] For example, have countries that have privatised their airports experienced greater improvements in efficiency, investment, pricing, etc., in that industry than countries that kept airports within the public sector? Benchmarking can also be used to assess whether a policy change has been effective by comparing before and after performance with that of other countries.

The performance indicators depend on the exact nature of the policy question being addressed, but typically can include indicators related to investment, pricing, cost, productivity, service quality and user take-up (e.g. traffic levels). Preferably, the performance indicators should be national averages or aggregates. However, in some sectors of the economy (including airports), there is a severe lack of reliable, aggregate data (this issue, as it relates to the airport industry, is discussed in more detail in Sect. 11.3). As a result, the comparison sometimes has been conducted at the firm level.

The choice of comparators also depends on the policy question. If the requirement is to determine where improvements can be made, the comparators may be countries that are viewed as "best in class", or which have enacted radical or interesting policy changes. If the benchmarking is to determine the effectiveness of a policy change, the comparators may be a control group of similar countries that have not enacted any policy change.[17]

Using Benchmarking to Inform Policy

An example of benchmarking being used to inform national policy is international benchmarking conducted by the Productivity Commission of Australia.[18] As part of a programme of major reforms of the Australian economy in the 1990s (the National Competition Policy), the commonwealth government commissioned an international benchmarking review, which was published in 1995. This review covered a broad range of major infrastructure service industries—electricity, telecommunications, rail freight, road freight, ports (referred to as waterfront), aviation (airports, air navigation and airlines), gas supply and coastal shipping. The benchmarking focussed on a small number of core indicators:

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[16] There have also been studies benchmarking the overall economic performance of countries, such as the World Economic Forum's *Global Competitiveness Report*. In 2019, Singapore ranked number 1, followed by the USA, Hong Kong and the Netherlands.

[17] In this case, it is also useful to have data collected over a considerable period of time, to allow before and after comparisons.

[18] Some of this benchmarking was conducted by predecessors to the Productivity Commission, such as the Bureau of Industry Economics.

- Prices (revenue per unit of output, or a weighted average of prices)
- Service quality (service interruptions, on-time delivery, etc., depending on the sector)
- Labour productivity (a partial productivity measure)
- Capital productivity (a partial productivity measure)

The analysis was carried out at the individual infrastructure provider level, rather than country-wide or state-wide averages. For example, the performance of Sydney Airport was compared against Melbourne, Cairns, Tokyo, Auckland, Hong Kong, London Gatwick, etc. The range of countries selected for comparison varied depending on the industry examined but included countries in Asia, North America, Europe and New Zealand.

The study highlighted the performance gap between the best Australia infrastructure providers and the best in the rest of the world, as well as the gap between best and worst Australian infrastructure providers. An example of the gap analysis, taken from the final study report, is provided in Fig. 11.1. The chart indicates that, with the exception of waterfront coal, the best (i.e. lowest priced in this example) infrastructure in Australia was found to be higher priced than the best foreign counterpart.[19] The findings of the report were deemed to support the argument for the implementation of the National Competition Policy (which was already underway, in any case).

The Productivity Commission's view is that the impact of the benchmarking on policy was largely indirect. Its chief value has been in informing the policy debate and creating greater awareness of Australia's relative economic performance.[20] One reason for this is that benchmarking rarely produces clear-cut evidence on the comparative performance of Australian infrastructure. The Productivity Commission views that it is generally hard to determine whether differences in performance are due to internal practices or external factors outside the control of the industry.

Assessing the Impact of Government Policy

Two policy changes that have come under considerable scrutiny over the years have been the deregulation of the rail sector in Canada and the U.S. and the deregulation U.S. airline industry. Benchmarking has occasionally been used in this analysis as it provides a means, albeit imperfect, to control for other factors not related to policy (e.g. fuel prices, recession, technological change).

In Canada, the rail industry was partially deregulated in 1967, in an attempt by the government to revive a heavily loss-making industry and enable it to compete with

[19] There also existed a considerable performance range within Australia itself. For example, the worst (i.e. most expensive) gas supply provider charged nearly double the best (i.e. cheapest provider).

[20] One exception to this was the container ports, which underwent radical government reforms after the benchmarking showed that they were significantly more expensive, less productive and poorer quality than international counterparts. Follow-up benchmarking in 2003 found that the ports had significantly improved their performance relative to international comparators.

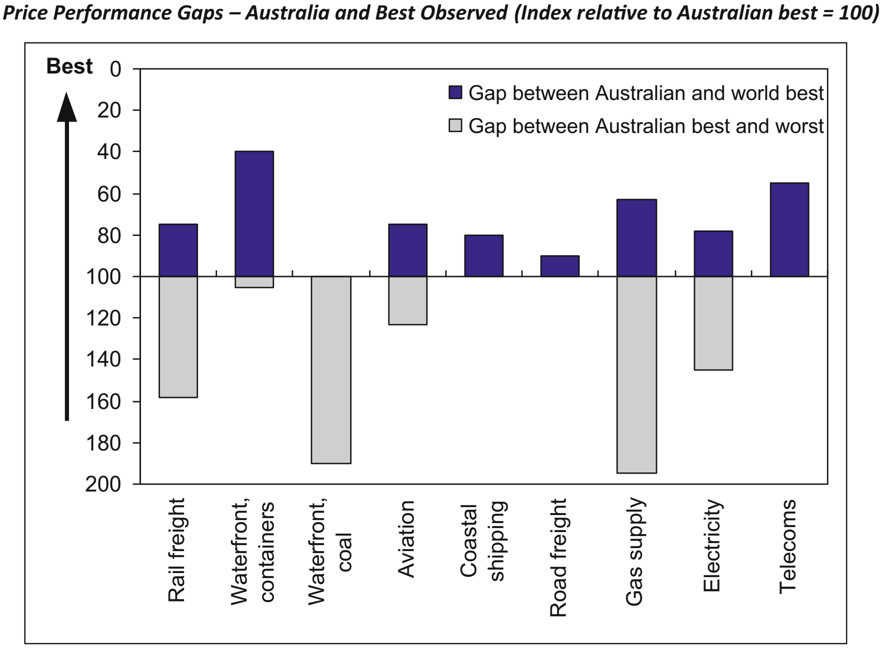

Fig. 11.1 Sample presentation of benchmarking gap analysis. Price Performance Gaps – Australia and Best Observed (Index relative to Australian best = 100). Source: Reproduced from International Benchmarking Overview 1995, Bureau of Industry Economics, Report 95/20, November 1995

other modes, primarily trucking.[21] Conveniently for researchers and policy-makers, the rail industry in the U.S. did not undergo a similar deregulation process until the late 1970s. The rail industries in both countries are broadly similar, using the same gauge, the same type of trains and are primarily involved in the transportation of goods, rather than passengers (one key difference is that, in terms of track and volumes carried, the U.S. rail industry is several times larger than its Canadian counterpart). This situation provided a prime opportunity to assess the impact of policy by comparing the performance of the industries in the two countries. A number of studies compared the productivity (TFP) of the railways in the two countries and found that the Canadian railways saw very distinct improvements in productivity following the 1967 reforms, relative to the U.S. railways (see for example, Caves et al. 1982). Furthermore, the Canadian railways were found to not only have achieved a higher *growth* rate of productivity, but the level of productivity also overtook that in the U.S., despite the natural conditions favouring the U.S. railways (economies of scale, milder weather, greater population density). The results of these studies had considerable impact on the debate on rail policy in

[21] Further deregulation occurred in 1987, with some modifications in 1996.

both countries, leading the way for further reforms and deregulation. The analysis benefited from the availability of reliable, detailed and largely compatible data on the rail sector in both countries.

There have also been studies that have benchmarked productivity and other measures of the U.S. airline industry to assess the impact of deregulation in 1978 (see for example, Caves et al. 1987). One challenge with this approach has been the quality of data available on non-U.S. airlines. While the U.S. government maintains exceptional detailed and comprehensive data on the U.S. airline industry, data from many other parts of the world is far more limited and often incompatible. Nevertheless, it has generally be found that there was improvement in productivity at U.-S. airlines following deregulation, relative to international airlines.

11.2.5 Supply Chain or Value Chain Efficiency

Airports are only one part of the commercial aviation supply chain or value chain.[22] They account for only 4–8% of total cost of commercial airline services.[23] Just as air carriers may be willing to trade off higher capital costs to reduce fuel, labour or other costs,[24] air carriers may also trade off the "airport factor-of-production" for efficiencies in other factors.

This is not a trivial matter. The operational performance and congestion of an airport has dramatic implications for airline productivity. The capacity and efficiency of an airport has a direct and profound impact on airline operating costs and capital productivity. A congested airport raises costs and requires longer aircraft block

[22] Recently the industry has been referring to the aviation ecosystem.

[23] The range is due to a) different levels of airport charges in different jurisdictions (e.g. U.S. airport costs are subsidised and thus are quite low relative to other jurisdictions) and b) the wide fluctuations in the cost of fuel which affects the share of all non-fuel costs in the total airline cost structure.

[24] An air carrier that invests in new aircraft which are more fuel efficient would be judged to have suffered a decline in capital productivity, even though total factor productivity may have been improved. This can work in the other direction as well. An air carrier may have 'best in class' variable factor productivity by having overinvested in aircraft and other airline capital, but be below its peers in total factor productivity. Variable factor productivity measures are dangerous if their evaluation ignores the level of capital. Neoclassical economics allows estimation of variable cost functions (equivalently production functions for variable factors or variable factor productivity functions) ***but only if the level of capital is included as a regressor***. A variable cost function or a variable factor productivity function which omits the level of capital stock, is not consistent with the economic theory of production. Measuring airport variable factor productivity is not a "solution" to the lack of a measure of airport capital. Economic theory requires a measure of airport capital, whether estimating a total cost function or a variable cost function or estimating a total factor productivity regression vs. a variable factor productivity regression. The lack of a measure of capital does not justify estimation of relationships which are inconsistent with economic theory.

times.[25] The latter means that a given aircraft will only be able to operate a reduced number of flights per day. While this may seem insignificant for a single flight, the requirement for an additional 15 min for each flight at a carrier's hub will mean (a) an average loss of roughly one hour productive service each day for each aircraft, (b) a decrease in airline capital productivity of roughly 10% and (c) the need for a fleet that is perhaps 10% larger than would be the case if the airport were uncongested. Congested airports also mean a greater number of travellers will miss connections. This raises airline costs due to additional ground and flight staff time and interrupted trip expenses.[26]

What is often overlooked is that airport investments often have dramatically lowered *airline* operating and capital costs. These cost reductions appear on airline accounting ledgers as (a) lower labour costs and (b) higher aircraft productivity resulting in lower aircraft ownership costs. As an example, if an airport undertakes a capital investment programme that reduces average block times by 15 min,[27] then a hub carrier operating 1000 flights per day through the hub will generate operating cost savings of roughly $350 million *per annum*. The higher aircraft productivity will save over 90,000 block hours annually, equivalent to the annual flying time of roughly 40 aircraft. At an average aircraft price tag of $100 million, this is a $4 billion reduction in airline balance sheet needs. Unfortunately, these airline cost savings from airport investment, while genuine, are not directly identifiable from airline accounting data.[28]

Only benchmarking an airport relative to its peers may find that the airports which make the greatest contribution to the commercial aviation value chain are assessed to be the least efficient and highest cost airports due to their higher capital investment in order to reduce airline costs. Such benchmarking would be a misleading indicator of airport performance. Benchmarking studies which only measure airport "outputs" as the number of aircraft movements, number of passengers or a similar measure of workload units are especially vulnerable to misleading findings on airport performance relative to peers. Given the importance of airport congestion as a driver of airline labour, capital and other expenses, the benchmarking measures of airport output must also include a measure of congestion or delay.[29]

[25] Block times are the time from when an aircraft departs the gate at the origin airport to the time when the aircraft arrives at the destination airport gate. Block times include not only the normal flight time between origin and destination, but also the additional time aloft due to queues on approach (e.g. circling or reduced en route flight speeds) and ground taxi/delay times.

[26] Meal vouchers, hotel accommodations, etc., for interrupted travellers.

[27] This might be due to additional runway capacity, more efficient de-icing operations, greater number of gates reducing wait times for gates and ramp loading/unloading of passengers, etc.

[28] We do observe that when airports undertake a social cost–benefit analysis (SCBA) for a major project such as a new runway, estimates of these cost savings appear there. One of the authors of this chapter was involved in the SCBA for a proposed investment in a parallel runway at Vancouver International Airport, where these airline operating cost savings were quantified, as well as a measure of passenger travel time savings.

[29] Note that in the parlance of economists, congestion delay is a "bad", while reducing congestion delay is a "good". The aggregated measure of airport output must be constructed so as to properly attribute congestion delay as a "bad".

Including a congestion or delay measure for airport benchmarking is a challenge, of course, as airports typically do not include such measures in their annual reports. Many airports do provide such measures in their master plans and forecast documents, but these are more difficult for researchers to obtain. A number of jurisdictions collect and publish data for on-time flight performance.[30] The raw data underlying these measures can be processed to construct measures of delay at airports. Alternatively, airlines or airports can be surveyed to seek quantitative or qualitative measures of delay. An example might be a survey question which asked whether the number of flights which experience congestion or weather delay falls into one of five performance bands.[31,32]

A survey to carriers using the airport is an alternative means to assess the impact of the airport on the commercial aviation value chain. Such a survey should be targeted at airline dispatchers, not airport stations managers (who are often focused on customers service and real estate issues). It is the dispatchers who intimately understand service performance and the impact on airline costs.

The key point is that airport benchmarking which ignores the impact of either or both of airport investment and operational efficiency, can produce a misleading assessment of the airport's contribution to economic efficiency. ***Of particular importance is that airport benchmarks which are based only on measures of airport variable inputs (with no control for airport capital) are biased and should be discouraged.***

11.2.6 Summary of the Uses of Benchmarking

Table 11.1 provides a summary of the broad uses for benchmarking and the type of measures and analysis undertaken in each case.

11.3 Issues in Benchmarking Airports

This section provides a more in-depth, technical discussion of some of the issues touched on in the previous section:

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[30] E.g., the U.S. and Australia.

[31] While weather is beyond the control of most airport management, airports can and do invest in landing systems (e.g. category IIIa) which greatly reduce the number of flights which are delayed due to low visibility weather, in cross wind runways which enable operations when the prevailing wind is not prevailing, etc.

[32] As an example, a question could be "Indicate the number of days when aircraft are delayed an average 5 or more minutes due to congestion—runway or de-icing: a) less than 5 days per year, b) 5–10 days per year, ... Indicate the number of days when aircraft are delayed an average of 15 minutes or more ..."

Table 11.1 Use of benchmarking

Purpose	Types of measure	Level of aggregation	Comparators
Assess performance	• Price • Customer satisfaction • Service quality • Unit cost • Efficiency (TFP, VFP, etc.)	Airport or individual services	• Best in class • Natural competitors
Collaborative benchmarking	• Price • Customer satisfaction • Service quality • Unit cost • Efficiency (TFP, VFP, etc.)	Airport or individual services	• Other group members
Price regulation	• Efficiency (TFP, VFP, etc.)	Airport	• Best in class or similar peer airports
Assess policy	• Price • Service quality • Unit cost • Efficiency (TFP, VFP, etc.) • Investment • Throughput or take-up	National or airport	To inform policy: • Best in class • Competitor countries • Countries that have enact major policy reform To assess policy outcomes: • Control group of counties that have not enacted policy change
Measure contribution to value chain efficiency	• Same as above, but must also include measure of congestion or delay	Airport	• Other group members

- Availability and quality of data
- Adjusting the data to provide meaningful comparisons
- Use of residual benchmarking, with reference to the ATRS study

11.3.1 Availability and Quality of Data

One of the main challenges in benchmarking airport performance is obtaining workable data. The availability and quality of data on airport activities and finance varies considerably around the world, depending on the ownership structure of the airports, accounting practices in each country and the data collected by government statistical agencies.

While most private and not-for-profit airports publish detailed financial accounts,[33] the financial accounts of some publicly (i.e. government) owned airports

[33] Required for reports to shareholders and reports to regulator or monitoring agencies. E.g., in the case of Australia, airports are no longer regulated but the prices monitoring programme requires airports to report data to the Australia Competition and Consumer Commission, which then publishes regular reports.

are not readily available in any great detail. Differing accounting practices can also create data inconsistencies. As an example, some airports treat interest expenses as an operating cost, while others treat it as a non-operating expense. Some U.S. airports originally treat grants and monies received from the Passenger Facility Charge (PFC) as offsets to capital expenditures rather than revenues although this practice has ended;[34] however, in Canada, the Airport Improvement Fee (AIF, similar to the PFC) is generally treated as a revenue source. The BAA depreciated runways over period of up to 100 years, while many other airport operators use shorter periods of between 20 and 40 years. Airports are also subject to differing tax regimes. To some extent, the data can be adjusted in order to apply a consistent accounting standard, but this can be difficult task requiring detailed data.

The issues of data quality and consistency have made the development of more complex metrics such as TFP even more challenging. While a number of techniques exist for estimating such measures (Tornqvist index, DEA), all require detailed and accurate data on the airport inputs and outputs. However, it is possible to provide a rough approximation of TFP using real unit cost, provided that the deflation of unit cost is based on input price inflation rather than consumer price inflation. The general equivalence of TFP and real unit cost is discussed in Annex.[35] While this approach is not without its challenges, it can provide a reasonable approximation where more complex approaches cannot be used.

In general, there is a dearth of aggregate data collected by government or industry associations by airport operations and finance. Generally, data on passenger, cargo and aircraft traffic does exist,[36] but more detailed information on airport operations and finances is sometimes not available in national statistics. This is not the case in other transportation sectors. The U.S. government collects very detailed data on the U.S. airline industry including traffic volumes, financial information, fuel consumption, employment, delays, lost luggage, passenger complaints, ticket price data.[37] Likewise, detailed information is available on the North American rail industry through government statistics and data collected by the Association of American Railroads and the Railway Association of Canada. Having this type and quality of

[34] This treatment of PFC revenue results in highly distorted balance sheet measures of airport capital for U.S. airports. While U.S. airports now report PFC revenues, they are not allowed to depreciate the portion of capital assets funded by grants and PFCs. An alternative is to construct a perpetual inventory measure of airport capital stock using airport investment (including contributions from PFC revenues). For a description, see Caves et al. (1982)

[35] Note that there is no equivalence of a VFP regression without capital stock as an argument and a variable cost function. The latter must have the level of capital stock as an argument, while VFP is devoid of any measure of capital. VFP regressions with a measure of capital stock can have an equivalence to a variable cost function, although with a highly restrictive specification.

[36] Even here there are gaps. For example, cargo data collected by the federal government in Canada is notoriously unreliable, and seriously understates cargo volumes.

[37] This data can be found at www.bts.gov (Bureau of Transportation Statistics).

data on the airport industry would be highly valuable in benchmarking national policy on airports as well as for other uses of benchmarking.[38]

11.3.2 Adjusting the Data to Provide Meaningful Comparisons

As already mentioned in Sect. 11.2, a difficulty using the results of benchmarking to improve performance or develop policy is understanding the true causes for observed differences in the performance metrics. Do the differences in the performance indicators reflect managerial performance (policy performance), are they the result of data inconsistencies or are they the result of external factors that management (or policy-makers) cannot affect?

For example, benchmarking landing fees may appear to be a straightforward exercise. However, airports around the world structure their fees and charges in quite different ways. Some airports charge the airlines using just a weight-based landing fee which covers all services at the airport; other airports have a plethora of additional charges including passenger terminal fees, gate utilisation fees, fees for use of the FID and announcement systems and other charges for specific airport services. In addition, many airports levy fees charged directly to the passengers, such as the AIF or PFC. A more meaningful comparison for an airport manager would be the total fees and charged levied on the carrier and its passengers for a flight by a typical A320, B767, A340, etc., with a load factor of X%.[39] Not only can airport management use this information to assess its airport's price competitiveness, but it can also be used to address misconceptions held by airlines and the public regarding the airport's pricing levels.[40]

Even with this adjustment there are many other issues that can affect the comparison of pricing levels. Some airports may have higher fees than others simply because they provide more services. While some airport's fees cover ground handling, fire and emergency service and cargo handling, other airports do not provide these services (these services are instead provided by third party vendors), and so have lower fees. This issue also affects benchmarking of other performance measures such as cost and productivity. However, if this measure (or any similar measure) is to be used to assess management performance, consideration needs to be given to factors outside of management control that may affect the comparison. There are a range of factors that can impact the comparison of airport performance:

[38] In our experience, there is also very limited data on the marine sector (ports, seaways, shipping).

[39] This type of approach is used by the TRL in its annual review of airport charges.

[40] For example, while one airport may appear to have exceptional high landing fees, when other charges are also considered, it may be in line with or lower cost than its competitor airports.

- **Degree of contracting out by the airport**. Where certain services are contracted out to third parties, who charge the airlines directly, this lowers the operating costs of the airport. Also, the extent to which the airport develops non-aeronautical activities can impact costs, productivity, revenues, etc. Airport operators have at least partial control over some of these factors. However, depending on the nature of the benchmarking exercise it may be useful to control for these factors (e.g. assessing aeronautical fees).
- **Weather**. Airports in cold climates require snow clearing and de-icing equipment increasing their cost base (unless, of course, these services are contracted out). Likewise, airports subject to inclement weather (hurricanes, high winds) may have higher costs or reduced output. Potentially, airports in hot areas could have reduced output levels as aircraft sometimes have to operate with lower take-off weights (hot air is less dense).
- **Government subsidy or assistance**. Airports operating within the public sector may benefit from government subsidy for operating or capital costs. Also, these may have access to lower cost financing as the loans or bonds are backed by the government. Public sector airports (or indeed some private airports) may receive certain services from the government at no cost or at a lower cost than those airports who provide the services themselves (or who contract them from the private sector). For example, fire and emergency services and security.
- **Traffic mix**. International passengers tend to require more infrastructure and space than domestic passengers (e.g. customs and immigration, higher baggage loads). They also tend to generate higher revenues to the airport, through higher fees and charges to the airline and higher retail spend rates. The proportion of connecting passengers, versus O/D passengers, can also have cost and revenue implications. The amount of cargo handled by the airport impacts its cost and revenue structure.
- **Capacity constraints**. The capacity of the airport may be constrained by factors outside of management control. For example, the airport may be subject to night curfews, noise quotas or slot constraints. Likewise, the airport's ability to manage airport capacity may also be limited by government regulation. Some airports may be able to apply peak period pricing while others are forced to apply undifferentiated fees, impacting on productivity and revenues.
- **Cost of Living**. Some airports face higher labour costs as they operate in higher labour cost countries. The cost of labour for Heathrow Airport is likely to be several multiples higher than that of New Delhi Airport.
- **Service Quality**. Productivity gains or cost reductions may be achieved by lowering the level of service at the airport. A comparison based purely on financial measures may miss this aspect of performance.
- **Economies of Scale**. Airport productivity can potentially be enhanced by economies of scale. Airports with higher traffic volumes have higher productivity

levels than smaller airports simply because it benefits from economies of scale. Arguably, this is a factor outside of management control.[41]

- **Congestion**. Unless service quality is controlled for, airports which are congested may appear to have very high productivity (e.g. movements per runway), when in fact they reduce the economic efficiency of commercial aviation.

One approach to account for some of these issues is to normalise the data, so that the benchmarking is based upon a uniform set of activities. This is the approach used by TRL in its annual *Airport Performance Indicators* report. The data is adjusted to reflect the costs, revenues and employment associated with a core set of activities. These activities include: provision of runways, taxiways and aprons; provision and operation of the terminals; provision of retail and food & beverage within the terminal. Examples of non-core activities include baggage handling, car parking, air traffic control, other non-aeronautical activities such as airport hotels and leasing of airport land. The data for each airport is adjusted to strip out costs, revenues, employment associated with non-core activities.[42]

This approach requires detailed data to carry out these adjustments as well as certain amount of judgement to determine costs and revenues in a hypothetical situation. Furthermore, the approach is not very effective in adjusting for factors such as traffic mix or economies of scale. To some extent, these factors can be adjusted for by benchmarking airports of a similar size and/or traffic mix. This, though, limits the pool of peer airports that can be compared, and may exclude airports of interest (e.g. best in class). Another approach used to address these issues is residual benchmarking, which is discussed in the next section.

It is worth noting that adjusting for these factors may not always be necessary or appropriate. For example, exploiting economies of scale may well be a policy objective. Differences in financing costs between public and privates are relevant to an analysis of the benefits of airport privatisation. The degree of outsourcing or non-aeronautical revenues development may well be relevant to an assessment of managerial performance.

[41] It can be argued that management can pursue strategies to increase traffic volumes so that the airport can benefit from economies of scale. However, there are also historic, political and geographic factors that can affect traffic volumes.

[42] For example, for airports that provide ground handling and parking services, the costs, revenues and employment associated with those activities are stripped out the airport data. The revenues of these airports are further adjusted to reflect the fact that if they did not provide these services, they would contract to a third party provider who would pay the airports concession of percentage of profits. Some adjustment are made for differences in corporate income taxes, but not all differences in accounting practices have been adjusted for, due to the complexity involved.

11.3.3 Use of Residual Benchmarking, with Reference to the ATRS Study

Residual benchmarking involves undertaking econometric or statistical analysis of performance indicators to determine the extent to which certain factors explain the differences between various airports. Generally, the raw or gross performance measure is regressed against a number of variables related to factors that may be of interest (e.g. traffic volumes for economies of scale, traffic mix, measures of service quality).[43] The approach has two benefits:

- It enables greater understanding of what factors may be responsible for changes in performance
- It allows performance measures to be adjusted for "external" factors not relevant to the study, which may distort the findings, leaving a residual measure

This approach is most commonly applied to TFP productivity measures. The annual benchmarking report by the Air Transport Research Society (ATRS) (2002, 2003, 2004) is an example of this approach. Since 2002, this annual study has reported cost efficiency and productivity measures for around 100 airports located in North America, Europe and the Asia Pacific. The first two reports included estimates of residual TFP (in the 2002 and 2003 reports) and residual VFP (in the 2003 and subsequent reports).[44] The logarithmic regression model used to estimate residual VFP in 2004 related the raw measure to factors such as:[45]

- Passenger traffic volumes (economies of scale)
- Percentage of international traffic (traffic mix)
- Percentage of revenue from non-aviation activities (impact of non-aeronautical activities on productivity)
- Percentage of air cargo in total traffic (impact of cargo activities)
- Capacity constraints (impact of capacity constraints on productivity)

However, there are many serious problems with the ATRS residual productivity regression analysis. First, many of the results from the residual TFP/VFP analysis conducted by the ATRS do not appear to be robust and bring in to question the validity of the findings. Reviewing the regression results shows major changes in magnitude and sign for the explanatory variables for managerial efficiency, as well

[43] An alternative to econometric regression analysis is to use variations of the data envelopment analysis (DEA) methodology, a linear programming methodology. Unlike econometric regression analysis, DEA assumes that the value of a data point is precise, and not subject to measurement or other error. It is more strongly influenced by extreme data points than regression analysis. For examples of DEA analysis of airport efficiency, see Adler and Liebert (2014) and Barros and Dieke (2007).

[44] The ATRS provide no explanation for decision to drop measurement of TFP in the 2004 report.

[45] Based on the "pooled" model using data from all airports. Separate models were estimated for North American, European and Asia Pacific airports with differing sets of explanatory variables.

as issues when pooling multiple years of data. In addition to this, the regression models change in the ATRS annual reports, making comparisons more difficult. For example, in each of the first three reports produced, the impact of airport size has varied dramatically as seen below. This lack of robust regression results, which fundamentally drives the ATRS measures of managerial efficiency, has continued over the following years.

ATRS estimate of impact of airport size on productivity

Year	Elasticity of productivity with respect to airport size	Meaning
2002	0.35	An airport of double the size will have 35% higher TFP
2003	0.15	An airport of double the size will have 15% higher TFP
	0.16	An airport of double the size will have 16% higher *VFP*
2004	–0.18[a]	An airport of double the size will have 18% ***lower*** *VFP*

Source: ATRS reports for 2002, 2003, 2004
[a]Result from the "pooled" model. The separate models estimated for North American, European and Asia Pacific airports produced airport size elasticities of –0.298, –0.647 and +0.06, respectively

According to the above ATRS results, the impact of economies of scale was reduced by half in a single year, and in 2004 it reversed sign—larger airports were now less efficient than smaller airports. Newark Airport, which was the fourth most productive North American airport in 2002 on ATRS' residual productivity measure became the second worst performing airport in 2004. The explanation given for the negative estimate in 2004 is that many of the airports (particularly in North America and Europe) are large airports that have exhausted their economies of scale. This is a curious explanation given that just a year previously this did not appear to be the case, even though the sample of airport was largely the same each year. A more likely explanation is that there are problems with the model specification or the data that require further examination. Other coefficient estimates also exhibit considerable (unexplained) variation. For example, the estimated coefficient on cargo traffic is positive in 2003 (airports with a higher proportion of cargo traffic are more productive), but negative in later report years, including 2017 (airports with a higher proportion of cargo traffic are less productive according to the ATRS study of that year).

Clearly these results are not robust, and it is troubling the ATRS reports do not appear to address this fundamental issue of statistical interpretation. This is compounded by the fact that the ATRS would not provide the raw TFP/VFP data even to those who purchase the reports, nor provide any details on the estimation of the raw TFP/VFP measures.[46]

[46]The raw TFP/VFP measures were estimated using a parametric method—the ATRS estimates a production function and infers the raw TFP/VFP score from the production function. Unfortunately,

Another serious problem with the ATRS residual analysis is that the VFP regressions are inconsistent with economic theory. As described in Sect. 11.2, since at least the time of Alfred Marshall's treatment of the theory of the firm, neoclassical economics ***requires*** that a variable cost function has the level of capital included. If a measure of capital is excluded from the variable cost function or its estimating equation, the specification is mis-specified—i.e., incorrect—and the results are biased and potentially meaningless.[47] The same applies to a VFP regression, which in some specifications (e.g. the Cobb Douglas) is dual to the variable cost function. A VFP regression which fails to include a measure of capital is mis-specified, inconsistent with neoclassical economics and likely biased. There is no interpretation possible for the regression coefficient on output in a variable cost (or VFP) estimating equation that does not have the level of capital stock as an independent variable. A justification offered by the former lead research of the ATRS group that produces the report is that a measure of capital is not available. Two comments should be made. First, the investment data available from airports would allow construction of a measure of airport capital using a perpetual inventory methodology, although it would require some work to gather the data and construct it. Second, the unavailability of data is not an excuse to estimate a relationship inconsistent with economic theory. The fact that a critical variable is unavailable never justifies analysis without it. ATRS press releases make statements regarding which airports are the most efficient. These statements, based on a methodology inconsistent with economic principles, are potentially misleading, and seriously degrade the policy dialogue on airports.

Additionally, other issues that have continued over the years in the ATRS benchmarking include data errors (e.g. erroneous average compensation estimates off by orders of magnitude—such data errors can profoundly affect least squares regression and data envelopment system results), unstable rankings (making comparison across years not possible), issues with comparability of landing fee benchmarks (based on issues with how airports charge landing fees and the impacts of commercial contracts) and a failure to include a measure of service quality in any results (which is an important aspect for airports, and will more than likely impact airport costs). Further, airport operators are aware of other variables which drive costs and for which ATRS is unwilling or unable to control. Any northern airport operator (or southern in the case of Chile) knows that snow removal costs can be enormously expensive and by not controlling for this, the purported measure of managerial efficiency is biased. In one case, Quebec City in Canada, snow removal accounts for 20% of annual costs due to the massive snowfall it experiences, more than double that of other Canadian cities such as Toronto and Montreal. ATRS

the ATRS does not report any of the parameters of its production function, only the resultant TFP/VFP estimates. In later years, ATRS would sell the data, as steep rates.

[47] Even in introductory economics textbooks, any diagram of variable cost or average variable cost is always indexed to a specific level of capital stock. There is no economic interpretation of an equation for variable cost that does not have the level of capital stock as an argument.

repeatedly claimed this airport to be the worst managerial efficiency performer, or among the worst, and highlighted the purported failure in comments to the press. This was not useful to assessing managerial performance of this airport and I would suggest it was destructive given the ensuing public dialogue in that community.

In general, residual benchmarking measures, while useful for some aspects of assessing the performance of managers of individual airports, have serious limitations which must be considered. Developing these measures requires well specified econometric and/or statistical analysis using reliable data and models consistent with economic theory. Such analysis can be easily biased by incorrectly specifying the factors that influence the benchmarking measure, by using one "functional form" rather than another, by using an incorrect statistical technique, or by using a distorted sample of firms/countries for the analysis, etc.

If the statistical analysis underlying the computation of residual benchmarking measures is not robust, then the residual performance measures can be quite different depending on the econometric model used, the sample selected, etc. This would appear to be the case with residual TFP/VFP measures estimated by the ATRS. As demonstrated above, the results of the ATRS residual benchmarking analysis are specious and should be treated with high caution or disregarded. It is strongly urged that the ATRS attempts to refine and improve the analysis before producing more residual VFP results, or discontinue this aspect of the study for the time being. As well, ATRS should make its data available for peer review.

11.4 Conclusions

This chapter has discussed the ways in which benchmarking has been used in the airport industry and in other parts of the economy. This included assessment of managerial performance, collaborative benchmarking, price regulation and informing and assessing national policy. The format of benchmarking differed in each case to match the requirements of the study.

The chapter also examined some of the key issue associated with benchmarking, primarily difficulties in providing meaningful comparisons and the approaches developed to improve the benchmarking comparisons such as residual benchmarking.

11.4.1 Is Benchmarking with Limitations Better than No Benchmarking?

While benchmarking has many issues and limitations associated with it, it is certainly not without value. Provided it is well designed and well executed it is a useful tool to identify deficiencies and excellence in performance. It can spur competitive forces and shake up conventional thinking (referred to as *paradigm blindness* by some benchmarking practitioners).

The answer to whether benchmarking with limitations is better than no benchmarking also depends on how the benchmarking is used. If benchmarking is being used to calculate the price cap applied to an airport, then the limitations of benchmarking can have major implications. Even minor errors in the benchmarking analysis that feeds into the price cap could result in a price cap costing the airport millions of dollars in unnecessarily forgone revenues (or conversely, allowing the airport operator to collect excessive revenues). On the other hand, if the benchmarking is being used to assess the impact of policy reforms then a broad, but imprecise measure may be sufficient, as it is not dependent on the outcome of a single airport. The benchmarking in this context would be able to identify the directionality and broad scale of impact, even if the level of precision is limited.

Benchmarking can serve as an effective decision-aid tool, but decision makers must be aware of the limitation of the analysis, and the analysis itself must demonstrate sufficient robustness.

Annex. The General Equivalence of Real Unit Cost and TFP

There is a general equivalence of TFP and inflation adjusted unit cost. TFP is the ratio of aggregate output to aggregate input:

$$\text{TFP} = \frac{\text{Aggregate output quantity index}}{\text{Aggregate input quantity index}}$$

Unit cost is the ratio of total cost to aggregate output:

$$\text{Nominal unit cost} = \frac{\text{Nominal total cost}}{\text{Aggregate output quantity index}}$$

Unit cost is the sum of the costs of individual factors of production (labour, capital, energy and materials). From the quantities of the individual factors of production, the aggregate input index is constructed. Dividing total cost by the aggregate output index produces an input price index (specifically, the “dual” input price index). Another way of expressing this is:

$$\text{Nominal total cost} = \text{Aggregate input quantity index} \times \text{Input price index}$$

Combining the last two equations yields:

$$\text{Nominal unit cost} = \frac{\text{Aggregate input quantity index}}{\text{Aggregate output quantity index}} \times \text{Input price index}$$

or:

$$\text{Nominal unit cost} = (1/\text{TFP}) \times \text{Input price index}$$

or:

$$
\begin{aligned}
\text{TFP} &= \text{Nominal unit cost/Input price index} \\
&= \text{Real unit cost}
\end{aligned}
$$

That is, a TFP index is equal to an inflation adjusted unit cost index.[48]

While there is conceptual equivalence of direct measures of TFP and real unit costs, there are some subtleties to the equivalency of the two. If these subtleties are not treated correctly, a computation that seems to be real unit cost may be a biased measure of TFP.

First, to get real unit cost, nominal unit cost is *not* divided by a consumer price index, but rather by an index of input prices. A few industries publish an input price index: for example, the U.S. rail industry publishes the Rail Cost Adjustment Factor which is an input price index. The U.S. airline industry (not the airport industry) publishes an index of increases in the prices of airline inputs. However, most industries and nations do not publish industry specific indices of input prices.

In the absence of an industry specific input price index, a producer's price index might be used as a proxy—at the very least it is superior to using a CPI. Another proxy would be an index of wages, as typically it moves closer to producer price indices than to consumer price indices.

Second, to use real unit cost as a TFP equivalency it must be measured based on total cost, specifically an economist's definition of total cost which includes the annual return on equity capital. Operating cost is not a sufficient measure of total cost for the equivalency.[49] Total accounting cost would be better than operating costs, although it should be augmented by a normal return on equity capital.

Third, in some sectors, data is so limited that neither total cost or operating cost data is available. This is especially the case when infrastructure services are provided by government departments, rather than by a corporation with its own accounting books. Highway and marine/air navigation services are often provided via government departments, with their costs imbedded in overall departmental budgets.

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[48] There is also an equivalence of TFP regressions and cost function regressions. This is proved in Freeman et al. (1987).

[49] Note that real unit operating cost, if it excludes any capital costs, is roughly equivalent to Variable Factor Productivity (VFP).

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Chapter 12
Practical Difficulties in Airport Benchmarking: The Case of Dublin Airport

Cathal Guiomard

Authorities should attempt at reducing the asymmetry of information . . . by benchmarking the firm's performance to that of similar firms operating in different markets (Tirole, Nobel Prize speech, 2015, p. 1666)

[T]here is little incentive for airports, whether state owned or private companies to release data which may lead them being exposed as bad performers (BAA 2001, p.6)

Abstract This chapter provides an overview of some of the practical issues facing a regulatory office seeking to use benchmarking to set a price cap at an airport. The focus is on operating costs, rather than commercial revenues under a single till, or capital costs. Top-down as well as bottom-up approaches are considered. To focus on the practical, the chapter describes and seeks to draw lessons from the specific experience of Dublin airport price-cap regulation which it suggests offers quite general lessons on benchmarking. Moreover, many different approaches to benchmarking have been investigated for Dublin over the years. For reasons of space, the chapter concentrates on the particular difficulties of introducing benchmarking for the first time before turning to a later set of investigations. It is concluded that benchmarking is possible, though not straightforward, provided that data can be assembled, that parties engage on the evidence, and that the economists working on the project have learned the lessons of regulatory gaming implied by the incentives facing parties to a price-cap review.

Keywords Airport · Airport charges · Airlines · Airport costs · Benchmarking · Regulatory capture · Consultation · Core opex · Dublin airport · Efficiency ·

While the content of this chapter expresses the author's views, it draws, as indicated below, on regulatory exercises carried out by former colleagues to whom the credit for that work is due.

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Bottom-up · Top-down · Operating expenditure (opex) · Outsourcing · Price regulation · Single till · Work load unit (WLU)

12.1 Introduction

In this chapter, I consider the benchmarking challenge from the perspective of a former airport regulator, using the history of some of that office's enquiries to suggest some practical lessons on airport benchmarking. [1]

The vantage point of the Irish airport regulator (the Commission for Aviation Regulation[2] or CAR) is a relevant one since, over its comparatively short life span since 2000, it has explored most of the numerous possible approaches to airport benchmarking and, arguably, encountered and sought to overcome many of the associated difficulties, theoretical and practical.

It may be wondered if price regulation at a single airport of moderate size, namely Dublin airport, could offer general lessons about regulatory benchmarking? There are reasons to think so. Price-cap regulation, launched nearly 40 years ago in the UK, has matured into a rather settled methodology applied in numerous sectors and jurisdictions [3] including, to different degrees, at many airports. [4] In principle, a set of similar methodologies is used by the relevant regulators, and lessons learned at one would often be applicable at the others (and in fact outside aviation). Finally, the Dublin case offers an insight into the early days of price regulation, when some of the challenges of benchmarking are arguably seen more clearly before routines have become settled.

Benchmarking by the CAR has been pursued in a number of different ways, all with the aim of taking Jean Tirole's advice to produce performance estimates that would be as independent of the regulated firm as possible.

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[1] Aside from practical considerations, there is, of course, a large and growing technical academic literature on airport price regulation; a recent discussion would be Czerny (2019). While it is highly desirable that regulators be familiar with the lessons of this literature, it is argued in Sect. 12.3 of this chapter that it is also desirable that there be an adequate fit between the theory and the practically possible (see also Czerny et al. 2016). In the view of the author, academics sometimes criticise regulators for a failure to benchmark without sufficient regard to the considerable practical challenges of good benchmarking.

[2] In 2022, the CAR is due to be merged with an aviation safety regulatory office to produce a single Aviation Regulator for Ireland.

[3] Examples include: Gassner and Pushak (2014) on the spread of price caps to the developing world; Hellwig et al. (2018) on price caps in the German electricity sector; Seo and Shin (2011) on price caps in the US telecoms sector.

[4] In the airport sector, see, for example, recent opex assessments using benchmarking methods include CEPA (2021) for the CAA analysing Heathrow airport opex, CEPA (2019) for the CAR analysing Dublin airport opex, and ADP (2019) for Aeroports de Paris. In the EU, there exists a forum for airport price regulators (the Thessaloniki Forum) which issues discussion papers from time to time, including material on airport benchmarking (Thessaloniki 2019).

The CAR has at different times used:

- Simple efficiency measures applied to operating costs of airports
- Statistical regression methods to project future commercial revenues
- Bottom-up professional judgements of operating costs and commercial revenues
- Consultants' assessments of the future costs of new facilities not yet opened
- Quantity surveyors' and consultants' benchmarking of capital costs
- Component analysis of the expected future evolution of the efficiency frontier
- Benchmarking airport costs with reference to cost trends in the national economy.[5]

For reasons of space, this chapter discusses benchmarking as it applies to airport operating costs. But the issues are not so very different for other types of expenditures. Also for reasons of space, I will concentrate on the challenges and lessons from two benchmarking exercises, at the start of the regulatory regime (2001) and a later set of benchmarking investigations (2014). (References to price reviews of recent years but before the disruption of Covid-19 are also provided.)

The structure of the remainder of this chapter is as follows. Section 12.2 discussed the place of benchmarking in setting regulated airport charges. A description of some of the ways the task of the price regulator differs in practice from the description found in textbook accounts follows in Sect. 12.3. The following section considers briefly the advantages and disadvantages of different types of benchmarking along with their different data requirements. Section 12.5 describes the considerable practical challenges faced by the CAR in its first benchmarking investigation. This is followed by a section that discusses the merits of attempting to identify 'core' operating costs of an airport. Section 12.7 then to a more recent set of benchmarking exercises at Dublin airport, providing an overview of a bottom-up and top-down exercise, and how these contributed to the operating cost allowance eventually set for Dublin Airport. Extensive engagement on benchmarking requires a substantial exchange of documentation; Sect. 12.8 provides some evidence on this point from the regulatory reviews at Dublin airport. Section 12.9 concludes.

[5] The resulting reports may be found on www.aviationreg.ie, organised under the year of the regulatory decision, e.g. 2001, 2005, 2009, and 2014.

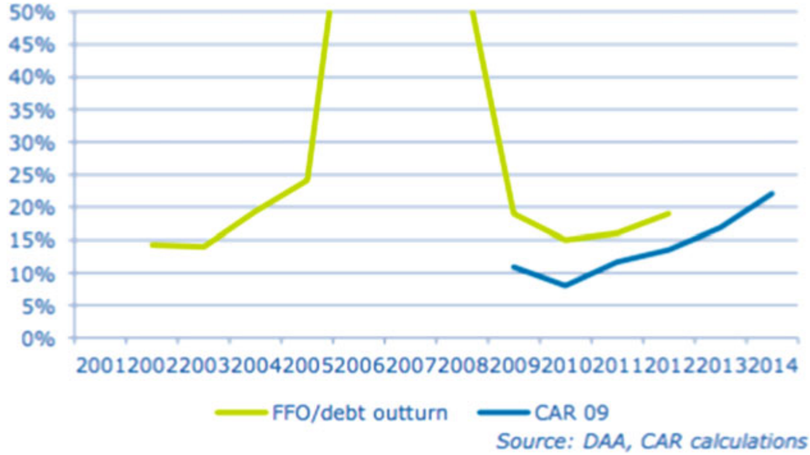

Chart 12.1 Company submissions and audited data of Dublin airport's financial performance. *Source*: Issues Paper, CP1/2014. The temporary spike in the chart (only partly shown) reflects the impact of the sale of a large associated business

12.2 The Practical Challenge of Benchmarking

Charges for airport services may be subject to a regulatory price cap. [6] To set such a cap, regulators must calculate an allowance to cover an airport's future costs, often for a period of about 5 years. Under a single-till [7] regulatory regime, an airport's non-aeronautical revenues must also be forecasted for a similar period. What information should be used to make such forecasts? A regulated airport will, of course, offer its own forecasts, but use of these *simpliciter* would make the price cap non-binding and reduce overall welfare from an already sub-optimal level by the amount of the costs of price regulation. [8]

Audited accounts may be of some assistance but these are available only with a lag, so a price review that needs to make projections for up to year $t + 5$ will often have available audited data only for year $t - 1$ and earlier. Moreover, there is a well-known temptation for regulated firms to manage spending over a regulatory period to generate a peak in year $t - 1$ in order to set a high cost base (or high debt, or low profits, etc.) to catch out a new, inattentive, or indifferent regulator.

As for unaudited data, the dangers are seen in Chart 12.1, taken from CAR's Issues Paper of 2013. This shows estimates of a standard accounting metric used to

[6] One assessment amongst many of the overall economic impact of price-cap regulation (also called 'incentive regulation') may be found in Adler et al. (2015).

[7] The scope of regulation, depending on the use of the single- or the dual-definition of the regulatory till, is discussed in Czerny et al. (2016).

[8] Even when economically redundant, price regulation might serve political purposes, for instance, by giving the appearance of consumer protection and shielding politicians from direct responsibility for price increases.

assess a company's financial strength (the ratio of funds from operations to debt). A ratio greater than 15% is normally associated with an investment-grade credit rating. In the chart, the lower blue line is the ratio reported by the company to the regulator—projected, prior to the setting of a price cap in 2009, to fall to under 10%. The upper green line is the number that appeared in the later audited accounts that showed the company's financial position on this metric to have been nearly twice as strong as claimed! Caveat regulator.

Even if the numbers available for year $t - 1$ were, for some reason, expected to reveal the costs of an efficient airport operator, these base-period numbers would still need to be carried forward to year t and then on to the end of the regulatory period. An assessment of the methodology of a price cap therefore needs to pay attention both to the way in which the starting allowance (for year $t + 1$) is chosen as well as the way the baseline values are projected into later years. [9]

Against this background, the benchmarking literature asks the question: are there *independent* sources of data available that might be used by regulators to set future cost allowances?

Setting a price cap on the basis of data exogenous to the firm, such as external benchmarks, is the core element of 'incentive' regulation. Its attractions are well-known and striking: firms have high-powered incentives to pursue efficiencies. But the stakes are also high, for regulators and ultimately for the industry also. The former London airports regulator, Doug Andrew, put it thus:

> [t]he [benchmarking] trade-off is stark ... with incentive regulation, it is possible for the allowed revenue to be out of line with true costs, leading to business failure that might or might not be desirable. (Andrew 2003, p.47)

On the other hand, if the benchmark leads to revenues that are set too high, profits or costs or both will be excessive, lowering welfare along with regulatory reputations.

[9]For this reason, an evaluation of a price regulatory regime is best done with reference to the underlying regulatory calculations. The spreadsheets, in some cases slightly redacted, used by the Irish airport regulator to set price caps at Dublin airport are available for a number of regulatory exercises on the office's website. Perusal of these spreadsheets gives some insight into the nature of the calculations involved. These are generally not complicated for operating costs but can be more so for investment costs.

https://www.aviationreg.ie/regulation-of-airport-charges-dublin-airport/2014-determination.576.html

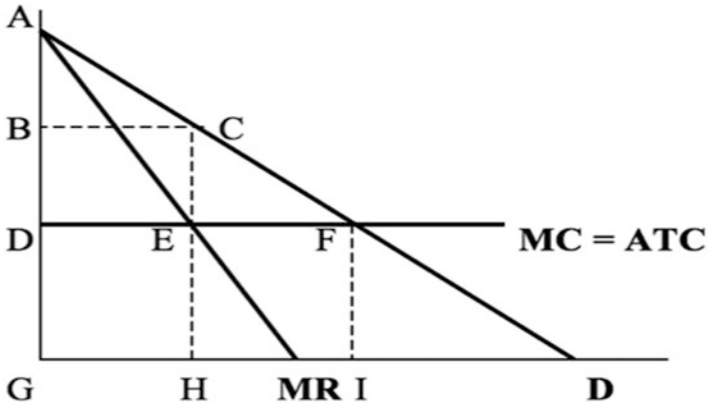

Fig. 12.1 Textbook presentation of competition and monopoly

12.3 Price Regulation: Textbook and Practice

In his 2014 Nobel prize lecture, Jean Tirole noted the shortcomings of some earlier types of price regulation: '... old-style public utility regulation . . . by and large insured public utilities against poor cost performance, led to inflated cost and poor customer satisfaction'. [10] While cost-plus style regulation can produce no other result, escaping the trap of regulatory capture is a considerable challenge for both theoretical and practical reasons.

The difficulty is not, however, apparent from many microeconomics textbooks, even today, which present the price regulatory problem in terms of a figure like Fig. 12.1.

Figure 12.1 leaves the impression that a regulator simply has to impose the competitive price in order to move the market, by diktat, from the monopoly solution (at C) to the competitive equilibrium (at F).

It is therefore worth repeating the figure, modified to show how the market would be observed by a regulator.

Figure 12.2 shows that a price regulator typically observes (for a single-product firm) only the prevailing monopoly price and the quantity being supplied (at point A). The location and slope of the demand and cost curves are not known, nor are elasticities. Setting the correct price is therefore a challenge of a quite different kind to the one envisaged in an undergraduate textbook. [11]

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[10] Tirole (2015, p. 1666).

[11] The academic literature is more realistic: "In order to implement efficient pricing rules, the regulator must know (a) the demand curves for each of the firm's products; (b) total costs and how they vary with output; and (c) how new investments will raise or lower costs. In practice, regulators seldom have any precise notion of these factors because the data and modelling requirements for solving the idealised monopoly regulation problem are quite formidable" (Sibley, 2000).

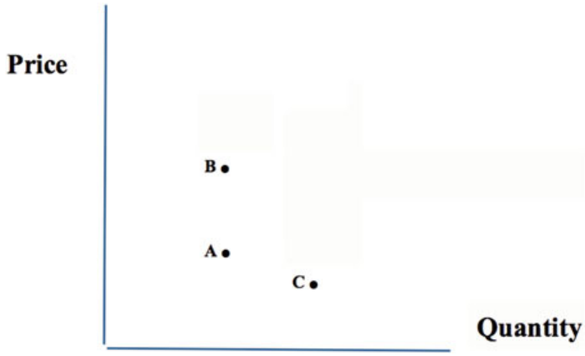

Fig. 12.2 Price-quantity pairs under monopoly (A) and as sought by producer (B) and users (C)

Actually, it might not strictly be true that the regulator only observes a single price-quantity pair, because the regulated firm will generally offer the regulator a tale likely to include reference to 'years of underinvestment', 'chronic underfunding', an imminent 'capacity crunch', and perhaps an alarming picture of the supposed frailty of the regulated firm's finances, all of which can be solved only by a large immediate price increase to point B (ideally with a schedule of others to follow). If users of the services of the regulated firm are large and organised, this story will be matched by an irate critique of the regulated firm's long history of 'gold-plating', 'waste', and 'inefficiency' which accounts for its excessive pricing and inefficiently low output that require an immediate reduction in price accompanied by a considerable expansion of services (such as at point C)

And both sides of industry will be able to offer a benchmarking report in support of their claims! [12]

A new regulatory office at the commencement of its responsibilities is therefore likely to be presented with two, or possibly three, price-quantity pairs; this is a lot less information that the textbook would have led one to suppose.

'Regulatory capture', in other words a non-binding price cap, is the default setting of price regulation in the absence of robust independent data; though, as the quote from Andrew (2003) shows, in a world of uncertainty, there is a considerable risk for a regulator to accepting benchmarking information over the regulated firm's reported costs.

Engaging with the industry only goes a small way to seeking to solve this information asymmetry. Rather cheekily, the UK airports operator, the BAA, responded in 2001 to the UK regulator's (CAA) concerns about information asymmetries with the breezy statement that, once the regulator had identified the areas where information asymmetry were believed to arise '[t]he problem can then be addressed by an exchange of information' (BAA 2001, p.2). But given the incentives facing firms in price-regulated industries, there is both a shortage of good information and a surplus of bad (or at least biased) information. The latter is

[12] Regulators are used to finding, on inspection, that the only airport common to the two benchmarking datasets is the airport being regulated.

illustrated by the frank quote also from the BAA at the head of this chapter, about the incentive for airports not to release data which might expose bad performers. This is certainly true for poor cost performance, but also as regards the state of a company's balance sheet, since a firm will not want to admit to a strong financial or profitability position either.

This, then, is the kind of benchmarking challenge that will be faced by a price regulatory office and especially so at the start of a price regulatory regime.

12.4 Types of Airport Regulatory Benchmarking Applied at Dublin Airport [13]

In setting a price cap, regulators must decide how much money to allow for operating costs. A comprehensive approach to that decision would fall into two parts:

- How efficient is the regulated entity, i.e. what is the scope for *catch-up* with the frontier and over what time horizon?
- How are the efficient costs of running the airport industry (to provide a given level of service) likely to evolve during the subsequent regulatory period? In other words, what industry *frontier shift* should be assumed?

Benchmarking seeks to answer the first of these questions; an appropriate evolution of the initial costs over the regulatory period also needs to be decided.

Benchmarking approaches to assessing airport efficiency include 'top-down' modelling as well as 'bottom-up' process or activity benchmarking. Over its history, the CAR has used both approaches. A mix of the two approaches allows a cross-check on the other's findings.

Top-down approaches usually rely on statistical or econometric evidence, often with reference to company accounting data. Benchmarking of this kind would include simple accounting ratios, stochastic frontier and data envelopment analysis, total factor productivity (TFP) or partial productivity studies, and nature-of-work studies. The CAR used simple top-down accounting ratios in 2001. A criticism of top-down measures would be that they ignore factors peculiar to the cost base of the regulated entity; for instance, they do not take sufficient account of specific kinds of airport heterogeneity.

In many subsequent pricing decisions (2005, 2009, 2014), the regulator mainly relied on a bottom-up assessment carried out by specialist consultancy firms. Bottom-up approaches focus on individual activities and processes of the regulated

[13] In 2013, the CAR Issues Paper discussed possible methodologies for calculating each part of the price cap (CP2/2013). In this section of the chapter, I have drawn upon this paper where it discusses airport benchmarking methodology. The most recent benchmarking report for the CAR is CEPA (2019).

firm. The findings of such exercises will depend in part on judgments by experts familiar with the activity being reviewed. Such exercises can make reference to data on similar activities performed by other companies, or modelling may attempt to develop an idealised cost-structure for the activity under review. Bottom-up studies are vulnerable to the criticism that the sum of the parts from such an exercise may bear a weak relationship to what is achievable in practice. Bottom-up studies vary in the choice of airports included in their sample and the data sources used (some rely on published accounts, others are able to collect survey information from the airports).

An alternative approach to comparing regulated opex with that at other airports is to consider how the performance compares with the rest of the economy. The choice of, and even the availability of, suitable data to permit a comparison can be a challenge.

12.5 Challenges Getting Benchmarking Started (Dublin, 2001)

In this section of the chapter, a number of the benchmarking challenges are illustrated by reference to the first regulatory benchmarking of Dublin airport in 2001. The account also illustrates the often difficult to-ing-and fro-ing between the regulator, the airport operator, and possibly the larger airport users, as interested parties manoeuvre for advantage.

A benchmarking exercise, especially one that gathers information directly from a set of airports, takes some time. In 2001, just before the legislation establishing airport regulation was put before the Irish Parliament, the regulator's office was notified by the Department of Transport that the time to conduct the first price review (1 year, according to the draft legislation) was to be cut in half. The Department of Transport was the owner of Dublin, Shannon, and Cork airports, the airports that (up until 2004) were price regulated by the CAR.

The resulting deadline was exceptionally tight—six calendar months—in which to establish a price-cap regime from scratch (i.e. consider and consult on the type of regime to apply, gather and analyse all necessary data, issue a draft decision for consultation, consider responses and publish a final decision). Timescales insufficient for a full benchmarking exercise will affect the scope of the work that can be conducted, and facilitate challenges to unwelcome findings.

The airport operator responded to the regulator's information requests by providing documents in boxes sealed with a statement that, if opened, the contents were to be used only with the written permission of the regulated firm. On the arrival of these badged boxes at the regulator's city centre offices, they were placed in a vehicle and brought right back to the airport operator's offices and deposited there

Table 12.1 Cost benchmarking indicators for Dublin airport (1999 data)

Cost indicators	Dublin airport (€)	Comparator average (€)	Gap with 'best in class' average
Operating Costs[a] per Work Load Unit	10.4	10.3	29–35%
Operating Costs per Employee	106,000	110,000	30%
Labour Costs per Employee	41,869	45,742	n.a.

Source: IMG Benchmarking Report, Appendix VII, CAR (CP8/2001)
[a]Excluding depreciation

(to the surprise of the security man on evening duty). Then, less than one calendar month after it had been established, the regulator commenced court action to enforce its powers to obtain relevant airport data. On the steps of the Irish High Court, the regulated firm agreed to provide data as requested, but some weeks had been lost.

Meanwhile, consultants acting for the regulator had been engaging with airports, mostly in Europe,[14] seeking to collect published airport accounts, in order to undertake the benchmarking exercise.

42 airports were asked to supply information; 25 responded. The larger airports in the Dublin airport peer group had a much higher response rate (72%) than the smaller airports in the Cork and Shannon airports' peer group (38%). Information on 45 operational and cost indicators were sought but data were available only for 30 (and not for all airports), and these were later narrowed down to 11. In the end, data were obtained from 12 airports (9 in Europe) with passenger numbers in the 5–20 mppa range (Dublin airport in 1999 had 13 m. passengers). In addition, data were reported for five large metropolitan EU airports which were treated as a 'leading European airports' peer group.

Mindful that airports provide cargo transport as well as passenger services, results were reported per workload unit, where WLU is defined as one passenger or 100 kg of cargo.

Table 12.1 reports the cost measures for which benchmarking data were obtained, the values for Dublin airport and for an average of comparators, as well as the gap between the Dublin value and an average of the best performing comparators. In the regulatory reports, data were also published for service (e.g. WLU per employee) and revenue performance.

The data presented a mixed picture of Dublin airport's performance. Productivity (WLU per employee) was about average. Cost efficiency, measured as operating costs excluding depreciation per WLU, was comparable to the 9-airport group *average*. However, that average was influenced by four airports whose costs were well above the average (Dusseldorf, Manchester, and especially Munich and Vienna) and by four others below or well below the average (Brussels, Copenhagen,

[14]Data was collected from some US airports and reported in the published tables but not used in the benchmarking exercise due to differences in the operating environment of US airports.

Table 12.2 2001–2006 efficiency targets based, inter alia, on the benchmarking exercise

Year		5-year efficiency target	Metric
2001 price review (1999 data)	Dublin	18.75%	Opex per WLU
	Cork	None	Opex per WLU
	Shannon	21.5%	Opex per WLU

Glasgow, and Stansted). Dublin airport's costs were 29% higher than the latter 4-airport average. This statistic was a main focus of engagement between the regulator, the airport operator, and the airlines thereafter. [15]

When the time came to decide how to use the benchmarking results to set airport charges for the first regulatory period (late 2001 to late 2006), only *half* the measured difference in unit costs was used as the efficiency target, to be delivered only in equal stages over the 5 years. This left a large difference—about which the airlines naturally complained greatly—between the efficiency target and the headline benchmark report finding, to allow for any mis-measurement and imperfect comparability between the airports included.

In deciding to set this efficiency target, the regulator's office would have been mindful of a number of additional factors. First, Dublin airport had been a monopoly provider of airport services in Dublin for more than half a century. Second, it was government owned. Both of these features would generally be consistent with costs likely to be above the efficient level. Third, most non-UK airports in the comparator group were also government owned and many were dominant or near-monopolies in their own markets. Even to perform well against such a group would not necessarily be a strong performance. Finally, the operating allowance for Dublin airport for 2001–2006 (before applying the efficiency factor) was computed as the per-passenger opex of the airport in 2001 multiplied by the growth rate of the passenger traffic forecast. This implied, in the absence of local airport elasticity estimates, an elasticity of one: cost allowance would grow one-for-one with the traffic forecast. This was generous. All in all, it would be difficult to characterise the opex allowance as unreasonable or unfair.[16]

As reported in Table 12.2, in its decision of September 2001, the CAR set a price cap calculated on the basis that Dublin airport would be able to reduce operating costs by 3.5% per annum for 5 years and that Shannon airport would be able to do so

[15] At the smaller regulated Irish airports, not included in Table 12.1, productivity at Cork was about equal to the comparator average, but Shannon's productivity was less than half of the group average. Cost efficiency at Cork was better than the comparator average but costs in Shannon were very high: non-depreciation opex per WLU was more than twice Cork's and one and a half times the group's average.

[16] The minutiae of the price cap calculation are mentioned here mainly to illustrate the need to scrutinise the detail of the regulatory calculations in order to judge how testing or otherwise an efficiency target is. The headline figure, or a summary of the methodology, may not do justice to the extent to which the operating cost allowance is challenging for the regulated firm.

at a rate of 4% per annum for 5 years. No efficiency improvement was sought from Cork airport. [17]

Locally, controversy surrounded the CAR's 2001 approach to benchmarking. The airport denied that it was inefficient, disputed the validity of the benchmarking exercise, and made the benchmarks part of its attempt to overturn the regulatory decision in the Irish High Court. In Court, the judge rejected the airport's challenge. He noted the compressed timetable and resources available to the regulator's office to conduct the benchmarking exercise, as compared to the substantial time and finance available to the regulated firm when mounting a subsequent court challenge. The court action commenced in late 2001 and proceeded in stages until June 2003.

The Court reaffirmed the prevailing Irish High Court standard that the judicial review process was to permit the setting aside of decisions that were unreasonable in the sense of 'irrational' or absurd or arbitrary. Legal challenges taken by litigants after months of painstaking investigation of a regulator's files and spreadsheets were not, the Court said, matters for judicial review but ought to be referred, if appropriate, to the appeal process provided for by law.

Some elements of the 2001 benchmarking exercise were updated by the CAR in 2012 (as an illustration for interested parties of how the method could be applied). The results are reported in Chart 12.2 and are included here for information.

Soon after the conclusion of the Court case, the operator of Dublin airport launched a staff redundancy programme equivalent to some 10% of staff levels in 2001.

12.6 Is 'Core' Airport Opex a Better Basis for Benchmarking?

The operator of Dublin airport rejected out of hand the 2001 benchmarking findings, proffering four main criticisms of the exercise. [18] The company disputed

- The output measure used
- The treatment of depreciation
- The definition of the cost base, and
- The selection of comparator airports

[17] For the smaller two regulated Irish airports, Cork and Shannon, a price cap which was set to allow the airports sufficient revenues to cover their costs and to earn their cost of capital proved to be far above what these airports could charge in the market. The 2001 decision was set as a price cap at the airport group (Aer Rianta) level but with a sub-cap on the charges at Dublin airport, to prevent Dublin airport charges financing cross-subsidies to Cork and Shannon airports. Since the economic price cap at the smaller airports was above what could be collected from airlines, the Irish Department of Transport in 2004 took the logical step of abolishing price cap regulation at these airports.

[18] See Footnote 14 in Chap. 2.

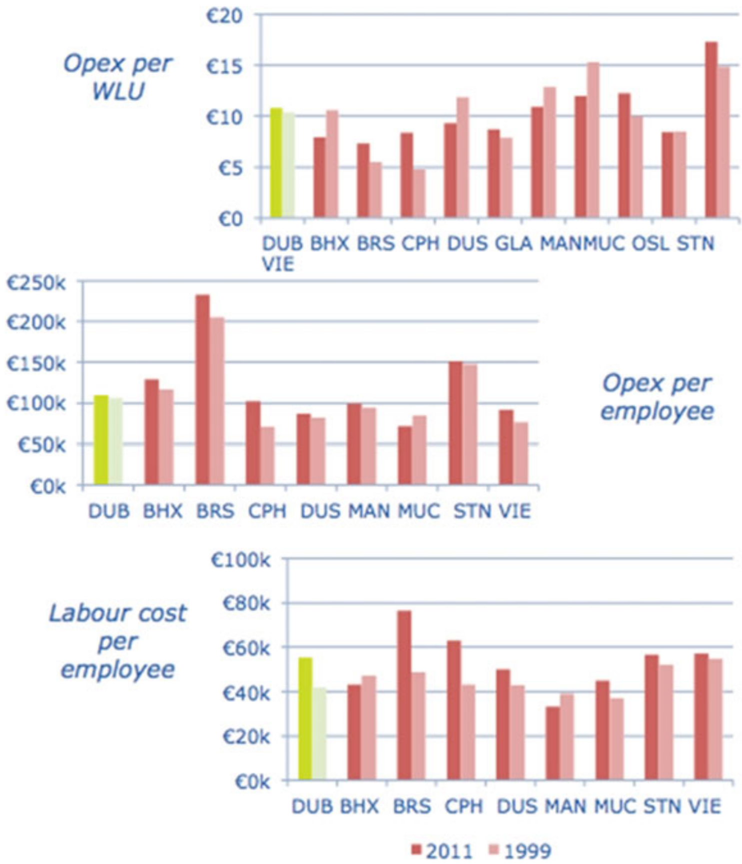

Chart 12.2 Cost benchmarks used in 2001 Dublin airport determination, updated to 2012 (in nominal prices). *Source*: Issues Paper, CP2/2013, Chart 3.8, p.33.

The company accepted that simple benchmarking offered a general impression of how a firm's performance compares with similar firms elsewhere but considered benchmarking not likely to be very informative, certainly not suitable to set regulatory price caps and at risk of being 'a mere random exercise'. [19] (Somewhat at variance with this position of principle, the airport operator accepted the favourable finding of Cork airport's efficiency and concluded that, at the group level, 'the efficiency of [the airport operator's] operations is borne out by various inter-airport comparisons' which found 'no evidence of inefficiency'.)

In particular, the airport operator argued that Dublin's opex related to the provision of both aeronautical and non-aeronautical (e.g. retailing) services, mostly provided in-house whereas, it claimed, some of the comparator airports outsourced

[19] Aer Rianta (2001, p. 63 and p. 74).

Table 12.3 List of adjustments sought by the BAA for airport international benchmarking

Different activities	ATC; Handling activities; International work; Crash and rescue; Security
Costs add-ons/'free rides'	Rates; police costs; airport licences; corporation tax; pension/social security costs
Different standards	Security—passenger/cabin baggage search; access control; hold baggage screening; fire; other airfield
Accounting differences	Asset valuation (replacement methodologies, asset ownership)
	Depreciation (lives, write-off policies); Inter-company charges
Financing costs	Ownership structure; debt/equity; local interest rates, tax breaks on debt
Other differences	Local utility costs, local property costs, local staff costs, exchange rates
In house/ outsourcing	Cleaning; engineering; security; catering; retail

Source: BAA submission to UK CAA on benchmarking, 2001, p. 7

the provision of many non-aeronautical services and therefore their cost base did not include part of the associated opex. Thus, the regulator's opex comparisons were not conducted on a like-for-like basis. The company presented alternative benchmarking data, prepared by its consultants, showing Dublin's *adjusted* per-WLU opex at around half of that calculated by the regulator's consultants and some 20% below the costs of the five-best performing airports in the regulator's sample. This benchmarking exercise was based on disaggregated airport cost data for the airports in question, which was not publicly available or verifiable.

In London, around the same time, the BAA commented on benchmarking that 'one can never know if an observed difference . . . is due to a real difference in efficiencies or simply measurement error . . .' (p.11). The BAA argued that benchmarking would not even allow the identification of which areas of a business needed further investigation—an extremely pessimistic conclusion if it were to be accepted.

The general issue is whether some adjusted or 'core' measure of airport costs is the proper focus for a regulatory benchmarking exercise and, if so, what would constitute such a core? The range of possible adjustments to get to 'core' opex is extremely large. From an airport perspective, the BAA, in a 2001 submission to the UK CAA, included a 'non-exhaustive' list under eight headings of 31 adjustments to the cost data to make inter-airport comparisons like-for-like.[20]

The adjustments in question, listed in Table 12.3 are rather remarkable. It is not clear what the 'adjusted' numbers would measure. They could hardly measure managerial performance since much of the deviation from the costs of different airports (whether due to laxity or efficiency) would have been adjusted away. Nor would the adjusted numbers measure airports costs as charged to users.

Kincaid and Tretheway (2009) comment that adjusting costs to isolate a 'core' measure of aeronautical costs 'may not be always necessary or appropriate. For example, exploiting economies of scale may well be a policy objective. Differences

[20] BAA (2001, p. 7).

in financing costs between public and private are relevant to an analysis of airport privatisation. The degree of outsourcing or non-aeronautical revenues development may well be relevant to an assessment of managerial performance' (p.16).

TRL, one of the publishers of airport benchmarking reports, periodically calculates measures of 'core' airport activities based on a smaller number of adjustments than those sought by the BAA.

What about airline views of the measurement of opex? Stakeholder engagement in order to be persuasive requires that airport users engage with the regulator on the basis of argument and evidence regarding the proper airport opex allowance. This has not always been easy to achieve although over time the *quality* of airline engagement with the regulator's office has improved in Dublin. However, for a considerable time prior to that, the representations of some airlines took a very simple form. The regulator's office would receive a short letter from the airline setting out the percentages of the airport's costs that should be disallowed for the purpose of the price-cap calculation. Sometimes, little or even no supporting evidence might be offered, other than passing references to miscellaneous, incomplete, and often unverifiable data. When challenged, these parties might respond with a barrage of accusations of regulatory capture. Some of this approach might have been due to the asymmetry between airline users—one airline amongst many and dealing with many other airports—and an airport for which the price-cap stakes at that airport were very much higher. Slowly, airlines using Dublin airport have moved in the direction of more substantive and evidence-based submissions.

Because of the unavailability of disaggregated data, the obscurity of how to interpret 'core' measures, but most of all because actual opex is what finds its way into airport charges, regulatory benchmarking of airports should be done on the basis of actual operating expenditures.

12.7 A Later Benchmarking Investigation (2014) of Dublin Airport Opex to Apply Over the Period 2015–2019

This section of the chapter turns from the introduction of regulation at Dublin to a discussion of a substantially more sophisticated benchmarking review, conducted some 15 years afterwards. That review remains representative of the methodology used afterwards, at least until the disruption caused by the pandemic.

In 2013/2014, the exercise involved an extensive bottom-up benchmarking project, three smaller top-down exercises, and engagement with the industry at a number of points regarding the proposed and final opex allowance for the 5 years 2014–2019.

12.7.1 The CAR's Process for Airport Benchmarking

To form a view about future opex allowances for Dublin airport, the regulator followed these stages:

- Set a baseline level of operating costs
- Use elasticity estimates in order to relate future opex to forecast traffic
- If necessary, make adjustments to the resulting numbers to take account of known specific factors with implications for costs (e.g. the opening of a new terminal would likely involve some initial loss of efficiency)
- Set annual targets for improvements in per-passenger opex allowances

12.7.2 Step 1: Bottom-Up Opex Benchmarking

The CAR commissioned consultants to undertake a bottom-up benchmarking exercise.[21]

The consultants offered a projection of airport opex (at prevailing service quality) under three scenarios: base, low, and high. The base option assumed no efficiency savings. The distinction between the low and high scenarios depended on whether the potential savings could be made without significant hurdles needing to be overcome.

In the base scenario, the implicit elasticity of aggregate opex to passenger numbers was 0.1%. Separate elasticity assumptions about different cost categories were made, ranging from 0% for cleaning costs to 0.3% for security staff costs to 0.5% for retail staff costs. Many of these elasticities were lower than those used in previous regulatory decisions at Dublin airport, reflecting updated judgements and circumstances. The opex allowances also disaggregated wage rate projections.

Elasticity estimates relating disaggregated airport costs to airport traffic are themselves not very plentiful. The UK CAA or its consultants have produced some and the academic literature contains some, but most elasticity estimates for aviation relate to the price sensitivity of general consumer demand. Historic cost/traffic relationships at a given airport may be calculated ignoring other relevant influences. But in the exercise being described some elasticity relationship is needed.

During the recession in Ireland after 2008, the operator of Dublin airport had found economies by reducing staff levels and negotiating new pay scales (especially for new hires to work in a new second terminal, T2, opened in 2010). In part, this explained an undershoot of outturn costs versus the opex allowances previously set by the regulator in 2009.

Comparing old and new employment contracts in terms of pay and productivity, the consultancy report identified very significant cost savings in the new contracts. It

[21] The report by Steer Davies Gleave is available on the CAR website www.aviationreg.ie.

Table 12.4 Dublin airport opex for 2019: base, low, and high scenarios, under draft and final decision of the regulator

m€ (2012)	Base	Low ambition	High ambition	Regulator's proposal	Final regulatory allowance
Total	204 €	196 €	184 €	190 €	202 €

Source: Draft Determination of Charges at Dublin airport, CP1/2014

found staff levels to be high in certain airport operations. It also identified that market wage rates were 40% below the airport wage rates paid to staff on older employment contracts.

In addition to the above, the bottom-up benchmarking exercise identified a range of further areas where there was scope for economies including:

- Security staff rosters in the old terminal much were less efficient than the new rosters in the new terminal which allowed the airport to match security staff to traffic flows more flexibly
- IT costs were high relative to benchmarks
- Central staff costs (finance, HR, management) were very high compared to an airport such as Gatwick, with very significant reductions in numbers achievable
- High marketing costs

Although a matter for the DAA, the consultants considered outsourcing to be the best route to achieve savings, but in practice likely to prove difficult to pursue because of the EU's Transfer of Undertakings (Protection of Employment) rules known as the TUPE Regulations.

The opex needed for 2019 under the base, low ambition, and high ambition scenarios is set out in Table 12.4.

The regulator's view was that operating costs at Dublin airport would be relatively unresponsive to passenger numbers (at least in the aggregate) so that opex was projected to be flat over the 5 years to 2019, implying a fall in opex per passenger, restoring some of the lost efficiency over the period of falling traffic after the 2008 financial crash.

After evaluating the benchmarking report, the regulator proposed setting an opex allowance at the midpoint of the low and high ambition options, some 8% below the base case costs, implying target annual savings of under 2% per annum if the benchmarking consultants' assumptions about elasticities and wages were achievable.

12.7.3 Step 2: Top-Down Opex Benchmarking

Following the 'over achievement' of savings targets by the operator of Dublin airport after 2009, some airlines at Dublin airport concluded that bottom-up assessments were flawed and proposed a return to top-down methods. The CAR undertook three separate top-down benchmarking exercises of different scope, designed to shed light on the efficiency of Dublin airport opex and to check for consistency of the bottom-up findings. The three reference groups were:

- A large sample of EU airports
- The two main airlines using Dublin airport, and
- A set of Irish government-owned companies

Airport Reference Sample

Given airport heterogeneity, the CAR included every European airport listed on Ryanair's and Aer Lingus' route maps as destinations from Dublin airport. The data came from publicly available annual accounts or regulatory reports. Information was collected for 69 airports, including 43 of the approximately 90 European destinations served by Ryanair and 47 of the 80 or so destinations served by Aer Lingus.

Airports were compared on the basis of opex per passenger. Chart 12.3, taken from the CAR's 2014 regulatory report, reports Dublin's opex per passenger.

The findings are telling: the top-down benchmarking reveals different performance gaps by reference to different subsets of the full sample. The figures indicate that Dublin's per-passenger operating costs in 2012 were:

- 1% below the sample average
- 7% below the average for airports between 10 and 35 million passengers per annum
- 5% below the average for destinations served by Aer Lingus
- But 10% above the average for Ryanair destinations

The green vertical line on the chart average values for the airports in a separate benchmarking exercise carried out by consultants acting for Dublin airport. The sample in the latter report had an average per-passenger opex 25% higher than the average for all airports in the CAR's sample.

The exercise confirms the decisive influence of choice of comparator on measured relative performance under benchmarking and therefore the unavoidability of final regulatory judgements between different benchmarks when these seem to point in different directions. Benchmarking rarely absolves regulators of difficult and controversial judgements.

Airline Reference Sample

As well as benchmarking an airport operator against other airport companies, there is a natural interest in comparing an airport's performance against that of its own customers, and in particular airlines. The CAR therefore compared Dublin airport's opex with controllable operating costs (excluding fuel, airport, and ATC charges) of the two main airlines operating at Dublin airport. The results are presented in Chart 12.4.

In the period after 2009, the airlines' and airport per-passenger operating costs remained very broadly flat; per-passenger costs at both Aer Lingus and DAA increased by 3%, whereas Ryanair's costs per passenger were the same as in 2009. Looking further back, the comparison is less favourable to Dublin Airport. Both

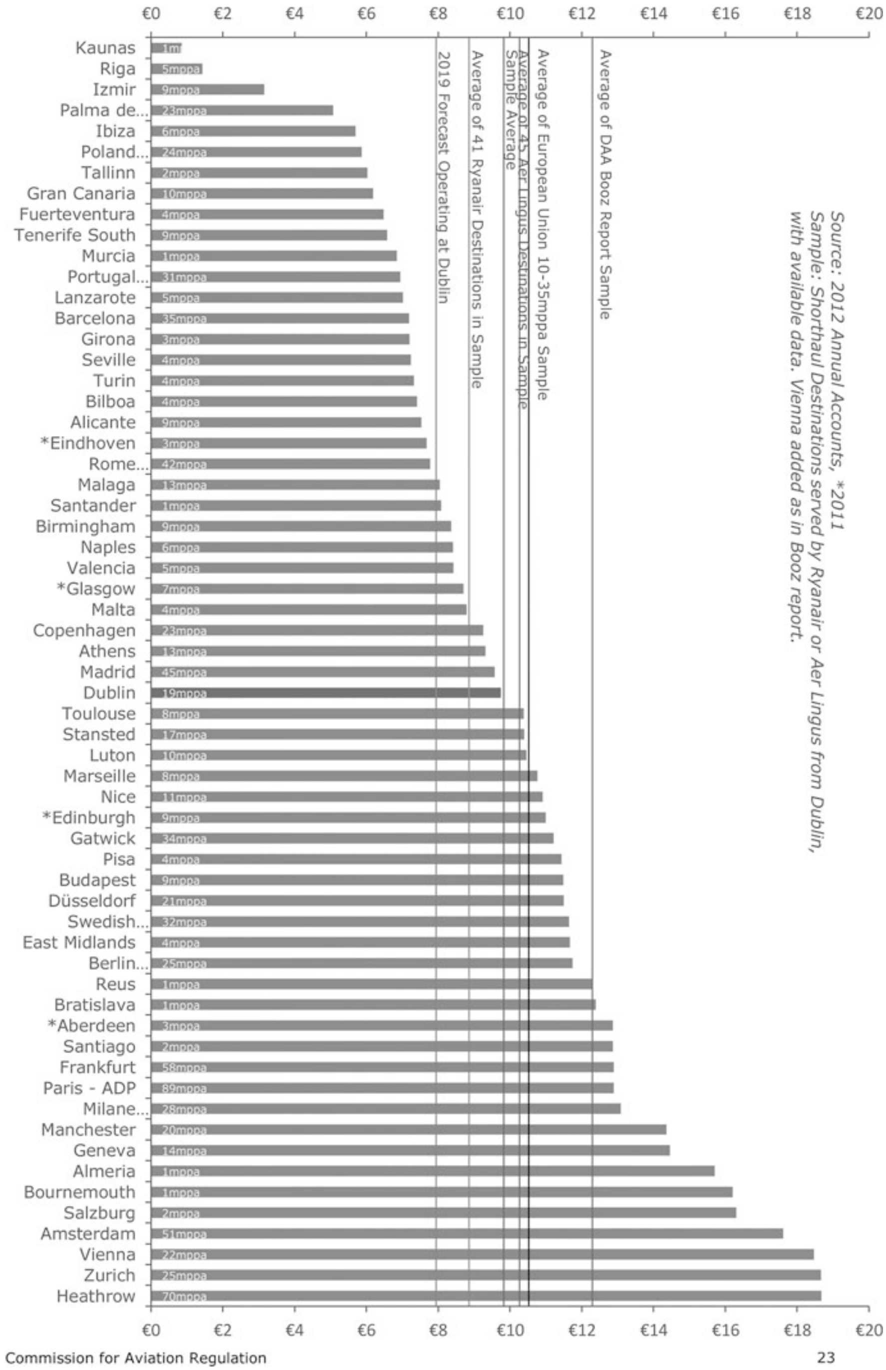

Chart 12.3 Airport operating expenditure per passenger 2012. *Source*: Draft Determination of Charges at Dublin airport, CP1/2014, Chart 4.4, p.23

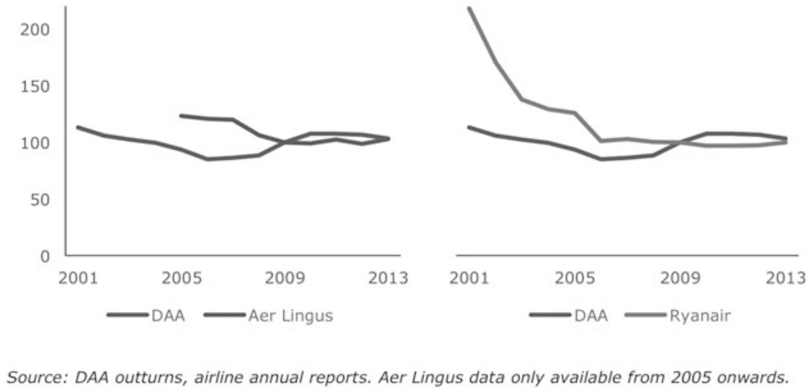

Chart 12.4 Selected airline and airport per-passenger operating costs 2009 = 100. *Source*: Draft Determination of Charges at Dublin airport, CP1/2014, Chart 4.5, p.24

Ryanair and Aer Lingus were able to realise cost savings in the years prior to the previous regulatory Determination, considerably so in Ryanair's case, whereas per-passenger operating costs at Dublin were higher in 2009 than they were in 2003.

Is such a comparison valid? While the businesses are different, both types of company operate in the same industry, have the same customers, experience the same demand shocks, and have similar regulatory and security requirements. Aer Lingus was also a government-owned company until 2006. Differences include increased airline competition (but less change in competition facing the airport) and a higher proportion of airport versus airline costs being sunk.

Government-Owned ('Semi State') Companies Reference Sample

A final comparator reported by the CAR in 2014 was between Dublin airport and six other government-owned companies in Ireland. The comparators were the postal operator (An Post), the gas board (Bord Gáis), the electricity supply board (ESB), the national broadcaster (RTÉ), the national bus and rail operator (CIE), and the ATC provider (IAA). Many of these businesses are monopoly providers with some or all of their charges set by a regulator. All have a common equity holder in the Irish state.

For this comparison, the CAR looked at how total operating rather than unit costs had evolved since 2007. That start year was chosen, as it offered an opportunity to consider the extent to which the companies had been able to manage operating costs since the 2008 economic downturn. Chart 12.5 suggests that Dublin Airport managed its operating costs in line with the average of this sample. Of course, each firm influences the average and one—Bord Gáis—increased its operating costs by 62% over this period.

Breaking down the costs, compared to this comparator set, DAA's management of staff costs appears to have been relatively good. While the sample of management costs fell by 2%, they fell by 9% at Dublin Airport. In contrast, non-staff costs at Dublin Airport have increased since 2007 by 20% whereas they grew by an average of 5% for the peer group.

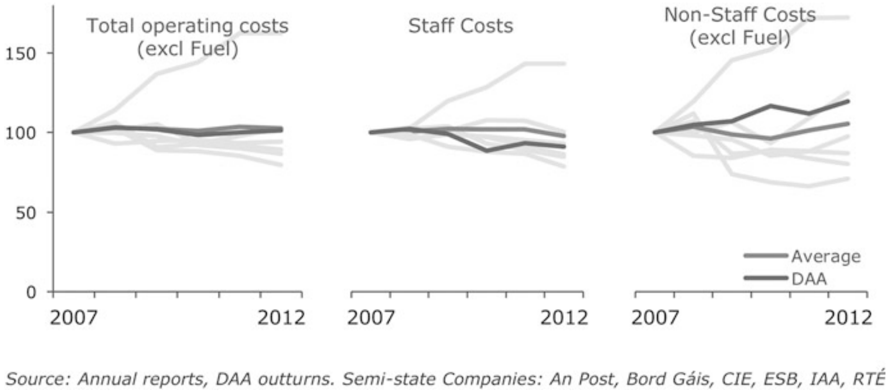

Chart 12.5 Operating costs at selected Irish state-owned companies 2007 = 100. *Source*: Draft Determination of Charges at Dublin airport, CP1/2014, Chart 4.6, p. 25

12.7.4 Step 3: Stakeholder Responses

Representations responding to the benchmarking report were received from 33 bodies including the airport, local and international airlines, international bodies representing airports and airlines, airport staff and pilot trade unions, the air traffic control operator, groundhandlers, economic development and local government bodies, and tourism and hotel interests.

The airport argued that the benchmarking exercise was flawed, contained errors, and was not achievable because the efficient level of opex had been underestimated by the consultants. In particular, the airport sought additional funds for security, and to compensate for deficits in the staff pension scheme. The operator also rejected outsourcing as likely to produce industrial unrest on a scale costing much more than any achievable savings. In a 750 page response to all aspects of the draft pricing decision, the airport and its consultants disputed many other of the regulatory judgements and calculations.

Many airlines took the opposite view, and doubted that the benchmarking exercise had sufficiently challenged the airport operator's costs. Ryanair considered the high ambition scenario to be the minimum acceptable level of efficiency. On pay, Ryanair recommended that the airport paybill be reduced in stages until average airport pay matched average pay across the Irish economy. Other airlines considered the benchmarking to be balanced. Some airlines expressed nervousness that a tight opex settlement might jeopardise operational features of the airport that were important to airline operations (e.g. smoothly functioning security). This view was partly shared by the economic development bodies and business representative bodies which sought a careful balance between pursuit of efficiency and reliable service quality.

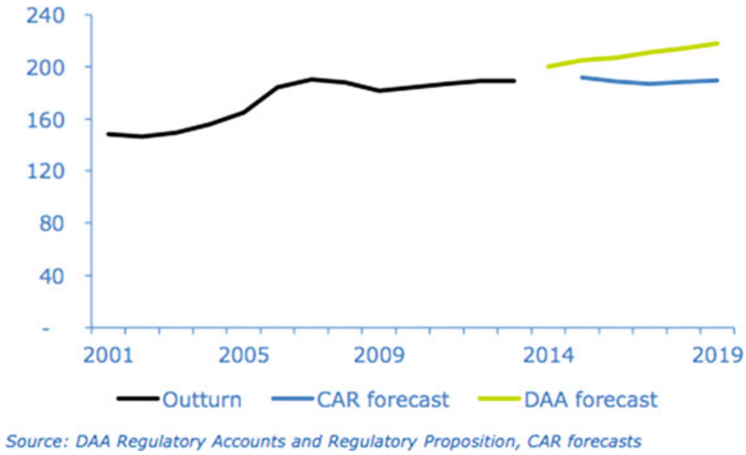

Chart 12.6 Regulator's total opex allowance, based on benchmarks, versus opex budget sought by airport operator. *Source*: Draft Determination of Charges at Dublin airport, CP1/2014, Chart 4.8, p. 27

12.7.5 Step 4: Final Regulatory Allowance

After this engagement, the annual opex allowance for Dublin airport was raised from 190 to 202 m € for 2019, almost exactly equal to the original base scenario and about 10 m € above outturn spending in 2013. Since traffic was expected to rise from 21 m in 2014 to 24 m in 2019, this implied a fall in per-passenger opex of 1.40 € (to 8.16 €) by 2019, of which a little over 1 € could be attributed to scale effects—traffic growth—and the balance to projected efficiency gains. [22]

Some of the reasons for the upward adjustment in the opex allowance were better information and correction of an error in the benchmarking work, along with decisions to eliminate projected savings that would have required outsourcing and agreeing to have passengers fund a small portion of the airport pension scheme's deficit.

In its final decision the regulator noted that a per-passenger opex allowance of 8.16 € for 2019 compared well with the comparator airports included in the bottom-up benchmarking exercise, was below the average opex of airports served by Ryanair (8.87 €) and required Dublin airport to achieving efficiency savings of 0.8% per annum, after controlling for scale effects.

For a longer term trend, Chart 12.6 presents opex outturn spending from 2001 to 2012 alongside the allowance proposed by the regulator and the opex sought by the airport operator in the 2014 review. The regulator's allowance foresaw total airport operating costs staying broadly constant over the 5 years to 2019. By contract, the

[22] Passenger traffic at Dublin airport in fact far exceeded the projection used to make the 2014 price cap, reaching 31 million in the final year before the Covid-19 pandemic.

Chart 12.7 Evolution of page count of regulator's proposals and decisions 2001–2014. *Source*: Author's calculations based on documents on www.aviationreg.ie

operator of Dublin airport had sought an opex increase almost 15% above the prevailing levels and further increases over time. The regulator's decision implied a decline in unit opex to below the levels achieved in 2007, whereas DAA planned a broadly constant level of unit opex.

12.8 Implications of Benchmarking for the Scale of Regulatory Documentation

Many decades ago, one of the leading early analysts of regulation, Alfred Kahn, predicted that a move from rate-of-return regulation to a price cap, envisaged as a less-intrusive form of regulation would cause the industry to reorganise its representations, with little reduction in intervention. Certainly, there has been no ultimate decline in the exchange of voluminous documentation, reflecting the incentives for each side of industry to seek to push the regulator, at the margin, in its favour.

In the final part of this chapter, I document the growth in the scale of regulatory engagement at Dublin airport over the decade and a half to 2014, to which the contributions of benchmarking exercises have been one contribution, particularly in 2014.

The charts in this section of the chapter report the page count of the regulator's publications (in-house and commissioned consultancy), as well as those of the airport operator and airport users, at the time of the main price reviews over a decade and a half. Four of these, in 2001, 2005, 2009, and 2014 were considered for this chapter. Each price review followed a three part publishing cycle: issues paper and industry responses, draft decisions and industry responses, and final decision. Starting with the regulator's own work, Chart 12.7 shows that the page count of the materials rose steadily until 2009, when it was 45% larger (some 650 pages) than

Chart 12.8 Growth in size of Dublin airport operator's regulatory submissions 2001–2014. *Source*: Author's calculations based on documents on www.aviationreg.ie

Chart 12.9 Size of Dublin airport users' regulatory submissions 2001–2014. *Source*: Author's calculations based on documents on www.aviationreg.ie

in 2001. Recognising this pattern, the CAR deliberately reduced the length of publications in 2014.

In contrast, there was no slowdown, indeed an acceleration throughout, in the scale of submissions on behalf of the airport operator. Chart 12.8 shows that, except for 2005, airport representations exceeded the size of the regulator's own reports. There was a jump in 2014, from 580 to 820 pages, reflecting a bumper response to the regulator's draft decision.

Finally, the aggregate of user submissions has been on a much smaller scale, with no upward trend over the full period (Chart 12.9). In the charts, externally commissioned professional consultancy reports are distinguished from in-house submissions; this shows that the external consultancy commissioned by the airport operator dwarfs in size that issued on behalf of airport users, by a factor of almost ten.

In total, for these four airport pricing decisions, there are some 5600 pages of materials on the regulator's website, an average of close to 1500 pages per review.

12.9 Conclusions

Perhaps there are few surprises from this retrospective on regulatory benchmarking at Dublin airport, at least once account is taken of the incentives that airport operators, users, and regulators face.

As the BAA accepted in 2001, airports, be they good or bad performers, are reluctant providers of information to regulators. Airport users will sometimes demand cost reductions with an equally less-than-solid base of evidence. Regulators must expect to have to do most of the information gathering and assessment, if they are to have reasonable confidence that costs and thus prices have been set on a broadly efficient basis.

The currently most promising basis to benchmark involves several steps. Starting with an airport's audited accounts, conduct a bottom-up assessment of opex with respect to the benchmarks to identify an efficient cost base. Project this forward over the next regulatory period by means of identified drivers, using estimated elasticities and forecasts of the drivers of future values. Adjust for expected capacity changes and other once-off changes. Apply a consistency check against top-down benchmarks. Open up the results to industry and public consultation; although the responses of interested parties are likely to be predictable, consultation should also generate some additional information and ensure that any errors or misinterpretations come to light before a final decision is made. After finalising the opex allowance, express it in annual terms and identify what performance change this implies compared to current opex.

Concerning methodology, discussions of the approach underlying many regulatory building blocks, not only opex benchmarking, are best conducted, if possible, outside the fraught circumstances of a price review, when methodological arguments are polluted by a short-term perspective on the next pricing decision (which can produce flip-flopping in a given participant's methodological recommendations over time). In principle, questions such as the scope of the regulatory till, the proper assessment of the cost of capital, and the appropriate approach to benchmarking, may be capable of cooler consideration after a price cap has been set and in time for any conclusions from the discussions to be properly prepared for application in the next price review.

Benchmarking is most challenging when first conducted, though insofar as the scale of inefficiency to be discovered may also then be considerable, simple measures may reveal considerable inefficiency. In any benchmarking work, a point to consider is whether the reference sample is a challenging or unchallenging point of reference, i.e. whether the benchmarks might be considered 'high performance' businesses or if, instead, the structure and ownership of the industry allows it to be behind the efficiency frontier.

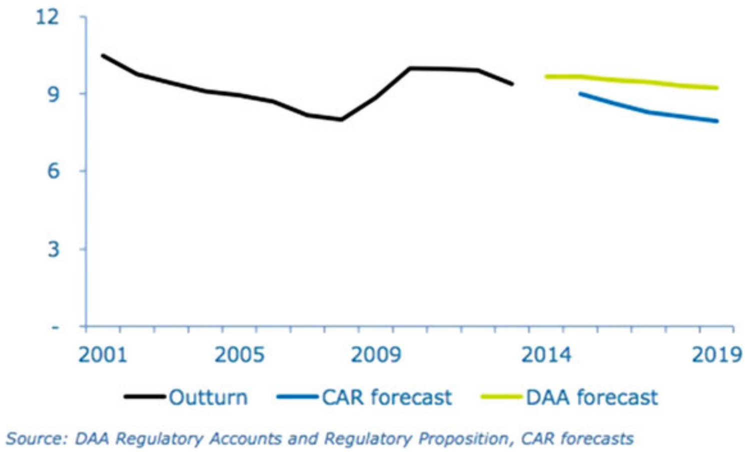

Chart 12.10 Evolution of airport per-passenger opex since start of regulation at Dublin (actual 2001–2013, airport's proposal & regulatory allowance 2015–2019). *Source*: Draft Determination of Charges at Dublin airport, CP1/2014, Chart 4.9, p. 28

Price regulators exist to work towards infrastructure users not having to overpay for a desired quality of a monopoly service. What then has been the actual history of unit opex at Dublin airport over this period? Chart 12.10 shows per-passenger opex to have ranged over a wide set of values. From a high level above 10 € when regulation started in 2001, unit opex fell below 8 € in 2006, at the end of a period of surging traffic served by a single terminal, though with considerable congestion and loss of service quality. In the late noughties, when traffic collapsed just as a second terminal opened, per-passenger opex rose sharply, but the 2015–2019 allowance required the airport operator to reduce unit opex to 2006 levels by 2019. [23] Since *ceteris paribus* each one-euro difference in unit opex implies a one-for-one change in airport charges, determining an opex allowance, on a benchmarking or some other basis, matters for airport charges.

Insofar as regulatory benchmarking is not as common as it might, and perhaps should, be, this chapter has sought to offer some suggestions as to why this might be so.

In terms of future research work, a current gap, as far as the author is aware, is the absence of comparative assessments of benchmarking at different regulated airports in terms of their approaches and their successes and failures.

[23] Subsequent outturn opex values will, of course, have been considerably disturbed by the impact of the pandemic on air transport.

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TRL (Transport Research Laboratory), various years, Airport Performance Indicators reports

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[24] Note:

• Publications marked with an asterisk may be found on the CAR's website, http://www.aviationreg.ie/charges-slot-regulation/regulation-of-airport-charges-dublin-airport.117.html classified by the year of the price review.

• Publications marked with a double asterisk may be found on the archive of the CAA's website: http://webarchive.nationalarchives.gov.uk/20140713054907/http://www.caa.co.uk/docs/5/ergdocs/benchmarking/baa_bm.pdf

Ireland through a period of substantial infrastructure expansion at a time of considerable economic turbulence. He holds a number of University Economics degrees, a BA (Galway), an MSc (Coleraine), an MPhil (Oxford) and a PhD (UCD). Cathal lives in Dublin, Ireland. He has two daughters but so far only two thousand books.

Part III
Country Studies

Chapter 13
Economic Regulation of Airports in the United Kingdom

Anne Graham

Abstract This chapter describes the development of airport economic regulation in the UK, comparing the system which was in force between 1987 and 2014 with the current regime. In the UK case, two key characteristics of the aviation sector need to be taken into account. It is a predominantly private industry, and the UK has an extensive number of different types of airports that is mainly explained by its geography. The new regulatory system is more fit for purpose for today's UK airport industry. The first indications at Gatwick show the innovative and more light-handed approach has brought improvements.

Keywords Airports · Economic regulation · United Kingdom · Privatisation · Heathrow · Gatwick · Stansted · Price cap · Competition · Efficiency · Market power

13.1 Introduction

The United Kingdom was the first country in the world to privatise its major airports and the first to use a price cap format to regulate them. This occurred over a quarter of a century ago in 1987. In April 2014, a new economic regulation system was introduced. This chapter provides an evaluation of the previous system, using evidence over the extensive period that it was in force, and makes comparisons with the current system.

In considering the UK case, there are two key characteristics of the aviation sector that need to be taken into account. First, it is a predominantly private industry with an entirely private airline sector, as well as a largely private airport industry. This, together with a fairly liberal approach to airline markets, means that airport regulation, in addition to the planning regime, are really the only two remaining key policy levers that the government has to exert influence over the airport sector. Second, the UK has an extensive number of different types of international and regional airports

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that is mainly explained by its geography. Indeed in 2019, there were over 20 airports that handled in excess of one million passengers each. These need different considerations within the context of economic regulation.

13.2 Economic Regulation Between 1987 and 2014

The UK Civil Aviation Authority (CAA) took on the role of the airport economic regulator as the result of the 1986 Airports Act. The CAA had four duties as regulator, namely furthering the interests of users; promoting efficient, economic and profitable operations; encouraging timely and appropriate investment and imposing minimum restrictions. However, one of the key problems with these was that there was no guidance given as to how to balance or weight them in importance. A notable concern was that the CAA had placed undue prominence on its duty to impose minimum restrictions (Competition Commission 2009). Moreover, the ambiguous phrase 'users' left open to debate as to whether the focus or priority should be given to airlines or passengers.

A two-tier regulatory structure was introduced. All airports that exceeded a £1 million turnover threshold, in at least two of the last three financial years, had to seek permission from the CAA to levy airport charges and had to meet certain conditions in the presentation of their accounts that were annually submitted. The CAA could also impose other conditions to remedy any anti-competitive behaviour. Moreover, certain airports could be designated by the Secretary of State for Transport for more intrusive price regulation and in 1986 these airports were London Heathrow, London Gatwick, London Stansted and Manchester. This remained the situation up until 2008, although there were a few unsuccessful calls for extending this list of airports, most notably to the major Scottish airports in 1994 and to London Luton airport in 2000. However, in the more recent years, as the UK aviation environment became more competitive, the focus shifted to consideration of de-designation. This was particularly the case for Stansted and Manchester airports, where evidence suggested that competitive forces were preventing them from pricing up to their nominal price cap. This led to the government reviewing the situation in 2008 (the CAA recommended de-designating both airports) and, as a consequence, Manchester was not considered to have substantial market power (SMP), and was de-designated, but Stansted remained designated (Department for Transport 2008a, b).

The designated airports were subject to a single-till Retail Price Index (RPI) +/– X price cap, based on the airport's Regulatory Asset Base (RAB), applied to the revenue per passenger yield. For the 2003–2008 pricing period the CAA considered using yardstick regulation rather than internal evidence to determine the price cap. However the data problems, the heterogeneous characteristics of airports and strong opposition to such an approach from major stakeholders meant that in the end explicit use of benchmarking was not used to inform the CAA's decision, although it played and continued to play an informal role when the airports' performance was assessed (Reinhold et al. 2009).

This regulation regime developed over time and specifically in 2003 a 'stand-alone' approach for the London airports (then jointly owned by the former BAA company) replacing the 'system' approach was introduced, which meant that the airports were considered individually rather than as a group. Starkie (2016) argues that this represented the first step towards the break-up of BAA (see discussion below). However, as the airports were regulated directly by statute, the CAA did not have the freedom to consider alternatives types of regulation—although they could add additional features. For example, in 2003, a service quality condition was included which meant that rebates were available to airlines if certain service quality standards were not achieved. Also, in this year capital investment 'trigger' points were introduced, which related to achieving particular capital milestones on time, where the airports could be subject to penalties through the price cap formula (CAA 2003). All these developments increased the complexity of the system, and arguably made it less flexible.

This price cap was normally set every 5 years and Table 13.1 shows the X values since 1987. In the early years, the price caps generally had negative *X* values, revealing the view that greater efficiencies could be made. In more recent years, there were positive values, which particularly in Heathrow's case reflected higher capital requirements.

The empirical evidence concerning the effectiveness of this price-cap regulation to produce efficiency gains is relatively scarce and somewhat contradictory. For example, Parker (1999) found no significant efficiency improvement since the privatisation and price regulation of BAA airports, whilst Assaf et al. (2012) concluded that regulation had had a significant impact on the efficiency of UK airports. Other studies have looked at the relationship between the large regulated airports and the smaller unregulated ones, but it is difficult to separate the size and regulation effects and reach firm conclusions. For example, it was found by Barros (2008, 2009) and See and Li (2015) that the (larger) regulated airports were less efficient than other UK airports, or that they experienced constant or diseconomies of scale (Assaf 2010; Bottasso and Conti 2012). By contrast, Assaf (2009) concluded that the large airports outperformed the smaller regional ones.

A regulatory review was undertaken every 5 years. This involved the CAA carrying out a detailed examination of the designated airports and then making an automatic reference to the Competition Commission, which was the general trading regulator in the UK. The Competition Commission consequently undertook its own detailed assessment and made recommendations to the CAA. The CAA was not obliged to follow these, but they also had to impose new conditions if the Commission found that the airport had acted against the public interest. Between these quinquennial reviews, there was very limited scope for the CAA to have much influence over the airports.

The initial rationale for having these two regulators was that the CAA had the detailed knowledge of the aviation industry, whilst the Competition Commission had much regulatory expertise on technical issues, such as the cost of capital, and so

Table 13.1 The '*X*' value used for the UK airport price caps 1987–2013

Airport	1987–1991	1992–1993	1994	1995–1996	1997–2002[a]	2003–2008	2008-2013[b]
Heathrow	–1	–8	–4	–1	–3	+6.5	+7.5
Gatwick	–1	–8	–4	–1	–3	0	+2.0
Stansted	–1	–8	–4	–1	+1	0	+0.0 / +1.63[c]
	1988–1992	**1993–1994**	**1995**	**1996–1997**	**1998–2002**	**2003–2008**	**2008–2013**
Manchester	–1	–3	3	–3	–5	–5	N/A

Source: CAA
Notes:
The stated year refers to April at the beginning of the charging period (e.g. 2008 = April 2008–March 2009)
[a]The normal 5-year charging period was extended to 6 years because of the timing of decisions related to the development of Terminal 5 at Heathrow
[b] The 2008–2012 charging period was extended to 2013 for Heathrow and Gatwick when the new regulation was introduced. For 2013 the X value for Gatwick was –0.5
[c]Charging period 2009–2013 (0.0 for 2009–2010; 1.63 for 2011–2013)

their roles should have been complementary. However, this approach lengthened the regulatory review process and introduced a considerable amount of uncertainty, as in practice the distinct role and responsibilities of the two regulators were less than clear. All too often this produced disagreement and conflict, for example with different views about the use of single versus dual till and assumptions related to cost of capital (Toms 2004). Another contentious issue was that the stakeholders did not have any rights of appeal to challenge regulatory decisions (except through a judicial review), in stark contrast to other UK regulated industries where the appellate body was the Competition Commission. This was one of the factors that contributed to the emergence of regulatory creep as the process became more complex and expanded in scope and time taken (Starkie 2012).

Commenting about this regulatory process, Littlechild (2018, 112) stated:

> ..It became particularly confrontational, putting airlines and airports against each other instead of enabling them to work together. It left the regulator to take difficult decisions that others were better placed to take.

To address this problem for the 2008–2013 (the so-called Q5 quinquennial period) price cap decision the CAA introduced 'Constructive Engagement' where it encouraged the airports and airlines at an early stage to discuss, and if possible agree on, generally less controversial matters such as traffic projections, capacity requirements and investment, non-regulated aeronautical revenues and service quality. This process was relatively successful at Heathrow and Gatwick but failed at Stansted (CAA 2006). It was again used as an important input for the next Q6 decisions at Heathrow and Gatwick.

13.3 The New 2014 Regulatory Framework

From the beginning of this century, there was a growing view that this regulatory system was not fit for purpose, was outdated, was too complex and inflexible and needed to be modernised, with this opinion being expressed both by individual experts (e.g. Beesley 1999; Starkie 2001; Toms 2003; Hendriks and Andrew 2004; Starkie 2008; Bush 2010) and government bodies (e.g. Transport Committee 2006; House of Lords Regulators Committee 2007; Department for Transport 2008c). Notably the Competition Commission (2009, 12) concluded:

> that the system of economic regulation of airports is a feature which distorts competition between airlines by adversely affecting the level, specification and timing of investment and the appropriate level and quality of service to passengers and airlines

This pressure for reform was heightened by the fact that airport regulation was out of line with other UK regulation systems. Moreover, there had been many changes since the original regime had been introduced. Airline liberalisation had occurred with traffic volumes increasing substantially, competition between global hubs had intensified, regional airports had expanded and low-cost carriers had emerged as an important and new managerial innovative airline sector. Additionally, the use of the

Internet had reduced the entry costs for airlines into new markets. All these factors meant that airlines had the potential to increase their buyer power whilst the airports faced more risks. As a result, a significant number of airports and airlines negotiated long-term contracts as a means of doing business (Bush and Starkie 2014). At the same time nearly all UK airports embraced at least some private sector involvement and became much more commercially focused in their outlook.

These forces for change accumulated in the Department for Transport undertaking an extensive regulatory review (Department for Transport 2009) with the subsequent introduction of a new system in 2014, which was established with the 2012 Civil Aviation Act. The new regime gives the CAA a single overriding duty to further the interests of current and future users of air transport services (passengers and owners of air freight) with a number of other supplementary or secondary duties, relating to financing; meeting demand; promoting efficiency; and addressing environmental impacts, government guidance and international obligations. It has a licencing framework which has already been widely used for UK utility regulation. Airports are required to have a licence granted by the CAA if they pass a market power test or determination. Having the CAA investigate market power has given it more independence rather than relying on the government's designation. Other airports, where annual turnover exceeds £1 million in at least 2 of the last 3 years, are required to have an operators' certificate. There is no longer an automatic referral to the Competition Commission (again giving the CAA more independence), but instead there is now a two-sided or symmetrical procedure where both airport operator and airlines can appeal to the Competition and Markets Authority (CMA) (which has taken over from the Competition Commission) and/or the Competition Appeal Tribunal concerning the licence conditions and/or airport designation decisions made by the CAA.

In 2014, the CAA reached its decisions for Q6 based on the three-part market power test (CAA 2014a, 17):

- Test A: the relevant operator has, or is likely to acquire, substantial market power (SMP) in a market, either alone or taken with such other persons as the CAA considers appropriate;
- Test B: that competition law does not provide sufficient protection against the risk that the relevant operator may engage in conduct that amounts to an abuse of that SMP;
- Test C: that, for users of air transport services, the benefits of regulating the relevant operator by means of a licence are likely to outweigh the adverse effects.

The CAA's view was that competition at Heathrow airport was quite limited with the degree of market power being the strongest of all the three airports. It therefore decided on a single till, RAB based price cap (RPI-1.5%), which was similar to the previous approach, as it considered this to be appropriate for airports with SMP; best able to balance the needs of todays and future users; and more acceptable to stakeholders than any other approach (CAA 2014a). A key feature of the CAA's argument was that the scope for competition, particularly at Heathrow and Gatwick, was limited by capacity shortages (see discussion below). These views were widely shared by many but rebutted by some (Starkie 2012).

The CAA concluded that Gatwick had market power but less than at Heathrow (CAA 2014b). They argued that the diversity of airline requirements (low cost, full cost and charter) meant that it was difficult to make a 'one-size-fits-all' decision and that there could be particular benefits from the airport and airlines working more closely together. Gatwick had already started to develop its so-called Contracts and Commitments Initiative which involved agreeing a series of commitments with its airlines on price, service conditions and investment, including maximum inflation price rises (RPI+0) to 2021. With a few airlines, such as Emirates, Norwegian and Thomson, it had integrated these commitments into bespoke formal contracts. The CAA was in support of this initiative as long as it was considered it to be 'fair' and to the benefit of passengers, and so they decided that this should be supplemented with a licence to ensure that the commitments were honoured. The CAA was also of the view that a more stringent pricing formula of RPI-1.6% (their so-called fair price benchmark) would be more appropriate and so they stated that they would scrutinise prices at Gatwick in relation to this, and check other areas such as service quality, resilience and investment, and the relationship with the airlines.

For Stansted the CAA reached the conclusion that the airport did not have SMP and so from April 2014 the airport has not been economically regulated (CAA 2014c). This decision was based on knowledge of the existence of spare capacity except at peak times, and evidence suggesting that the two main airlines (Ryanair and EasyJet) had countervailing buyer power. In addition, in February 2013, the airport had been bought by the Manchester Airport Group (MAG) replacing common ownership under BAA which previously had undoubtedly restricted competition between the London airports. Moreover, in the summer of 2013, MAG concluded long-term deals with Ryanair (10 years) and easyJet (5 years) that offered lower prices in return for traffic growth, at a level significantly lower than the 2013/14 price cap.

Table 13.2 summarises the key differences between the old and new system. So has the new system overcome the weaknesses of the previous one? It certainly is less complex and burdensome with less likelihood of the development of regulatory creep, with perhaps less negotiation tactics and regulatory gaming. There is no longer the automatic referral to the Competition Commission, and it is the CAA, rather than the Secretary of State, that now makes decisions on airport designation—arguably which should be an economic rather than political decision. At the same time the CAA has become more accountable through the system of appeals which have been established.

In addition, the CAA now has a clear primary duty to further the interests of passengers, and owners of air freight, rather than being faced with multiple duties with no allocated priorities. This was an area of much debate during the regulation review process, particularly as regards whether passenger and airline interests always align. The aviation industry differs here from other regulated sectors because the main customers at the airport are not the end users. When there is effective airline competition, the interests of the two stakeholders should align, although arguably this may not always be the situation, particular if airlines have market power, and especially as airlines will tend to focus on current rather than future passengers and

Table 13.2 The key characteristics of the two regulatory systems

Period	1987–2013 (1986 Airports Act)	2014 – (2012 Civil Aviation Act)
Responsibility for designation	Secretary of State for Transport	Civil Aviation Authority
Regulation framework	Price cap established by statute	Licence established by statute
Duties of regulator	Four unweighted duties	Primary duty to further the interests of users of air transport services
Regulation process	CAA 5 yearly review with automatic referral to the Competition Commission	Licence details determined after review by CAA Initial stated periods: • Heathrow: April 2014–December 2018 • Gatwick: April 2014–March 2021
Regulation features	Heathrow, Gatwick, Stansted (and Manchester up to 2008 when de-designated) single till, RAB based, price cap	Initial period: Heathrow: single till, RAB based, price cap Gatwick: monitoring process Stansted: not designated
Availability of appeal process	Limited to judicial review and airports only	The airport operator or airlines can appeal to the Competition and Markets Authority and/or Competition Appeal Tribunal

Source: Adapted from Graham (2018)

may disregard passenger interests in periods of severe disruption. However, whatever the circumstances it is the role of the regulator to promote the interests of the final consumers and so this focus on passengers must be correct. To further the interest of passengers the CAA established a new Consumer Panel in 2012 that reports to the CAA Board.

There can be very little doubt that the previous 'one-size-fits-all' regime established by statute that had become increasingly more complex was not fit for purpose and lacked the flexibility for today's UK airport industry. The London airports are very varied in terms of passenger volume and characteristics, capacity utilisation, RAB, airline customers, route networks and exposure to competition. The degree of risk and the approach needed to protect consumers are different. The new system of licences is a definite improvement by introducing flexibility and the capability of being able to tailor regulation more closely to individual needs of the different airports and encourage more innovation. Indeed, Cheong (2015) describes the new system as a revolution rather than an evolution in airport economic regulation. There is the possibility of using alternative forms of regulation and to adapt to new circumstances, such as new service quality requirements, rather than waiting until the end of the regulatory period. Nevertheless, specific sector regulation will always be a second best option compared to competition and competition law. However, the role of airport–airline collaboration and agreements brought by a shift in the airport–airline relationship which has become so important at non-regulated airports, has clearly had a very significant impact on the CAA's recent decisions.

In terms of the CAA's decision for Q6 as regards the de-designation of Stansted for some commentators this was long overdue (e.g. see Starkie 2004) and, given today's post BAA break-up environment, this must be the right way forward. Indeed, easyJet said that it was:

> Supportive of the CAA's approach to Stansted airport which under new ownership has shown itself willing to take a more commercial approach to airlines which will also benefit passengers (easyJet 2014).

However, by contrast, Ryanair vehemently disagreed by stating that:

> foxes had been put in charge of the chicken coop

and

> Effective regulation with aggressive price caps is the only way to ensure that consumers are protected and that Stansted can grow its traffic on a sustained basis (Ryanair 2014)

As regards Gatwick, with the mix of different traffic and more competitive environment, an ex post monitoring approach certainly seems to bring a number of advantages as opposed to ex ante price cap regulation. Arguably the CAA could have gone further as desired by the airport operator, by reasoning that with the new commercial negotiations there was no requirement for an economic licence. However, this would have been one step too far for some, and in particular its largest airline customer easyJet who still viewed the airport as having SMP.

In 2016, a mid-term review of the new framework was undertaken at Gatwick. This focused on the airport's service quality and airport resilience (including on-time performance); its investment performance and its relationship with airlines and other stakeholders (CAA 2016). It was found that many aspects of the new framework appeared to be working well with Gatwick agreeing bilateral contracts with airlines representing more than 85% of passengers. Traffic growth had exceeded expectations, overall passenger satisfaction had increased and most of the service quality targets had been met. Moreover, Gatwick had held its charges below the 'fair price' benchmark set in 2014. The CAA stated that no airlines had argued for a return to the previous more heavy-handed form of pricing regulation.

However, with regard to investment, although Gatwick had invested more than their minimum commitment, it had not yet expanded the capacity in response to higher than expected traffic growth. Moreover, the airport and airlines could not agree on whether capacity constraints were contributing to poorer on-time performance on the airfield since 2014. In addition, the relationship between the airport and its airlines appeared to be mixed. In some areas the relationship had improved but in others it had worsened. Overall the CAA concluded that they had not seen any evidence leading to a material adverse impact on passengers, but they did have some potential concerns about the progress of airfield investment projects, on-time performance and some aspects of the airport–airline relationship which they would continue to monitor.

Turning attention to Heathrow, the adoption of a similar regime as before brought with it many of the issues that have been extensively debated over the last 25 years, particularly in relation to investment incentives (Graham 2008; Starkie 2006). The CAA has demonstrated that it has no appetite to re-open the single vs dual till debate and so some of the theoretical drawbacks, such as distorted investment decisions and pricing signals, remain. Likewise, the RAB building block exercise has been maintained, bringing with it the challenging and time-consuming task of determining an appropriate and acceptable cost of capital. This has been all too evident with the CAA's adoption of a 5.35% cost of capital for Heathrow for Q6 compared to the airport operator's own estimate of 6.7%.

In terms of other details for Heathrow, yardstick regulation is still quite rightly considered to be too difficult to apply, albeit that the CAA made increased use of informal top down and bottom up analysis and process benchmarking to inform its decisions for Q6. Service quality scheme changes for Q6, such as the inclusion of a self-modification provision to allow the airport operator and airlines to make immediate changes, and the removal of bonuses in areas where the airport has consistently outperformed, all seemed to have offered the opportunity to enhance the service quality.

However, competition and regulation are not independent from ownership and privatisation trends within the UK (Littlechild 2018; Starkie 2016), and there can be little doubt that the London airports entered into a new era of greater competition, following the pivotal decision to break-up BAA. This occurred in 2009, when the Competition Commission completed an investigation into whether any features of the markets for airport services in the South East of England, as well as in Scotland, had given rise to adverse effects on competition in connection to the airports owned by the then private operator BAA (Competition Commission 2009). BAA had been operating four airports in the London/South East of England region (Heathrow, Gatwick, Stansted and Southampton) and three in Scotland (Glasgow, Edinburgh and Aberdeen). After 2 years of extensive research, the Commission concluded that BAA's common ownership had produced adverse effects. Consequently, BAA was ordered to divest itself of both Gatwick (actually sold during the inquiry) and Stansted airports in London and either Glasgow or Edinburgh in Scotland. BAA completed its sale of Gatwick in 2009 and BAA's successor entity, Heathrow Airport Holdings (HAH), divested itself of Edinburgh in 2012 and Stansted in 2013.

In 2016, the successor to the Competition Commission, the CMA, undertook a detailed assessment of the effects of such divestment (CMA 2016). It identified a number of factors that indicated increased competition at Gatwick, Stansted and Edinburgh since divestment, such as greater passenger growth than at other airports with increased efforts to attract new airlines. It also observed that the airports had altered the structure of their charges to airlines in order to become more competitive. In addition, it found increases in both capital investment and operational efficiency at the three airports. Moreover, it concluded that service quality had improved markedly at the first sold airport Gatwick, and similar enhancements were expected at Stansted and Edinburgh once a number of changes had become fully embedded. So overall there was significant evidence to support the view that competition had been strengthened since BAA's break-up.

A key question that remains is the extent to which capacity shortages constrain competition with the London airports. Moreover, it can be argued that when dealing with severely capacity constrained airports such as Heathrow, there is a danger that when the regulator caps the charges, it is merely transferring the economic or scarcity rents to airlines (Cheong 2015). Conversely taking account of major additions to airport capacity within the regulatory framework can be just as challenging as is discussed below.

13.4 Looking Forward

In 2016, the CAA opened its next review of economic regulation at Heathrow airport. Some interesting proposals included a customer challenge group to work with the industry and advise the CAA (CAA 2016). It also proposed moving to an outcome-based as opposed to output-based regulation in relation to service quality (i.e. outcome-based service quality assessment focuses on what airports are actually delivering to users compared with output-based measures that assess how this is delivered) and this is an area where Heathrow had already made many suggestions (Heathrow Airport Limited 2020). However, the key issue to consider was the possible development of a third runway. This is because the Airports Commission, an independent commission established in 2012, recommended in 2015 that a new northwest runway should be built (Airports Commission 2015). This view was accepted by the UK government who in 2018 established a policy framework for the expansion of the airport with the publication of its Airport National Policy Statement (Department for Transport 2018).

The original period for the current regulatory was set as April 2014–December 2018 for Heathrow but this was changed because of the possible third runway developments. Initially the price cap was expanded to December 2019 with just a simple rollover of the existing cap during the period when the government was considering its response to the Airports Commission. The price control was consequently extended up to December 2021, taking account of interim commercial arrangements agreed between Heathrow and certain airlines, so that the next main regulatory period could be better aligned with the wider capacity expansion programme at Heathrow airport. Undoubtedly taking into consideration the financing of a new runway is a huge challenge for this regulatory regime (Cheong 2015). A significant amount of work had already been undertaken by the CAA, Heathrow and other stakeholders as to how to the new regulatory framework should take into account this substantial investment and enable the efficient delivery of capacity expansion (CAA 2020a). However, in February 2020, plans for the third runway at Heathrow were thrown into significant doubt after a Court of Appeal ruling said that the government approval for expansion was unlawful because it had not adequately considered the government's commitments to tackle climate change. However, the Supreme Court overruled this decision in December 2020 but much uncertainty remains, particularly taking into account the impacts of COVID-19.

As regard Gatwick, following consultation in 2018 by the CAA, the airport and airlines negotiated a new set of commitments to apply from April 2021, which was agreed with the CAA. In another development, in January 2020, the CAA announced that it had received a request from an interested party for the CAA to undertake a market power determination in relation to Manchester Airport. When such a determination has not previously been carried out—as with Manchester—the CAA is required to undertake this test if a request is received from an interested party. If the CAA makes a determination that the market power test is met, then Manchester could once again be subject to economic regulation. The CAA is yet to make a decision and may consult with the airport and other relevant parties (CAA 2020b).

In conclusion, this chapter has traced the development of airport economic regulation in the UK, comparing the first system which was in force between 1987 and 2014 with the regime that has replaced it. This new system is undoubtedly more fit for purpose for today's UK airport industry, particularly with first indications at Gatwick showing that the innovative and more light-handed approach has brought improvements—albeit that more could be done in some areas. It could be that Manchester airport in the future is brought back under regulatory control and, in this case, decisions would need to be made regarding the most appropriate licence. However, it is at Heathrow, where arguably the largest test of the regulatory system will be whether it can effectively enable the efficient delivery of the third runway—that is, if and when such expansion plans become definite.

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Chapter 14
French Airports Case Study

Estelle Malavolti and Frédéric Marty

Abstract The competitive environment and the institutional and regulatory framework for airports in France has undergone major changes over the past three decades. While competition and carriers consolidation and the growing importance of low-cost airlines can be observed in the countries we have studied in this book, the institutional changes in France are more unique. The 2005 Law changed the rules on airport ownership and opened it up to private investors, leading to a different ownership structure of the larger French airports today, even though the planned privatization of AdP, the Paris airports, had to be postponed. The regulatory framework of airports has therefore also undergone major changes with the creation of a sectoral regulatory agency ASI, whose powers have been transferred in 2019 to the ART (Transport Regulatory Authority). Both single-till and dual-till regulation is being used. There are difference between the regulation of the large airports (category I &II) and the regulation of state-owned small regional airports, that started to be transferred to local governments since 2004. They are under the supervision of the DGAC, and for local airports (below 100,000 PAX/p.a.) under the supervision of the Prefect, the State's representative in a region or a department.

Keywords Regulation · Institutional change · Management contract · Aeronautical revenues · Non-aeronautical revenues · Single till · Dual till

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14.1 Introduction

What is interesting about the situation in France is that the competitive environment and the institutional and regulatory framework of French airports have undergone major changes over the past three decades. Firstly, competition in the air transport sector has intensified with the liberalization of European air transport in the mid-1990s, which sets the stage for the emergence of the low-cost airlines (hereafter LCCs) with important consequences for the airports' business model.

This transformation of the competitive landscape with the emergence of LCC's has to be analyzed in an institutional and regulatory context, which changed considerably since 2005. The management of French airports is increasingly delegated to private-law managing companies that operate public airports through concession contracts. Their business models have evolved toward a more profit-oriented structure, including non-aeronautical activities. At the same time, local and regional authorities, particularly regions, have become increasingly involved in the management of some infrastructures since the 2005 Law related to airports management.

The ownership structure of French airports changed, as the rules on airport ownership were also changed in the 2005 Law and opened it up to private investors. Toulouse, Nice, and Lyon airports were successively involved in this process. Aéroports de Paris, operated by a 100% state company under a private-law statute was also a candidate for privatization, but the privatization was postponed in the spring 2020 because of the uncertainties induced by the pandemic, and a overcautious public consultation.

Independent of these changes, there are still airports with persistent market power. The regulatory framework of airports has therefore also undergone major changes with the creation of a sectoral regulatory agency, the ASI (Independent Supervisory Authority) whose powers have been transferred in 2019 to the ART (Transport Regulatory Authority). However, there are difference between the regulation of the large airports (category I &II) and the regulatory problems of small regional airports with excessive capacity which, for political reasons, cannot be closed. The market power is reversed in the airports of the third and fourth category. Here the airlines, in particular LCCs that are not locked in a specific airport can arbitrate between them and thus have much choice because of the excess of airport capacities in numerous French regions.

Our chapter is structured as follows. Its first section presents data on French airports. It describes the main characteristics of their activity and addresses the question of their financial situation, mainly up to 2012. [1] The second section is devoted to the analysis of the legal and regulatory framework. The third section deals

[1] Financial data are only available for the period until 2012. After 2012, the DGAC, the French civil aviation authority, decided not to collect such financial data anymore, only traffic data. These data however are homogenous among airports whereas more recent data, when available, do not have the same granularity and homogeneity among airports. Still the presentation of the financial data from year 2012 gives an idea of the structure of the revenues for airports and how it evolved through time.

Table 14.1 French Airports Traffic (PAX MIN (resp. PAX MAX) represents the lowest (resp. highest) number of PAX of this particular group of airports)

Airport group (2019)	Number of airports	PAX MIN	PAX MAX
Paris Aéroports (CDG + Orly)	2	31,855,126	76,167,233
Large Metropolitan airports (> 5M PAX)	7	7,225,390	14,484,299
Overseas	15	114,659	2,487,348
Medium regional airports (1M PAX<<5M PAX)	8	1,065,976	3,982,531
Intermediate (100,000 PAX< < 1M PAX)	23	102,064	851,558

Source: DGAC (2020)

with two important but different regulatory issues: The first is how the regulation of large airport with persistent market has been reformed and especially how the trade-off between single-till and dual-till has been dealt with. The second issue consists of the fact that there are too many small regional airports so that Low-Cost Carrier can excessively gain from this situation. The final section concludes the analysis.

14.2 Some Basic Facts of French Airports

There are 550 aerodromes in France and its overseas territory, 460 on the mainland. However, only 40 airports [2] have more than 100,000 passengers per year. Almost 214 Million passengers traveled through French airports in 2019, before the Covid pandemic struck in 2020. This was an increase of 3.8% compared to 2018, a bit lower than the increase of worldwide traffic (5.5%). Just a few airports are accountable for the major part of the traffic, [3] with Paris Aéroports (CDG + Orly), accounting for almost half, see Table 14.1.

The network of French airports is particularly dense, which has many consequences for the economic model of the different airports. In a report published in January 2017, the General Council for Equality of Territories (CGET 2017) identified three different types of infrastructures with different implications for economic activity, development prospects, and budgetary equilibria:

The Paris Aéroports (CDG + Orly) together with the airports in large metropolitan areas belong to the first category. Their geographical position gives them a strong

[2] Including seven overseas airports (with about 180,000 PAX/per year).

[3] The major airports considered in our analysis are the Paris Aéroports (at the time ADP-Aéroports de Paris, including Orly and Charles de Gaulle airports), and nine regional airports: Aéroports de la Côte d'azur (Nice), Lyon (Lyon Saint Exupéry), Marseille-Provence, Toulouse-Blagnac, Bâle-Mulhouse, Bordeaux-Mérignac, Loire-Atlantique (Nantes), Montpellier-Méditerranée, and Strasbourg-Entzheim, and three overseas airports: la Réunion, Pointe-à-Pitre, and la Martinique.

position vis-à-vis companies that have few alternatives in the point-to-point services market (only Beauvais airport catches some of the LCCs' customers). [4] Nevertheless, Paris airports, specifically CDG compete with other international hubs (such as, for example, Frankfurt, Amsterdam, and Heathrow) for transfer passengers (connecting rate was 22.7% in 2019), particularly those to which the major regional French airports are linked. [5]

ADP also has a high-speed train station and get passengers through intramodality. On some routes, Paris Aéroports also compete indirectly with high-speed rail lines, but this intramodal competition is stronger for regional airports, such as Bordeaux or Strasbourg airports, where high-speed rail links have recently been opened. [6]

The second category of airports are the major regional airports. Their position has been strengthened by the concentration of traffic at major regional airports. [7] Indeed, Toulouse and Bâle-Mulhouse concentrate an increasing share of the regional traffic of Occitanie and Grand Est regions, respectively, at the expense of smaller regional airports such as Montpellier and Strasbourg. But, at the same time, they are facing a tougher regulatory system related to the level of their fees.[8]

The third category of airports corresponds to infrastructures benefitting from a dynamic hinterland linked to a large urban area such as Montpellier, Lille, Rennes,

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[4] ADP controls the two largest French airports and all the routes connecting to Paris. In the government privatization initiative it had never been envisaged to dismantle the two ADP airports in order to intensify competition in contrasts to the British experience, which broke up the BAA monopoly for the London region. See CMA (2016) for further details.

[5] Market power on most transfer traffic is not very high. See Mueller et al. (2010) in Forsyth et al. (2010) estimated in their market power study of Amsterdam Airport that in comparison with Heathrow, Schiphol, and Frankfurt airport, CDG was dominant on the Europe/South America market with 36% of the transfer passengers, But it had only 14% of the market with North America and 13% of the market with the Middle East (Appendix J)

[6] Such intramodal competition would be even stronger with environmental policies-based constraints restricting point-to-point domestic flights, or completely prohibited. "The French National Assembly approved a ban on internal flights where an alternative train journey is available on a trip of 2h 30min or less." https://www.railjournal.com/regions/europe/french-parliament-backs-ban-on-short-domestic-flights-that-compete-with-rail/

[7] This process is known in Geographical economics as *metropolisation* of the economy. See, for instance, Krätke (2007). The notion is used by the French Government (CGET 2017, p. 17). The underlying idea is the following: As the traffic is more and more concentrated in large regional airports the smaller airports increasingly face overcapacities. Lower economic activity in certain French regions (except in their largest cities) leads the incumbent carrier to reduce its routes from secondary airports. Therefore, smaller airports become increasingly dependent on LCCs. These airports cannot address their overcapacity as it is a sunk cost. Furthermore, it is impossible from a political point of view to reduce their capacities or even close the airport (political cost related to a decreased connectivity). From a broader perspective this is not only a political but also an economic issue, as the revenues generated by tourism and so on in the regional economy make policies attracting low-cost carriers politically attractive. It may even lead to participate financially in marketing campaigns or to grant rebates on airport charges. We address these issues in our last sections.

[8] One measure of the more stringent regulation of airport charges could be a change in the rate of refusals of these requests by the French regulator.

Table 14.2 Share of low-cost traffic for the ten major French airports in terms of PAX in 2019

Airport name	Share of LCCs in total traffic (PAX)
Paris airports	
Paris Charles De Gaulle	14.7%
Paris Orly	40.4%
Large metropolitan airports	
Nice	44.9%
Lyon	39.7%
Marseille	37.5%
Toulouse	43.4%
Nantes	63.7%
Medium regional airports	
Paris Beauvais	99.9%
Lille	48%

Source: UAF, 2019 report

or Strasbourg. The challenges for these airports are related to the fact they are required by local goverments to preserve their routes in a defavorable context charaterised by a strong competition that is both intermodal (especially for routes to Paris) and by significant overlaps between their catchment areas and but those of other neighboring airports. [9]

The fourth category of airports is mostly unprofitable. These airports are those with a catchment area more oriented toward residential or leisure activities. They face more competition from one another because of they have the highest rate of dependence on LCCs [10] (see Dobruskes 2005 and Table 14.2, for instance, with Nantes, Lille, and ultimately Paris Beauvais), and have the most precarious financial equilibrium (Carrard 2013, 2016), because their capacity to generate commercial revenues is much more limited.

While bigger airports still have an important share of LCCs traffic, this share will often be limited by the fact that Legacy Carriers operate frequent connections at these airports (Table 14.2). Besides, access to slots is limited by the Grand Father's rights rule, which may prevent the expansion of LCCs at these airports. [11]

[9]The CEGT report (2017, p.25) provides striking examples of airports catchment areas' overlappings. Such overlappings are particularly significant between Marseille, Avignon, Nîmes, and Montpellier airports.

[10]For vicinity airports, the share of LCCs often exceeds 80% as, for instance (Béziers, Carcassonne, La Rochelle, Limoges); source CEGT (2017), with DGAC data.

[11]We can mention the ongoing negotiations between the French Gov and the EU Commission regarding the restructuring of aid to the benefit of Air France (transforming a shareholder loan in a mezzanine debt). The counterpart required by the EU Commission is for Air France to abandon some slots at Orly, as the Lufthansa did last year in Munich and Frankfort. The unavailability of slots in Orly (in the morning and in the evening) is a barrier to development for Low-Cost Carriers in the French domestic market. It also impairs their ability to propose self-connecting offers to their customers.

Besides, some of these smaller airports are part of the process of national land planning aiming at developing regions and ensuring better connectivity, so these are often financially supported by local governments to this end. [12] Others play part in local governments' strategies aiming at attracting tourism demand. However, the economic success of such infrastructures is often questionable. [13] Furthermore, one often finds a lack of coordination with nearby local governments, which are also engaged in supporting their own airport infrastructures. The CGET (2017) report illustrates this case for several French airports, for instance, between Marseille and Montpellier. Its analysis converges with the one performed in 2014. This is also confirmed by the European Court of Auditors Report (2014) that is mentioning the overlapping catchment areas of regional airports (mainly in Spain and Portugal) developed without coordination. [14]

Traffic Analysis

Paris Aeroports with 108 million PAX/pa represents 57% of the traffic operated by the 13 largest airports shown in Table 14.3. Orly airport operated 31.9 Million PAX in 2019, in reduction by 3.8% with respect to 2018. Charles de Gaulle airport, on the contrary, has seen an increase of its traffic by 5.4%, reaching 76.2 Million PAX in 2019. The third largest airport is Nice—Côte d'Azur with 8% of the traffic. A relative concentration is observed in the aircraft movements: Paris Aeroports (Orly and Charles de Gaulle) represents 49% of the total number of movements, whereas Nice airport is the third most active airport with 11% of the movements.

Table 14.4 shows a general growth of traffic at the main French airports [15] during the past 5 years. The year 2019 has been a very active year in terms of traffic in France. Despite a lower GDP growth over the same period (+7%), traffic growth was 21.5%. The biggest increase of traffic took place at regional airports. Bordeaux and

[12] See, for instance, the case of Dole and Dijon airports as analyzed by the Cour des Comptes (the French public accounts control body) in its 2015 Report. The Cour stresses that these two airports cannot be profitably operated because of their geographical proximity and their lack of coordination. According to the Cour, from 2008 to 2013, traffic for each airports never exceeded 100,000 PAX. In 2019, commercial movements in Dijon airport were zero. Only business aviation flights are operated. The traffic in Dole reached in the same time 111,161 PAX/pa.

This issue of a possible bias regarding the investments in public infrastructure by local governments is well documented in academic literature. See, for instance, Rodriguez-Pose et al. (2018) who suggest that weak local government is more inclined to commit into over-sized transport projects because of a reliance on to optimistic traffic forecasts or/and a genereous ex ante socio-economic gains assessments.

[13] The same reasoning can be applied to other airports regarding freight activities, for instance, Paris Vatry airport.

[14] However, one must keep in mind that some small airports may have a different business model by specializing in general or business aviation and can thereby potentially reach a financial equilibrium with a much smaller scale than typical regional airports.

[15] Paris Beauvais airport had almost 4 Million passengers in 2014 but is excluded from our analysis because of the lack of financial data available.

Table 14.3 Traffic at main French airports (2019, 2015)

City/airport	Total terminal passengers 2019	Variation average 2019/2015 (%)	Total movements 2019	Variation average 2019/2015 (%)
Paris Airports	107,968,021	3.2	716,524	0.6
Incl. Paris Charles De Gaulle	*76,150,007*		*498,175*	
And Paris Orly	*31,853,049*		*218,349*	
Large metropolitan airports				
Nice	14,468,813	4.8	166,781	1.4
Lyon	11,691,524	7.9	113,524	1.8
Marseille	10,122,706	5.4	97,503	1.8
Toulouse	9,597,311	5.9	87,731	2.2
Bale Mulhouse	9,087,253	6.6	81,572	2.7
Bordeaux	7,679,425	9.8	66,794	6.0
Nantes	7,190,862	13.7	63,207	6.4
Medium regional airports				
Montpellier	1,934,460	6.4	19,284	3.5
Strasbourg	1,283,287	2.0	18,423	–3.3
Overseas airports				
La Reunion	2,451,666	4.5	13,204	2.1
Pointe A Pitre	2,412,963	4.7	28,260	–0.6
Martinique	1,975,325	4.8	18,350	–2.6

Source: ENAC Database (these data are based on airport traffic; therefore, we can have some double accounting for domestic passengers. For instance, a passenger flying from Paris to Nice will be accounted both in statistics for ADP and Nice)

Nantes airports increased their rates a the two-digit level, while the increase in the major regional airports has also been above the average (5.4%) growth of the group. The reductions in movements and low increase of traffic at Paris Orly Airport is a special case and the result of the legal capacity constraint in place, [16] even though Orly's economic model is mainly based on daily business travels between French major cities and Paris.

Concerning "hub competition" in France, some competition exists between the largest French airports and large European airports on international flights. For instance, ADP competes with Schiphol (Amsterdam airport [17]) or Frankfurt airport on Asian destinations, and Nice and ADP airports compete with Frankfurt airport for

[16] Indeed, the Air France Shuttle frequency is at its maximum at peak load periods of the day, e.g. early morning, and late afternoon.

[17] As a reaction to the merger of Air France and KLM ADP and Schiphol formed an alliance in 2008 in order to coordinate the dual hub. See Forsyth et al. (2011).

transatlantic routes. ADP has a very strong position on routes to Latin America (Mueller 2009) in Forsyth et al. (2010). Some airports compete with other airports (French or foreign) that are within their catchment area, for instance, Bâle-Mulhouse compete with Stuttgart and Baden-Baden, Lyon with Geneva airport. The HST traffic from/to Paris competes with flights from Lyon airport, Marseille-Provence airport, Bordeaux airport, and Strasbourg airport. Moreover, the other airports like Marseille, Montpellier, and Strasbourg are mainly competing with other means of transportation as high-speed train, and competition with other airports is lower (Forsyth et al. 2010).

Financial Data

Financial data used are the ones from the year 2012. [18] These data come from the annual report of the DGAC, the French Civil Aviation Administration. According to the report produced by the CGET in January 2017, the financial equilibrium of airports (including financing of investment and real estate) is achievable above 1 million PAX/p.a. Above 3–5 million PAX it is possible to diversify activities and remunerate shareholders. Financial equilibrium would be more difficult to achieve below 1 million PAX and impossible below 500,000 (CEGT 2017).

Table 14.4 gives total revenues by source (aeronautical and non-aeronautical), as well as the turnover per passenger. For instance, each passenger at ADP airports yielded almost 22 € in 2012, the highest value in the table. These airport revenues are from two activities: aeronautical revenues/aeronautical fees (for passengers, landing, and parking of aircraft) [19, 20] from their core activity, and non-aeronautical revenues from commercial activities like property rental and parking fees (for passengers), which are becoming more and more important. For instance, at Paris Airports, a passenger yields 9.77 € of aeronautical revenues, and 11.39 € of non-aeronautical revenues in 2012. Overseas airports have higher aeronautical revenues per PAX than the average. Interestingly, the table shows also that the share of the aeronautical and non-aeronautical revenues differs across airports: for instance, aeronautical revenues represent 45% of the turnover for Paris Airports but only 35% for Bâle-Mulhouse airport or 36% for Montpellier airport, which is smaller in size and allows fewer specialized shops and restaurants.

[18] We have made the choice to rely exclusively on the DGAC data because of their homogeneity. We could extract data from the different airport's financial reports, but we would be exposed to several concerns related to the heterogeneity of the underlying accounting conventions and choices and to some extent to a lack of a reliability.

[19] The aeronautical revenues are stemming from the fees paid by the airlines to the airports for the aeronautical services. These are called "airport charges" for the rest of the document. The airport charges calculations are based on various criteria such as the number of landings, the number of PAX, the duration of aircraft parking, the aircraft weight.

[20] The figures exclude the airport tax set by the government and collected by the airport to finance security activities (pre-financed by the airport and reimbursed by the State).

Table 14.4 Turnover allocated between aeronautical and non-aeronautical

Airports	Aeronautical revenues 2012, €/PAX	Non-aeronautical revenues 2012, €/PAX	Turnover 2012, €/PAX
Paris Aeroports	9.77	11.89	21.66
Large metropolitan airports			
Nice	6.21	7.95	14.16
Lyon	6.49	7.43	13.92
Marseille	4.26	6.39	10.65
Toulouse	5.39	6.04	11.43
Bale-Mulhouse	5.81	10.67	16.48
Bordeaux	3.81	6.06	9.87
Nantes	5.28	6.01	11.29
Medium regional airports			
Montpellier	3.76	6.73	10.49
Strasbourg	5.63	7.31	12.94
Overseas airports			
La Reunion	11.24	7.88	19.12
Pointe-A-Pitre	10.17	6.24	16.41
Martinique	9.52	6.51	16.3

Aeronautical revenues per PAX, 2012. Source: DGAC report, 2012

The aeronautical charge is subject to specific regulation in France, due to a historical monopoly [21] position of the airport. The regulation contract stipulates generally price-caps [22] to limit the level of the airport charges.

14.3 Institutional and Legal Features of the French Airports

French Airports Economic Situation and Institutional Regime: An Overview

What is interesting about the situation in France is that the competitive environment and the institutional and regulatory framework of French airports have undergone major changes over the past two decades. Firstly, competition in the air transport sector has intensified with the introduction of low-cost airlines (hereafter LCCs) with

[21] The total fee paid by the airlines to the airports is divided into two parts: the airport charges for the aeronautical services and the taxes finally set by and due to the State.

[22] See supra for a description of the area of regulation and the criteria taken into account to set a level of price-cap.

important consequences for the airports' business model. [23] In other words, airport infrastructure operators now have to deal with the competitive pressure from airlines, contrary to the conventional conjecture according to which airports systematically enjoy market power.

This new competitive situation does not affect all airports in a uniform manner, as LCCs being themselves different from one another. A company such as EasyJet is a competitor to Air France on domestic routes, whether transversal (province-province) or radial ones (province-Paris). It exerts competitive pressure on the incumbent operator. Nevertheless, its development is hampered by the lack of slots available at peak times at ADP, particularly at Orly. Indeed, the level of airport charges is not the main concern for the LCC's as these are capped by sectoral regulation. Furthermore, a growing proportion of its customers on this radial segment are business customers whose demand is not very price elastic, but is particularly attached to frequency but also to journey duration. Thus, both at Paris airports and at the major provincial airports, the slots for these radial connections are seen as strategic assets that must be preserved. The possibility of putting airports in competition with each other on Paris related routes is therefore extremely low, if not zero. Furthermore, there is no overlap between the catchment areas of the various major regional airports for these routes Province to Paris. [24]

The situation is quite different for the secondary regional airports., where the low-cost carriers operate mainly leisure related routes (with the exception of Beauvais). LCCs can therefore play on the "geographical" competition between these airports whose catchment areas sometimes overlap, or which serve touristic locations, which may be in competition with each other for foreign leisure customers. The pressure of LCCs on infrastructure managers to obtain reductions in charges may be all the greater as they have low-cost exit options and their customers are particularly price sensitive.

This transformation of the competitive landscape with the emergence of LCC's has to be analyzed in regard to an institutional and regulatory context, which changed considerably since 2005. Since then, the management of French airports is increasingly delegated to private-law managing companies that operate airports though concession contracts. Their business models have evolved toward a more profit-oriented structure, including non-aeronautical activities. [25] At the same time,

[23] The economic model of LCCs requires shorter rotations at the airports, which sometimes leads to specific investments (e.g., dedicated terminals), implying additional fixed costs, reduced flexibility and in some cases, airports receive lower revenues per movement, as LCCs request to reduce the level of fees, or even to cover part of the investments and costs linked to new services, and to co-finance marketing campaigns. This can conflict with charge setting rules, as it would disconnect charges from costs and may lead to differences in treatment of airlines and would result in second-degree discrimination. At the same time, it would compromise the ability of infrastructure managers to balance their accounts by not allowing them to cover all their costs.

[24] These catchment areas are also smaller for business than for leisure customers.

[25] For instance, a French ministerial report (CGET 2017) shows that in Montpellier non-aeronautical revenues represent 37% of revenues, in Basel-Mulhouse 54% of the total revenues; and in Beauvais

local and regional authorities, particularly regions, have become increasingly involved in the management of some infrastructures since the 2005 Law related to airports management.[26, 27]

The ownership structure of French major regional airports managing companies has also changed. Following the precedent of private French highways, the rules on ownership for some of the airport companies were changed with the 2005 Law [28] and opened to private investors, so they could be operated through concession contracts. Toulouse, Nice, and Lyon airports were successively involved in this process Aéroports de Paris, operated by a 100% state company under a private-law statute was also a candidate for privatization, where the private investors would have been awarded a 70-year concession contract. [29] However, the privatization was postponed in the spring 2020 because of the uncertainties induced by the pandemic, and a public consultation/referendum initiated by opponents of the project. [30]

The regulatory framework of airports has also undergone major changes with the creation of a sectoral regulatory agency, the ASI (Independent Supervisory Authority) in October 2017, whose powers have been transferred to the ART (Transport Regulatory Authority) in October 2019. [31] This sectoral regulator is responsible for the regulation contracts of airports, or in the absence of such a multi-year contract, of the yearly homologation/approval of their airport charges. The latter includes the level of airport charges, which are an essential dimension of negotiations with the LCCs, as numerous competition law-based procedures testify.

The issues raised by the new regulatory framework are important as the different airports' bargaining powers depend on their size and the relative importance of the

68%, there largely through the operation of a bus service to Paris. In the case of Beauvais, the low airport charges are partially financed through the revenues yielded by the offered services to access to the airport. See Decision No. 19-D-22 of the French Competition Authority of 22 November 2019

[26] This transfer was aligned with a general policy of decentralization, which second phase took place in 2002 (after a first one in 1982). The purpose was to empower local governments by giving it the authority on regional economic development and transport planning.

[27] The French law n° 2005-357, dated 20 April 2005 has led to the creation of private airport companies ("Société Anonyme") in which public local authorities have become shareholders, owning 15% of the shares for 12 major regional airports.

[28] For instance, Toulouse airport remains owned in majority by public shareholding as the State only sold 49.9%.

[29] The privatization project of Aéroports de Paris, the managing company of Orly and Charles De Gaulle airports was initiated in the summer of 2018. This was integral to Macron's drive to curb government involvement where he believes the private sector would better deliver investment and change. https://www.reuters.com/article/us-france-adp-privatisation-analysis-idUSKCN1TS29V

[30] See https://www.internationalairportreview.com/article/104573/groupe-adp-industry-stability-regulations/

[31] The transport regulatory authority (ART) regulates only 8 French airports with an annual traffic of 5 million PAX, e.g. Aéroports de Paris (108 millions), Aéroports de la Côte d'Azur (14.5), Aéroports de Lyon (11.7), Aéroport de Marseille Provence (10.1), Aéroport de Toulouse Blagnac (9.7), Aéroport de Bâle-Mulhouse (9.1), Aéroport de Bordeaux Mérignac (7.7), Aéroport Nantes Atlantique (7.2); 2019 traffic data available on the ART website.

different airlines. Simultaneously, airlines claim that all airports, despite what they say, have strong market power and therefore advocate for stronger regulation. Additionally, airlines are concerned that economic regulation contracts are imposed on them without a sufficient transparency and negotiation margin.[32]

The "blurring of the lines" between public and private ownership and management of airports, highlighted by the 2016 ACI report (Airport Council International—Europe 2016), is also a major characteristic of the French infrastructure. Against the history of dominant public involvement in airports in the past, this is now changing. The corporatization process that begun at Paris Aéroports in 2005 has spread over the country. Major regional airports operating companies were created under the form of private-law companies, exclusively State-owned. Concession contracts were used to arrange the relationships between these companies and the public authorities that still enjoy property rights on the airport's assets. Simultaneously, secondary airports were transferred to local governments for infrastructure property while their management could be delegated to private operators through concessive agreement [33] (Table 14.5).

When envisaging privatization, the market positions of French airport's present sharp differences in terms of traffic size, business models, financial situations, etc. Regional airports are not such attractive candidates, because they do not benefit from the same bargaining power vis-à-vis carriers as ADP or large regional airports because of their relative "substitutability" for LCCs (especially for leisure travelers), with some cases of overlapping catchment areas, and consequently by tax competition phenomena among them. Given the high level of fixed and sunk costs, that are more and more commonly run through concession contracts, and as local governments exert a significant political (and contractual) pressure to maintain and to develop routes, airport managing company has strong incentives to enter in contracts with LCCs, whatever it takes. In other words, this dynamic may lead to unbalanced privatization contracts.

But, on the other hand, Paris Aéroport is a hub enjoying market power on feeding routes, considering the French centralization of the political and economic activity, so it was an attractive candidate for partial privatization. Some major regional airports as Nice, Lyon, and Toulouse, where also seen as attractive privatization candidates, when considering the transformation of their ownership structure, evolving toward private control via a managing company. When a new airport was promised to be built near Nantes under a concession contract, this was also seen as

[32] French regulation obliges the airport managing company to consult the airspace users on their projects (notably airport charges) before requesting the approval by the regulator (Cocoeco—Commission Consultative Economique). Hence, airlines are informed but cannot influence the outcome.

[33] From to 1929 to the 2005 Law, regional airports were operated by local Chambers of Commerce, a public entity. The transfer of the management to local governments was made to pursue regional economic development.

Table 14.5 Airport operating companies' partial privatization

Airport's concessionaire partial privatization	Date of the partial privatization and comments	Date of the concession contract
Toulouse	April 2015 Initial shareholder structure Casil Europe 49.9%; 10.1% French State; 40% local governments and public entities (Haute-Garonne Chamber of Commerce and Industry 25%, City of Toulouse 5%, Haute-Garonne department 5%, and Occitanie region 5%) Current shareholder structure In December 2019, Eiffage group bought the 49.9% of Casil Europe. This operation has been approved by the French Competition Authority	2007
Nice	October 2016 64% Azzurra Aeroporti (Atlantia, Aéroport de Rome, and EDF), Nice Côte d'Azur Chamber of Commerce and Industry 25%, City of Nice 5%, Provence–Alpes–Côte d'Azur region 5%, Alpes-Maritimes department 1% Current shareholder structure In June 2017, the principality of Monaco acquired 12.5% of the shares, the participation of Atlantia felt at 51.5%	2008
Lyon	March 2017 60% (Vinci Airports, Caisse des Dépôts et Consignations, Crédit Agricole Assurances—Predica), Chamber of Commerce and Industry 25%, Rhône-Alpes-Auvergne region 5%, Rhône department 5%, Lyon Métropole 5%	2007
Paris	Decision to postpone the privatization taken in March 2020 because of the COVID-19 Crisis and public consultation concerns	None
Bordeaux	N/A	2007
Montpellier	N/A	2009
Fort de France	N/A	2012
Marseille	N/A	2014

Source: airports annual reports and ART

attractive deal, but the planned construction was cancelled by government because of local opposition (Cour des comptes 2020). [34]

Even if the airports remained in public ownership, its operations can be managed by private firms, through concession contracts. Besides, the recourse to a private

[34] In the Nantes concession contract, the concessionaire was allowed to pre-finance the future airport by imposing +2% of charges every year. Nantes was probably the more profitable airport of the last decade with no investments, public funding, and a high level of charges.

management model can be both explained by the budgetary constraints of public bodies, but now, also from the influence of EU competition rules regarding equal access to the management of economic activities. [35] For instance, Vinci operates 12 airports in France (including, e.g., Lyon, Nantes, and Rennes) through dedicated projects companies. Pau airport has been managed by Air'Py (a concession between the Chamber of Commerce, Egis, and Transdev) since 2017.

Finally, EU regulations become important concerning nondiscriminatory access regarding airport contracts with airlines. On the other hand, the EU 2014 guidelines, which are neutral on the issue of the public or private ownership [36] provide some room for public intervention (aiming, for instance, at correcting market failure or the compensation of a regional disadvantage). However, since airports perform an economic activity, they are subject to competition laws.

At the airport level, one of the major concerns of competition policy is state aid. In the case of government support (subsidy, tax rebate or exemption, government guarantees, etc.), the EU must be notified if this falls under the scope of compatible State Aids (regional handicap, one-off measures for new lines, transitory operating aids, etc.) or can be admitted while it meets the requirements of the criterion of the market private investor. [37] In other words, if the risk associated with the investment could have been accepted by a diligent private investor, the investment decision would not be considered as "State aid" and consequently, would not have to be notified to the European Commission.

Even if an operating company is not privatized, it has incentives to adopt a market-based logic consistent with the notion of hybridization of airport management. [38] This stems from the necessities for some of them to raise funds to develop or to maintain infrastructure and from the requirement to limit financial imbalances (and by the way the required public budgetary support) for others. The growing

[35] Some airports were operated by the chambers of commerce through concessions contracts since the 1930s. However, these contracts were awarded without any competition. The principles of equal access to administrative contracts impose a move to competitive tendering.

[36] EU Commission, Guidelines on State aid to airports and airlines, 2014/C 99/03, 4 April 2014

[37] An EU competition law-based dispute relating to public aids regulation can be taken as an example. The one involved an agreement between Ryanair and Nîmes airport. According to the European authorities, the co-financing of a promotional campaign by the airport did not correspond to the logic of a private investor in a market economy, since the campaign benefited the LCC more than the airport itself. See the case T-53/16, Ryanair v European Commission, General Court.

[38] The notion of hybridization can be defined as organizational arrangements at the intersection of public and private spheres of economic activity (Quélin et al. 2017). In the case of airports, it involves government property of the infrastructure with the management of the airport transferred to a public–private consortium through a concession contract. Such a model can also be linked to the notion of institutionalized public–private partnership. See, for instance, European Commission, interpretative communication on the application of Community law on Public Procurement and Concessions to institutionalized PPP (IPPP), OJ C 91, 12 April 2008.

importance of non-aeronautical revenues, mostly composed of commercial revenues in the airport business models, [39] testifies of this paradigmatic shift.

In the industrial organization literature, airports are increasingly modeled as two-sided platforms (Sokullu et al. 2012). In a nutshell, the management of the airport operations no longer exclusively relies on aeronautical revenues to balance the airport's account. The financial balance may be reached by playing on the positive externality produced by passenger flows on airport commercial revenues (royalties on shops, car park revenues, etc.). [40] In other words, the loss of revenues implied by strategies aiming at increasing the demand on a side of the activity (e.g., reducing aeronautical fees in order to increase airlines traffic) may be overcompensated by the additional revenues produced on the other side (e.g., commercial ones [41]). Such a strategy may lead an airport manager, who acts as a private market investor, to grant rebates to low-cost carriers in order to increase the traffic. If the cross elasticity is sufficient, the distortion induced by the tariff structure allows to balance its accounts. The trade-off between single-till and dual-till models should be considered under this light.

To summarize, the privatization process of French airports operating companies can be considered in the light of the transformations in air transportation sector. The structure of the financial revenues of airports suggests that the airports have adapted their business models: operating as a two-sided platform and benefitting from the cross-effects between aeronautical and commercial revenues can be the best way to optimize airport profits (Carrard 2016; Albalate et al. 2014).

The Institutional Dynamics of French Airports

This section addresses the case of three categories of airports: the case of Parisian airports, the major regional airports such as Nice, Marseille, Lyon, or Toulouse, and local airports. We analyze separately the case of Paris Aéroports and one of the three major regional airports because of the economic specificities of the first one, but we

[39] According to Malavolti (2016), the share of non-aeronautical revenues was higher than 50% for Bâle-Mulhouse airport from 2008 to 2012 and systematically above a threshold of 35% for the other French major airports. Their share has increased from 54% to 60% for Paris Aéroports between the same period.

[40] See Hagiu and Wright (2015) for a definition of situations, which correspond to two-sided markets. Such a model can be applied to airports. Ivaldi et al. (2015), for instance, quantify the externalities between commercial and aeronautical activities on US airports.

[41] In the perspective of two-sided business model, the airport management company may balance its accounts between these two sides of its activity. In a single-till model the other stakeholders benefit from the profits realized on the second side of the market. Things are rather different in a dual-till model without mandatory transfers from one side to another. The case of Nice Airport is emblematic of such a situation. The Aéroport de la Côte d'Azur company was authorized to opt for a dual till by ministerial order issued the 12 July 2018. As this one was cancelled by the State Council (31 December 2019), a new ministerial order was issued the 3 February 2020. This one confirms that no transfers have to be made from the unregulated perimeter to the regulated one: "profits from activities outside [the regulated perimeter] are not taken into account when setting charges" (article 1).

do not consider its specific place in the French public debate. [42] The case of local airports is considered with respect to their budgetary difficulties.

The Parisian airports are operated by a state-owned dedicated public company, Paris Aeroports (Aéroports de Paris). From 1945 to 2005, the managing entity was a public one ("établissement public") and since 2005, it has been corporatized (as Société anonyme), but it is still majority owned by the State.

The corporatization process of the Parisian airports started more than 15 years ago in order to cope with the transformation of air transport sector and the necessity to invest more in airports, [43] and the requirements of the EU competition laws. The large state-owned regional airports were managed since the 1930s by the local Chambers of Commerce through concession contracts. [44]

The policy shift was prepared by a joint committee associating the main stakeholders of airports which published in November 2002 a *Livre Blanc* proposing to create private companies publicly owned to run airports and to make the State regulation evolve from a cost-reimbursement regulation model to a more incentive compatible price-cap regulation (Union des chambres de commerce et gestionnaires d'aéroports 2002).

Airport property started to be transferred to local governments since 2004. [45] The whole institutional landscape was turned into a landscape showing increased corporatization and devolution by the 2005-357 law of 20 April 2005 (Carrard 2016). Thus, Paris Aéroports was transformed into a State-owned company, in which the State is allowed to cede some of its shares but has to keep a majority. A first transfer of Paris Aéroports shares took place in June 2006, a second in 2008 to institutionalize the alliance with Amsterdam-Schiphol Airport (cross-shareholding agreement), and a third in 2009, at the benefit of the French sovereign fund, the *Fonds d'Investissement Stratégique*.

The April 2005 law also affected the main regional airports. Twelve important regional airports implemented the model of a private-law company with public shareholding, with a joint management between the State, local governments and

[42] A project of "privatization" of the Paris Aéroports managing company (through a concession contract) was initiated in 2018. This very contested project (by both politicians, unions, citizens, and academics...) was eventually cancelled because of the COVID 19 crisis.

[43] Two types of investments should be distinguished. The first ones are related to commercial facilities (see Roissy, Toulouse, or Nice, for instance). The second ones concern new infrastructure (as the now-cancelled project of a new terminal "T4" in Roissy Charles De Gaulle airport.

[44] The concession contract allows to recoup initial investments through the operated services by the airport. Typically, in a concession contract, the assets are transferred back to the concession contract grantor for free. The specificity of the Paris airport concession contract was the concessionaire would be financially compensated at the end of the contract. It was all the more surprising that the duration of the contract was a long-term one (70 years) and that the infrastructure (except the T4) was already existing. The 2014 EU directive on concession contract establishes a direct link between the investments expected from the concessionaire and the duration of its concession.

[45] The 2004 law is related to the decentralization of airport ownership from the State to public local authorities: 150 airports were at stake; this process was implemented in 2007.

the chambers of commerce and acquired the possibility to sell shares to new public or private investors.

Finally, the 2005 law also resulted in the transformation of the airport regulation framework. The regulation, as we will see below, has taken the form of an optional 5-year regulatory contract [46] implementing a price-cap model. [47] The 2005 Law has transformed major French Airports into limited commercial companies pursuing commercial strategies, even if they remain public entities. Regarding regional airports, the transfer of ownership to local authorities was completed in 2007 so that several airports were managed through SARs (société aéroportuaires régionales).

However, the institutional transformations of the French airports sector did not end with this 2005 law. The partial divestitures of the State shares of the managing companies of regional airports were initiated from 2014 on with the Toulouse airport. A consortium of Chinese funds and operators, and SNC Lavalin, a Canadian firm that already operated several small French airports, bought part of the State shares. This decision was sharply disputed by several stakeholders, notably on strategic grounds. However, only the airport management was transferred to the private partner (see Oum et al. 2006 for an analysis of such corporatization processes). The infrastructure itself is still state-owned, and in the concession contract, the grantor keeps control over the asset. After Toulouse airport, shares from Nice and Lyon were sold with the same kind of local oppositions (Carrard 2016). [48] In August 2015 the Macron law organized this partial privatization process.

The privatization of Toulouse Airport has been characterized by many difficulties, not only in its process but also in the management of the infrastructure. However, the French Highest Court of Auditors considered in its 2018 report on the privatization of the Toulouse, Lyon, and Lille airports that the subsequent privatizations of the managing companies of Nice and Lyon airports did not result in comparable difficulties, largely due to better preparation of the privatization process and better supervision of the company, who were awarded the concession contract (Cour des comptes 2018).[49] However during the privatization of the managing company of Nice airport some legal disputes arose, mainly regarding the adoption of a dual-till system of regulation, which is discussed in detail below.

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[46]The ERA are optional. It is part of the regulatory possibilities but it is not systematic. At the moment, all ERA have expired and major airports are back to a yearly system to fix the charges (even Paris)

[47]The regulatory contracts allow airports to automatically raise their charges on a year-to-year basis during the length of the contract. The absence of such contracts, the charges increase has to be confirmed by the regulator on a yearly basis. Moreover, airlines operators criticize the way that regulatory contracts are negotiated between airports and sector-specific regulator, considering the lack of involvement of other stakeholders as airlines.

[48]In Toulouse case, only 49.9% out of the 60% shares owned by the State were sold, whereas at Nice and Lyon, the totality of the 60% of State shares was sold.

[49]Concerning Toulouse Airport, the Cour indeed stresses the limits of that privatization process in terms of contract awarding (lack of experience from the main contractor in airport management) and in terms of transparency of airport financials.

The concession regime is not a new scheme in French administrative practices. It may also show variations in terms of duration, contractual flexibility, or control sharing between the operator and the grantor. A convergence toward more manageable governance structures can be found in an institutionalized public–private partnerships (IPPP, that is embodied in the French legal system by the *société d'économie mixte à operation unique* (de Brux and Marty 2014), a legal structure created in 2014). [50] Such a legal form is part of a continuum that begins with the corporatization of a public entity that is managing an airport (Klien 2014) and may end with the privatization of that managing company. The major difference with the latter option is that the contracting public entity retains control rights and can therefore regulate the company not only by contract but also from "inside" through its presence on the governing board. This reduces the asymmetric information from which the public partner suffers, and it limits the transaction costs. The academic literature is not unanimous about the economic effects of this governance structure. If informational concerns (moral hazard) can be partially addressed, some conflicts of interests are exacerbated as the public partner is both customer and shareholder (Da Cruz et al. 2014).

Indeed, the report on the French airports network published in 2017 by the CGET highlighted the possible difficulties associated with concession contracts used for private investors (CGET 2017). The duration of contracts, the uncertainty about airports charges, and the uncertainty about demand could lead the private investors to require high risk premiums. The IPPP model would therefore reconcile economic efficiency (via risk sharing arrangements between public and private partners) and control by public shareholders (de Brux and Marty 2014).

The transformation of airport activities, with an increasing share of non-aeronautical revenues and relying on both private sector management skill and capacities to invest with better access to private funds [51] has increased the interest for the use of concession contracts. However, also in the case of airport

[50] Such a contract is implemented for the redevelopment of the Gare du Nord in Paris, the public–private joint venture with Ceetrus, a commercial real-estate developer. The legal basis for the Gare du Nord project, the law n° 2017-257, enacted the 28 February 2017, is related to the Grand Paris project. The law was later modified by the executive order n°2019-552, 3 June 2019. The legal provisions states that "The company 'Gare du Nord 2024' has been set up for a limited period of time on an exclusive basis with a view to concluding and executing a concession contract with SNCF Voyageurs, the sole purpose of which is, on the one hand, to carry out a major restructuring and transformation of the station and, on the other hand, to operate and manage commercial and service activities within the Gare du Nord in Paris, in preparation for the City of Paris' bid to host the 2024 Olympic Games. This company, which will be in charge of the project and the financing of this operation, will not be able to carry out the tasks related to basic services or additional services." The Gare du Nord project is the most relevant model of an institutionalised PPP that can be implemented for airports management concession contracts.

[51] As is the case for many public infrastructures, the involvement in long-terms PPPs or concession contracts can be attractive for long-term "patient" investors as pension, insurance, or sovereign funds (Della Croce 2011). However, the current crisis tends to show that concession contracts (more than availability-payment based PPP ones) can be negatively impacted by risks of traffic reductions both circumstantial and structural (Amenc et al. 2020).

market power, a managing model via concession contracts will require an effective regulatory framework. Such a supervision, through regulatory contracts, may result in the airport manager accumulating and holding accounting reserves to, for instance, finance the development and maintenance of infrastructure [52] and to cope with episodes of sharply reduced activity such as the one we are experiencing today with the COVID-19 crisis. The dividend distribution policy must, for example, take into account the specific risks of an industry with extremely high fixed costs and which is therefore highly vulnerable to cyclical hazards, even beyond the environmental issues that may hinder the development of airports in the long term (nuisance for neighborhoods, flight shaming, etc.), despite the attractiveness of such investments for some long-term investors, such as insurance companies, sovereign funds, or pension funds.

14.4 Regulation of the Airports

This section discusses firstly the situation of the airports in the first two categories. These are usually airports with persistent market power. The reform of regulation has tried to improve the effectiveness of this regulation. The market power is reversed in the airports of the third and fourth category. Here the airlines, in particular footloose LCCs can chose between airports and thus have much choice because of excessive capacity in their region. What regulation can do in such a situation is discussed in the second part of this section.

The Regulatory Framework of Large French Airports

Before the 2005 law came into effect, the regulation of French airports was performed by the General Directorate for Civil Aviation (DGAC), the Ministry of Finance, and the DGCCRF. A cost-reimbursement scheme was usually proposed to the ministers in charge of economic affairs and transportation, following an assessment of the adequate airport charges and fees. This discretionary framework was radically transformed from 2005 on. If the airport managing companies opt for a regulatory contract, [53] it must submit a proposition to the regulator, after having consulting airspace users. This proposal is then discussed by an independent airport consultative committee. The price-cap was set considering the planned investments. The Ministers of Transports and of Economic affairs then proposed to the Government a regulatory contract based on an economic oversight formula, e.g. a price-cap regulation. [54]

[52] The tariffs take investments incentives into account, but it is not a tool able to assess efficiency of these investment decisions.

[53] But many of the major airports do not yet have a regulatory contract with the ART.

[54] We have to take into account the interplay between sector-specific regulation and the regulation by contract model induced by concession agreements. These last ones can provide for charges level & dual-till system (ex. Nice airport), pre-financing of future infrastructures (ex. Nantes). These

This regulation is not confined to a *RPI - X* type formula, as it may encompass essential dimensions of airport economics such as the choice between single and dual till. For instance, Paris Aéroports was allowed in its previous regulation contract (for 2011–15) to implement an adjusted dual-till system, moving a major part of non-aeronautical revenues outside economic regulation: exclusively the revenues from the car parking were included in the area of regulation. Toulouse Blagnac Airport was the second airport to adopt an economic regulatory contract in March 2009. This economic regulatory contract framework applies independently of whether the airport is publicly or privately operated. However, the airport managing company is free to opt for a multi-year regulatory contract or to choose a yearly homologation of its airport charges by the regulatory body in compliance with the 2009 EU directive on airport charges.

It should be noted that the signature of an economic regulation contract over 5 years has several advantages for the airport managing company. It allows it to avoid having to get its tariffs and their modulations approved each year by the regulator (as an incentive to develop traffic, increase the number of services, increase the rate of use of the infrastructures, etc.). Evolutions of charges can be implemented automatically as long as they are in line with the conditions provided for in the contract. However, airport managing companies may waive their commitment to an economic regulation contract. This was the case for Nice airport in 2017 [55] but also more recently for Aéroports de Paris due to the pandemic. [56]

A new regulatory authority was created through the decree 2016-825 of 23 June 2016, the *Autorité de supervision indépendante des redevances aéroportuaires (ASI)*. [57] The airport sector is converging toward a model with an independent administrative authority in charge of specific regulation for multiple sectors. The rail and road regulatory body (ARAFER), whose past mission was to approve the access charges of the railroad network, started in October 2019 to also take on the regulation of airport charges and became the ART—autorité de régulation des transports [58] (Table 14.6).

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provisions can limit the margin of the regulator and impair the capacity of airlines to be involved in the regulatory dialogue. The Commission Consultative Economique aims at addressing this issue but is often accused of being insufficient for guaranteeing an adequate level accountability toward the various stakeholders. The main criticisms rely on a lack of financial and accounting information regarding the weighted average cost of capital or an insufficient information about the efficiency of investment decisions.

[55] Opinion n°1704-A1 6 July 2017, Autorité de Supervision Indépendante related to an economic regulation contract between the Government and Aéroports de la Côte d'Azur.

[56] Aéroports de Paris, which had undertaken to negotiate a fourth economic regulation contract for the period 2021–25, renounced it in the spring 2020.

[57] As requested by directive 2009/12/EC of 11 March 2009 on airport charges (art.11).

[58] Before its replacement, the ASI had approved the charges for Basel-Mulhouse airport in February 2018, Toulouse-Blagnac, and Paris Aéroports in March 2018, Lyon in April 2018, and finally Bordeaux in April 2019.

Table 14.6 Contracts of economic regulation

Contracts of economic regulation	Dates
Paris Aéroports	3 successive economic regulation contracts 2006–2010, 2011–2015, 2016–2020
Lyon	2015–2019 delivered by ASI
Toulouse	2nd contract from 2014 to 2018

Sources: ART and authors

The case of Nice airport provides a typical example of the difficulties of regulating airport charges over time. Between April 2016 and March 2017, the charges were approved (tacitly) by the DGAC, which was then responsible for this task. ASI was created in June 2016, but the charges for the period between April 2017 and August 2018 were not submitted to it for approval, as French regulation allows the tariffs to be extended by 1 year, if they are not the subject of a new application for homologation. Using this possibility, Nice airport then asked the ASI to homologate its tariffs for the next period, which the latter refused by a decision of 12 December 2018. In the absence of a new request for approval, the ASI revised the airport charges on its own and decided in April 2019 to reduce them by a third. A new application for homologation was rejected by ART in November 2019. [59] After formal notice was served on Nice Airport in June 2020, ART finally approved new proposed charges on 17 September 2020 for the period from November 2020 to October 2021. [60]

Not all applications for the approval of airport charges have resulted in such conflicts. For instance, the ART has approved an increase of 1.59% of Paris Aéroports aeronautical charges as of 1st April 2020. [61] It has also approved the airport charges of Bâle-Mulhouse airport in February 2020 [62] and in February 2021 the tariffs proposed by the Marseille-Provence airport, correcting a negative decision from December 2020. [63]

[59] It should also be noted that the Conseil d'Etat ruling of 31 December 2019 overturned one of the provisions of the ministerial order of 12 July 2018, which set out the conditions for changes in charges. These must be negotiated between the airport and the sector regulator.

Autorité de régulation des transports (ART), Décision n°2019-075 du 7 novembre 2019 relative à la demande d'homologation des tarifs des redevances aéroportuaires applicables aux aérodromes de Nice-Côte d'Azur et de Cannes-Mandelieu à compter du 1er février 2020.

[60] Decision n°2020-060, 17 September 2020, Autorité de Régulation des Transports, related to the homologation of Aéroports de la Côte d'Azur charges.

[61] The ART has published the 17 February 2020 an opinion (n° 2020-017) related to the weighted average cost of capital for the 2021–2025 regulation contract. This was set for between 2.0% and 4.1%.

[62] Decision No. 2020-018 of February 27, 2020 of the Transport Regulatory Authority relating to the request for approval of the rates of airport charges applicable to Basel-Mulhouse airport as of April 1, 2020

[63] Decision n°2021-011, 11 February 2021.

The specific decision concerning the approval for Paris Aéroports is of a particular interest. At first, the managing company proposes a 3.1% increase. The ART refusal leads the concessionaire to propose an increase that put in place an implicit risk sharing agreement with airlines. Indeed, the increase is differentiated according to the different situation of the two airport terminals (the charge applied to the T2 one is constant) and according to its different components. The charge per PAX was increased by 3.68%, but the parking charge only by 2.12%. Such a differentiation limits the risk for airlines with a low load factor. [64]

The regulation of French airports differs, mainly according to size. Indeed, the ART only regulates airports with annual traffic exceeding 5 million passengers. [65] The rest of the airports are under the supervision of the DGAC, and for local airports (below 100,000 PAX/p.a.) under the supervision of the Prefect, an administrator in charge of a local region. [66] However, even with high level of traffic, competitive pressure may vary across airports and is difficult to assess. [67]

Moreover, the French regulatory regimes do not define a precise regulatory area. As Table 14.7 shows, airports can possibly opt for a single, double, or mixed single-till system. This point is very controversial as airlines naturally advocate a single-till regulation.

The regulation is implemented through the use of price-caps. The regulation itself can be questioned on the basis of the cost calculations used for the certification of airports' charges. ART launched a public consultation on WACC estimation methods in November 2019 and a second one in July 2020. Should the fair return on invested capital be based on return on capital employed (RoCE)? Should the cost of debt be based on historical data or on prospective data, taking into account, for example, the possibility of refinancing? The second option in which the regulation is based on prospective data is more adapted to turbulent times (regarding, for example, the consequences of the pandemic) but raises concerns in terms of information

[64] During the covid-19 crisis the ART tended to be particularly reluctant to approve an increase in airport charges, especially since they are not based on new investments and they cannot be considered as moderate (between 0 and 5%) according to the French administrative courts case law. For instance, the ART has homologated the charges of Toulouse airports for which only the tariff below 6 tonnes airplanes increased of 5% (ART decision n° 2020-063, 29 September 2020) but has refused to approve the ones of Lyon (4.9% of increase—see ART decision 2021-010, 11 February 2021).

[65] These are Paris Aeroports, Nice airport, Lyon airport, Marseille-Provence airport, Bâle-Mulhouse airport, Bordeaux-Merignac airport, and Nantes airport.

[66] The higher rank representative of the State at the department level.

[67] Market power can be significant for Paris Aéroports because its hub related characteristic and the scarcity of available slots. However, this hub is in competition with other European ones and market power on transfer traffic might not be very high (see, for instance, the technical report by Müller et al. (2009) on Amsterdam airport, which shows that competition might also has increased in the past 10 years). Market power can also be significant for major regional airports but they are disadvantaged by high fixed costs. On the contrary, market power is very low for small airports because they are often characterized by overlaps of catchment areas and overcapacities.

Table 14.7 The possible airports' regulation regimes

Single-till: In a single-till system all products are included in the airport accounts (both aeronautical and non-aeronautical). The single-till system is the default regulation regime of French Airports
Dual-till: In this regulation system, revenues from competitive (non-aeronautical) activities are not taken into account for setting aeronautical fees. It increases airports charges and favors the self-financing of airport's investments or the profitability for its shareholder. The case of Aéroports de la Côte d'Azur is the sole French implementation
Mixed till: In this adjusted dual-till system, some of the surpluses generated by commercial revenues are taken into account when calculating the level of airport charges. Such regulation is implemented for Paris Airport for which parking revenues are integrated in the regulated perimeter. It limits the capacity of airports to exert its market power by integrating in the setting of the tariff a part of its non-aeronautical revenues

Source: Malavolti (2017)

asymmetries between airports management companies and the regulator. [68] Such regulation is subject to adaptation as economic circumstances such as the COVID-19 crisis shows. [69]

In a nutshell, for major airports (above 5 M PAX) an independent regulatory body is in charge to approve airport charges' variations on an annual basis or through a 5-year regulatory contract. On the other hand, the perimeter of regulated activities is to be set by law, after a proposal made by the airport.

14.5 The Regulation of Small Regional Airports

This section will address some of the issues raised by the current regulatory regime of French airports related to the monopsonic power some LCCs enjoy toward secondary airports, which are usually characterized by overcapacities and financially unbalanced concession contracts.

A first challenge deals with competition between airports within the same catchment area. This might result in overinvestment in capacities. However, regulation of airport charges is not intended to address this issue. Hence, one can question the economic opportunities of new investments in infrastructure and even the pursuance of operating and maintaining some existing regional airports, this was done, for example, by the European Court of Auditors (2014). The French superior audit institution of public accounts, the Cour des comptes and its regional chambers has

[68] See Malavolti (2017).

[69] The COVID-19 crisis and its repercussions on the air transportation sector could lead to a renegotiation of the regulatory contracts. The capacity of the airports to reach a financial equilibrium can be questioned. The figures related to their profitability the last decade will not be easely reproduced and simultaneously the airlines willingness and capacity to pay airport charges can be significantly impaired. It can follow even more adversarial negotiations between these two players and the choice of the regulatory regime will have a strong impact on their results.

also published several reports on this issue (Cour des comptes 2008). More recently, the Cour des comptes expressed bitter criticisms on the managing entities in charge of the airports of Dijon and Dole (in Burgundy) because of the negative externalities produced by their non-coordinated investment decisions and by their commercial policies toward LCCs (Cour des comptes 2015).

Part of the solution may be a closer coordination realized through the supervision of local government in those regions that gained significant more decision-making authority since the 2004 decentralization law, as well as through the 2015 law, called "loi NOTRe" (*nouvelle organisation territoriale de la Republique*). In some situations, such a coordination may avoid internal welfare reducing competition among excessively close airports and may help to increase the bargaining power with LCCs.

A second solution against excessive investment in regional airports may be through the corporatization or the privatization process. Indeed, a "private" operator in a market economy has to assess the profitability of an investment decision in advance and has to balance revenues and costs. A private manager operating several airports (both in concession agreements and in availability payment schemes) may mutualize some of its assets and coordinate its policies toward air carriers. It may both reinforce its bargaining power (buyer countervailing power) and avoid the fiscal competition phenomena.

Such a coordination may be possible considering the relatively small number of private companies that operate French airports. For instance, Vinci is mainly involved in the management of major regional airports through its subsidiaries like "Special Purpose Entities" and SNC Lavalin [70] that are involved in local airports. Other operators, such as Transdev or Egis, [71] are also present. However, coordination between several airports, each endowed with legal personality, may lead to double marginalization when LLC market power toward the airport is reduced or disappears (i.e., if we end up in a monopsony game). In such a case, the coordination between several adjoint airports gain market power toward the airline and passengers, and such a situation would be even worse for the final consumer.

Nevertheless, the rise of private or mixed public–private models of airports governance may help to efficiently manage airports and more importantly, airport investment, especially within a two-sided market model. Firstly, it may facilitate the choice between single- and dual-till model. Secondly, it may facilitate the agreements with LLCs in terms of support for launching new routes or for operating existing ones. The 2014 European Directive tolerates these subsidies for a transitory period. However, if we analyze the airport as a two-sided platform, following Ivaldi et al. (2015), it becomes economically rational to distort the pricing structure between the two sides of the market in order to enhance the total profitability. Reducing prices on the aeronautical side may increase passenger flows enough to induce higher commercial revenues. Thus, when the airport is considered as a

[70] Since January 2017, SNC Lavalin's airport branch has been divested to Edis.

[71] A project company run by Egis was entrusted with the management of Bergerac airport in October 2019 (it has been operating Pau and Brest-Quimper airports since 2017).

two-sided platform, the sacrifice on the aeronautical side may be more than compensated for on the commercial side for large airports. [72]

However, such a scheme induces two kind of difficulties. A first one is related to competition law concerns, where such cross-subsidy support may be considered as a non-transitory operating aid. However, it can also be analyzed as a rational choice made by a private market investor to maximize its profits on the two sides of its activity. A second difficulty is more related to public economics issues. The airport charges are regulated, as we have already noticed, through a price-cap model. [73] The purpose of this regulation is to cover the full costs of the infrastructure in order to avoid public subsidies, considering the situation of public accounts and the marginal cost of public funds. Such a regulation is appropriate for an airport enjoying a monopoly position. It prevents exploitation at the expense of airline carriers and finally of users (the higher the aeronautical charges, the lower the number of routes proposed). However, many French airports are characterized by overcapacities. Some of them have no bargaining power with the LCC carriers which operate a large part of the routes they fly. Capping the aeronautical charges does not make sense as the LCCs are able to negotiate large discounts. Then airport do not cover their costs, and instead it makes their deficit bigger, requiring additional support from local governments. [74] This requires, as first suggested by Le Roux (2014), engaging in actions in order to reduce airport costs and secondly, substituting cap-based regulation by a floor-based one for airports that do not have market power in order to limit the ability of airlines to capture airport profits.

The financial situation of the local airports was already difficult even before the Covid crisis. Over and above the need to reduce costs, they would like to increase traffic, but extra passenger flows can only be brought in by LCCs which negotiate the level of charges from a position of strength. However, the local airports have a weak bargaining position, leading airlines to get rebates on charges. Insofar as the charges are designed to cover costs, the increase in traffic is not sufficient to reach the breakeven point. [75] It would be relevant in such a case to opt for a price-floor regulation to limit the discounts that LCCs can obtain (Malavolti and Marty 2019).

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[72] But it is difficult to see how this would work for local airports for which nonaviation revenues are not very important.

[73] Notice that some of the eight airports are not regulated by an economic regulation contract.

[74] It raises several concerns in terms of level playing field among airlines, illustrated by several litigations before EU jurisdictions (concerning state aids control). The case of the EU Commission decision n°2016/6333 of the 23 July 2014 (confirmed by the EU General Court in December 2018) provides a good example of such an issue. A LCC operated a route from Nîmes to London Gatwick on a daily basis. In order to tackle its overcapacity and to favor touristic activities in the region the airport managing company contracted with this company. to develop routes (both by increasing the number of flights to London and by proposing new ones to Charleroi). However, the conditions negotiated (rebates on airport charges and financial participation to the airline marketing campaign) were considered inconsistent with the requirements of the market investor principle and qualified from the legal point of view as States Aid. As these ones were not previously notified and as they induce a competition distortion, its reimbursement was required.

[75] See Bubalo (2021), which show that the break-even is reached only above 1 Million PAX/year.

This is all the more necessary as the airports can enter in a tax competition race, which is all the more destructive from a collective point of view that political logic prevent an airport manager to stop its loss making operations and requires to finance the operating deficit through State Aids. Such a situation leads to a suboptimal use of public funds (considering their marginal costs, for instance) and a weak incentive structure for the airport managers (deep pocket phenomenon or soft budget constraints). In this perspective, a price-cap regulation is not optimal for secondary airports.

Whatever their size, the ability of French airport management companies to develop a two-sided model can be affected by several specificities or even be challenged by different sectoral dynamics. First, the ability to generate ancillary revenues depends on size, passenger profiles, and the diversification and investment capacities of airports. [76] Secondly, the ability of airports to capture these revenues may be increasingly constrained through the digitization of certain cabin purchases and sales (to the detriment of duty-free shops [77]). It can also be constrained through competition from parking lots outside the airport area.

The economic regulation of French airports must therefore take into account the transformation of the airports' economy. Indeed, the growth of LCCs and the increasing share of commercial revenues lead to specific issues depending on the size of the airports. For large airports, the issue is that of cross-subsidies between aeronautical and commercial revenues. For local airports, the issue is that of reconciling incentives for LCC services with deficit limitation. The articulation between regulation by contract and regulation by a specialized authority should also be considered in view of the disruption to the economic equilibrium of the airports' business model due to the collapse of air traffic induced by the crisis and the possible irreversible growth of the market share of LCCs at the detriment of legacy airlines. Economic balance could justify requests for charges to be increased. At the same time, French administrative law may entitle concessionary companies to compensation from the government (i.e., the grantor) under the theory of force majeure or under the one of the *imprévision* (e.g., contractual unbalance compromising the supply of the service induced by external events out of the control of the concessionaire and impossible to expect and to cover through insurance mechanisms). Articulatingly, these two levels of regulation can be particularly difficult in regard of the conflicting interests of the airport economy stakeholders, the information asymmetries, and the current situation of radical uncertainties airports managing companies have to face.

[76] The CGET report shows that with less than 2 million PAX/p.a. Montpellier's non-aeronautical revenues represent 37% of revenues (CGET 2017). In Basel-Mulhouse with about 9 mill. PAX/p.a. this rate is 54% and in Beauvais with more then 4 mill. PAX p.a. it is 68%. This very high share of nonaviation revenue is largely through the operation of a complementary activity: the operation of a bus service to Paris (see in particular Decision No. 19-D-22 of the French Competition Authority of 22 November 2019).

[77] See Arthur D. Little (2018) report

14.6 Summary

Economic situations of French airports are different, the main driver being traffic. However, they still all are facing similar upheavals: the growing share of LCCs traffic and the increasing weight of non-aeronautical revenues in their business model. This business model transformation has been accompanied by many institutional changes over the last 20 years. Airport management is increasingly being transferred to private operators. The supervision of the French airports sector is then carried out through two channels. The first is regulation by contract through the privatization of the concession companies in charge of the airport's management. The second is sector regulation through economic regulation contracts. The transfer of competences to a new sector-specific regulator for the largest airports and the difficulties experienced in officially approving economic regulation contracts on the eve of the 2020 crisis demonstrated the difficulty of balancing the interests of the different stakeholders and preventing competition distortions.

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Chapter 15
Airport Regulation and Benchmarking: Case Study Germany

Frank Fichert

Abstract In Germany, most large airports are owned by the states and/or municipalities in which they are located. Only few airports are partially privatized. As a German peculiarity, almost all airport companies are the largest provider of ground-handling services. There is no official market assessment, but according to academic studies, at least five airports possess strong market power. Regulation is assigned to the state level (usually ministry of transport). Until 2000, a rate-of-return regulation was applied. Later, in some states long-term charging agreements were concluded between regulator and airport. Some of them might be considered to be pure price cap schemes, whereas others are more similar to a rate-of-return regulation. Since 2012, regulation is based on the European directive 2009/12/EC. Today, usually a rate-of-return scheme and the dual till approach are applied. As in most cases states are major shareholders as well as regulators, the independence of regulation has been questioned by airlines and external observers. Moreover, an independent regulator on the federal level might be in a better position to apply benchmarking. From 2008 until 2018, average charges were quite stable (except Frankfurt due to large investment), but in efficiency benchmarking studies, German airports often do not perform well.

Keywords Airport groups · Market power · Low-cost carriers · Ground-handling services · Profitability · Regulation · Airport charges · Airport privatization · Traffic risk sharing · Long-term agreements · Consultation process · Dual till · Independent regulator · Benchmarking · Incentive schemes · Congestion

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15.1 Large Airports in Germany: Ownership, Market Power, and Financial Results

The German airport system is decentralized and diverse. In 2018, 18 airports served more than one million passengers, nine of them exceeding the five million passenger threshold. However, the five largest airports accounted for almost three quarters[1] of all passenger arrivals and departures in Germany, including almost all transfer passengers. The cargo market is even more concentrated, with a dominant position of Frankfurt (FRA) airport in the "traditional" cargo segment and two large to medium-sized airports (Cologne/Bonn - CGN, Leipzig/Halle - LEJ) serving as hubs for freight integrators.

All German airports are organized as corporate entities; only few airports are integrated within (small) regional airport groups.[2] Eleven out of the 18 largest airports are in full public ownership (as of December 2019). The shares of the airport companies are usually held by states and/or municipalities, in eight cases they are the sole owners. In addition, the Federal Republic holds minority shares at Munich (MUC), Cologne/Bonn, and Berlin.

Three out of the five largest airports are partially privatized[3]: Fraport, the operator of Frankfurt airport, is listed on the stock exchange with the state of Hesse and the city of Frankfurt together holding more than 50% of the shares. The share of strategic private investors is 50% at Düsseldorf airport (DUS) and 49% at Hamburg airport (HAM). The remaining shares are held by the city of Düsseldorf and the city-state of Hamburg, respectively. There are only two larger German airports that in 2018 were (almost) fully owned by private shareholders: Hahn (HHN),[4] with 2.0 m passengers in 2018 (2.6 m in 2013), and Niederrhein/Weeze (NRN),[5] serving 1.7 m passengers in 2018 (2.5 m in 2013). Both airports focus on low-cost airlines. Finally, 30% of the shares of Hanover airport are held by a private investor.[6]

In Germany, no "official" assessment of the market power of airports exists.[7] However, two academic papers tackle this issue (Malina 2010; Beckers et al. 2010). Both studies find "strong" (or "significant") market power for the airports at

[1] 179 m out of 245 m PAX in 2018.

[2] The Berlin airport company operated the (formerly) two Berlin airports; the publicly owned Mitteldeutsche Flughafen AG is the major shareholder of the airports at Leipzig and at Dresden. Furthermore, Stuttgart airport is the majority shareholder of Karlsruhe/Baden-Baden airport, which is located in the same state.

[3] An attempt to privatize Berlin airport was started in 1997, but failed in 2003.

[4] In 2018, 85 percent of the shares were held by a Chinese investor, 15% by the state of Hesse.

[5] Approximately 75% of the shares are held by a Dutch investor, the remaining shares are held by local municipalities.

[6] Until 2018, these shares were held by Fraport.

[7] In 2010 the federal government published an update of its "airport concept paper," stating that in Germany, competition between airports as well as between airlines exists (Bundesregierung 2010, 77).

Frankfurt, Munich, Hamburg, Stuttgart (STR), and Berlin. With respect to the airports of Dusseldorf and Cologne there are different views. Malina considers these two airports to be rather close substitutes (the driving distance between them is approximately 60 km). Beckers et al. emphasize the capacity restraints at Dusseldorf airport as well as the limited degree of substitutability in the business traveler segment; despite some intramodal competition they see market power for each of these two neighboring airports. In both studies, the airports of Hanover and Nuremberg (NUE) are considered to possess "modest" (or "relevant") market power. Malina adds Bremen (BRE), Dresden (DRS), and Leipzig/Halle to this category. Therefore, out of the 18 largest German airports, 13 are considered to possess at least some market power by at least one of the two studies quoted above. The remaining five airports without market power focus on low-cost carriers and served between 1.0 and 2.3 million passengers in 2018.

Eight German airports are covered by a quantitative study on the market power of large European airports (Maertens 2012). The classification of Frankfurt, Munich, Hamburg, and Stuttgart as airports with strong market power is supported also by this study. The two Berlin airports, although belonging to the same group, are treated separately by Maertens, showing significant market power for Tegel (TXL) and little market power for Schönefeld (SXF). From the passengers' perspective, Dusseldorf is considered to possess strong market power, whereas the market power of Cologne is slightly above the value calculated for Berlin-Schönefeld.

In 2016, the German Airport Association commissioned a study on the market power of eleven German airports (Copenhagen Economics 2016).[8] By analyzing the share of the largest airline at the respective airport, the switching behavior of airlines, and the share of "flexible" passengers (basically VFR[9] as well as leisure travelers), the study concludes that "it is unlikely that any of the German airports considered have market power" (Steer Davies Gleave 2017, 374).

Table 15.1 summarizes basic information on all 13 airports which are considered in the literature to possess at least some market power. With the exception of Berlin all larger German airports offer ground-handling services (GHS) either directly or through a subsidiary. Until the partial opening of the ground-handling market by EU directive 96/67/EC, German airport operators usually held a monopoly position in this market. In 2018, at seven airports, all of them with more than 5 m passengers, the airport operator (or its subsidiary) competed with an independent GHS provider (BDF 2016). Dusseldorf is the only airport where the competitor holds a higher market share than the airport operator (above 80%, see Wilke et al. 2016, 72). At the other airports, the competitor's market share is between 5% (Hamburg) and 35%

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[8] As of December 2019, this report is not publicly available. Results are summarized in Steer Davies Gleave (2017), and Persch (2017). Except for the three smallest airports (BRE, LEJ, and DRS), the study covered all airports listed in Table 15.1, plus HHN. As the entire report has not been published, it is not possible to critically assess the rather strong conclusions made by Copenhagen Economics.

[9] VFR = Visiting Friends and Relatives.

Table 15.1 Basic information on German airports with (potential) market power

Airport	PAX 2018 (m)	Av. PAX growth (%) (2008–2018)	Cargo 2018 (1000 t)	Av. Revenue 2009–2018 (m EUR)	Av. Profit 2009-2018 (m EUR)	Av. Profit / av. Revenue (%) (profit margin)	Private share (%)
FRA	69.5	2.7	2214	1951	228.8	11.7	48.7
MUC	46.3	3.0	375	1236	121,3	9.8	0
DUS	24.3	3.0	75	437	48.8	11.2	50.0
BER (TXL + SXF)	34.7 (22.0 + 12.7)	5.1 (4.3 / 6.8)	45 (32 + 13)	338	-100.8	–29.8	0
HAM	17.2	3.0	33	257	41.9	16.3	49.0
CGN	13.0	2.3	859	288	5.4	1.9	0
STR	11.8	1.8	53	243	11.5	4.7	0
HAJ	6.3	1.3	18	141	1.1	0.8	30.0
NUE	4.5	0.5	8	95	–3.4	–3.5	0
BRE	2.6	0.3	1	42	–1.0	–2.4	0
LEJ	2.6	2.6	1221	93	–44.2	–47.7	0
DRS	1.8	–0.3	0	42	–8.7	–20.6	0

Source: German Airport Association (ADV) traffic data, annual reports, own calculations

(Munich). Revenue and profit figures in Table 15.1 are based on infrastructure provision, GHS, and non-aeronautical activities like car parking and retail.

Until 2019, the airport companies at Frankfurt, Munich, Dusseldorf, Hamburg, and Cologne have been profitable for more than a decade without any exception. Stuttgart airport was generally profitable but made losses in 2016 and 2017 caused by significant payments for the investment into the high-speed connection to the new Stuttgart railway station (Stuttgart 21). Hanover was profitable since 2014. The Berlin airport system was slightly profitable until 2010. Since then, the (flawed) construction of the new airport at the German capital has led to enormous losses for the company. However, Tegel airport was profitable at least from 2008 to 2012 (no current data has been published but increasing passenger numbers suggest that this airport is still highly profitable). All other airports, serving between 1.8 and 4.5 million passengers in 2018, are usually loss making.[10] Nevertheless, the EBITDA of these airports in general has a positive sign, indicating that revenues cover at least variable costs.

[10] At Bremen and Nuremberg also some profitable years were recorded.

15.2 Legal Framework for Airport Regulation

Until 2012, airport regulation in Germany was based on § 43 I LuftVZO (Air Transport Licensing Regulation).[11] According to this regulation, an ex ante approval of aviation charges was mandatory for all airports. The task of airport regulation has been assigned to the German states (Länder), where the Ministries of Transport usually became the airport regulation authorities. Already in 1980, the states agreed on common principles of airport regulation. Airport charges should be cost related and allow for cost recovery including a reasonable return on equity. Moreover, specific objectives of transport policy should be taken into account. Until 2000, all regulators followed the single till approach.

It was often criticized that the regulation process had not been transparent. For example, the common principles of regulation have not been officially published. In 2000, a German court decided that an airport operator has to provide at least some information on the justification of charge increases to the airlines (Neuscheler 2008, 272). In 2002, Dusseldorf airport had to reimburse two airlines after a court decision on its landing charges (Flughafen Düsseldorf GmbH 2004, 40).

Accompanying the partial privatization of some German airports, the regulatory approach changed at least in those states in which the partially privatized airports are located. In 2000, the first "framework agreement" was concluded for Hamburg airport (ICAO 2013). Subsequently, long-term charging agreements were signed at the airports of Frankfurt (2002), Hanover (2003), and Dusseldorf (2004). In general, these agreements were the result of a negotiation process between the airport operator, the airlines, and the regulator. At Hamburg airport, the framework agreement installed a price cap regulation, based on the RPI-X formula and an additional traffic risk-sharing mechanism (Immelmann 2004). Moreover, the airport operator guaranteed specific quality levels for key services. The framework agreement had been prolonged twice but was terminated in December 2014. At Hanover, also the RPI-X formula was used.

The agreements at the other airports (DUS and FRA) limited the increase of infrastructure charges for a period of several years without explicitly referring to the RPI. Similar to the Hamburg agreement, they contained a traffic risk-sharing mechanism (also referred to as "revenue sharing"), i.e., charges decrease if traffic growth is above the forecast, and vice versa.

In general, only the regulatory regimes at Hamburg, Hanover, and Dusseldorf (first agreement) might be classified as "pure" price cap regulation. Although the other agreements also set maximum average charges for several years, it might be stated that they apply a rate-of-return regulation[12] (Steer Davies Gleave 2013, 15), since the level of the charges is (also) linked to the expected cost development but

[11] A description of this legal framework can be found in Littlechild (2012).

[12] Interestingly, the regulator described the regulatory regime at Frankfurt as rate of return, whereas the airlines rather saw it as a form of price cap regulation (Steer Davies Gleave 2013, 17).

Table 15.2 Basic information on selected long-term charging agreements in Germany

Airport	Duration	Selected elements
Dusseldorf	2004–2016 2018–2020	• 2004: Fixed average revenue per passenger (if PAX numbers are within a certain range) • 2018: Total revenue cap (increase in first year: 2.6%; increase in second year: 3.8%)
Frankfurt	Since 2002	• "Revenue sharing" • Total increase in average fares in 2010 and 2011: 12.5% (four steps). • 2012–2015: Annual increase: 2.9% • Reduction by one third, if passenger growth above forecast
Hamburg	2000–2014	• Price cap regulation with traffic risk-sharing mechanism
Munich	2014–2020	• Average increase of 2% p.a., linked to infrastructure provision, e.g., higher increase after satellite terminal went into operation

does not depend on external factors like the RPI. Table 15.2 provides basic information on long-term agreements at selected German airports.

In 2012, the regulatory environment in Germany has changed significantly. According to § 19 b of the German Air Traffic Act (LuftVG) an ex ante approval of airport charges is still mandatory for all airports, and the states still serve as regulators. The requirements for the approval now follow the European directive 2009/12/EC: charges have to be suitable, objective, transparent, and non-discriminatory. Especially, they should be cost-related. Differentiations of airport charges (e. g. incentive schemes) are permitted if they comply with other regulations, in particular the European framework for state aid. As a German particularity, airports are obliged to introduce a differentiation according to noise emissions into their charging scheme and shall differentiate also for pollutants.

For airports with more than five million passengers, a consultation process is mandatory if the airport wants to increase its charges. Generally following the procedures laid down in the European directive, the law stipulates detailed deadlines for the different elements of the consultation and approval process, e.g., the draft charging scheme as well as a justification for the changes have to be made available to the airport users 6 months before the intended entry into force. There is at least one example (Frankfurt) for the inclusion of the local committee against aircraft noise into the consultation process.

Airport charges have to be authorized by the regulator if there is a "reasonable relation" between the charges and the expected costs, and it is observable, that the production of the airport's services is "efficiency oriented." If a written agreement between the airport and the airlines on airport charges exists, the regulator may not investigate whether the charging scheme fulfills the requirements of cost orientation and efficient service provision. Though, the agreement has to comply with the European rules on state aid. The decision on the charging scheme (but not the justification) has to be published.[13] Furthermore, an airport and its users may negotiate service level agreements.

In addition to the consultation process preceding changes in the charging scheme, the law calls for annual consultations between the airport operator and the airport users, again following the requirements of the European directive. For these consultations, the airport has to provide the users with actual as well as future-oriented information on costs, revenues, subsidies, investment, and use of infrastructure. In return, airport users have to provide information on their planned number of movements and passengers.

According to the new German regulation, an airport operator may decide whether costs and revenues from non-aeronautical activities should be considered in setting the charges for the use of the airport infrastructure. In other words, the airport operator can choose whether it wants to apply the single till or the dual till approach. Not surprisingly, at all nine airports with more than five million passengers, the airport decided in favor of the dual till approach (Steer Davies Gleave 2013, 15; Steer Davies Gleave 2017, 310 and 429). According to a recent evaluation of the airport charges directive, the largest German airports (with the exception of Hanover) are regulated based on the rate-of-return principle (Steer Davies Gleave 2017, 310 and 429).[14]

15.3 Theoretical and Empirical Evidence

From an economic perspective, airport regulation should lead to an efficient provision of airport services in the short run (variable costs and service quality) as well as in the long run (investment), an efficient allocation of existing infrastructure in case of capacity constraints (especially slots), and it should prevent the abuse of market power by the airport operator. Moreover, the transaction costs of regulation should be proportionate (see also Niemeier and Müller 2013, 143). Whether the German airport regulation fulfills these requirements may be analyzed from a theoretical or from an empirical perspective.

The institutional design of airport regulation in Germany has been criticized quite often. Since most states are also shareholders,[15] potential conflicts of interest have been emphasized by academics as well as by airlines (e. g. Lufthansa 2010). Although the potentially opposing functions could be assigned to different branches of the government (usually the Ministry of Transport is responsible for the airport

[13] Usually the official reports on airport regulation are rather short (one or two pages) and basically list formal steps and the final decision made by the regulator.

[14] Quite remarkably, Frankfurt airport describes the regulatory regime as light handed regulation. On the other hand, the independent supervisory authority of North Rhine-Westphalia stated that the airports of Cologne and Dusseldorf are not regulated.

[15] The only exception among the largest airports is Dusseldorf.

regulation whereas the Ministry of Finance executes the shareholder rights), the regulator may not have a strong incentive to prevent excessive charges and profits. However, in 2015 Frankfurt airport withdrew its application for an increase in charges after the regulator questioned the underlying cost of capital (Fraport AG 2016, 48).

Moreover, even if a regulator may not be influenced by the government's budgetary considerations, its factual regulatory power is often considered to be quite limited. First, regulators within the state ministries only deal with a small number of airports. In many states only one airport exists that is considered to possess some market power. Therefore, comparing or even benchmarking different airports is hardly possible, and the (informal) exchange of experience among regulators is probably not sufficient to overcome this structural problem. In addition, the personal resources within the ministries are often rather limited (Niemeier 2002, 42; Steer Davies Gleave 2017, 432).[16] Therefore, it has been proposed several times to assign the task of airport regulation to an independent institution (Monopolkommission 2016), e.g., the German Federal Network Agency, which is the independent regulator for the electricity, natural gas, telecommunications, postal services, and railway industry.

From an empirical perspective, on the one hand, the level of infrastructure charges, its structure, and its growth rate, on the other hand, partial or total productivity indicators could be used to assess the outcome of airport regulation. Therewith, each indicator has different advantages and disadvantages.

Comparisons of airport charges are often based on the costs for an aircraft turnaround. Some German airports are covered by the annual ATRS benchmarking report, which also used to include a comparison of the charging level. In 2013,[17] the charges at the two large German hub airports (FRA, MUC) were clearly above the European mean value for all 69 airports analyzed in the study. However, the charges at competing hubs like LHR and CDG were significantly higher than at Frankfurt, whereas at Zurich and Amsterdam, charges were slightly lower than at Munich. With respect to London and Zurich, the exchange rate may also matter. Four German airports were slightly below (DUS,[18] TXL, HAM, HAJ) and two other airports were significantly below the mean value (STR, CGN). However, benchmarking studies on

[16] However, the EU wide comparison by Steer Davies Gleave (2013, 81–83) shows that the number of staff members in one (large) German state is above the number of staff members in most EU countries.

[17] In 2015, ATRS analyzed the cost competitiveness of 14 European airports with more than 25 m passengers. Frankfurt ranked at no. 8, and Munich at no. 10. In the group of 23 European airports serving between 10 and 25 m passengers, DUS ranked at no. 12, HAM at no. 17, STR at no. 19, CGN at no. 20, and TXL at no. 22.

[18] The example of Dusseldorf airport shows that even the ATRS comparison of charges has to be used with caution. In the 2011 benchmarking report, Dusseldorf was one of the most expensive European airports with a combined landing and passenger charge of almost US$4000. In the 2014 report, the total charge for the same aircraft is approximately US$3000. This decline cannot be explained by the change in the exchange rate.

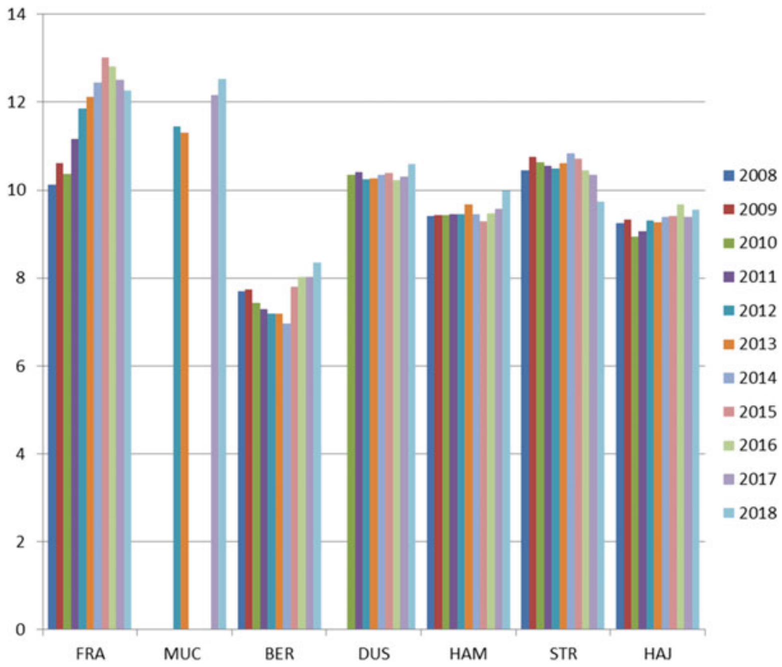

Fig. 15.1 Average charging revenues (EUR per WLU) for selected German airports (2008–2018) (Dusseldorf and Munich airport did not publish infrastructure revenues for the entire period). Source: Annual reports, own calculations

user charges have to be based on specific assumptions, especially on the type of aircraft, the load factor and (for hub airports) the share of transfer passengers. For example, comparisons published by the German airline association show higher charges at Hanover airport than at Hamburg, Berlin-Tegel, and Dusseldorf, whereas according to the ATRS report, Hanover has lower charges than the three other airports.

As an alternative, the average charging revenues per passenger or per work load unit may be analyzed,[19] potentially covering also income losses by incentive schemes which have become widespread at German airports (Fichert and Klophaus 2011).[20] However, some German airports (e.g., CGN) do not publish their revenues from infrastructure charges separately. Figure 15.1 shows the average revenue from infrastructure charges at seven German airports from 2008 to 2018. The two hub

[19] For most German airports, the average charges per passenger show basically the same development as the average charges per work load unit. Exceptions are Frankfurt airport (with larger fluctuations due to different growth rates in the passenger and the cargo market but the same overall trend) and Dusseldorf airport (due to a large decrease in the cargo volume in 2018).

[20] In general, discounts based on incentive schemes may be treated as revenue losses or as additional expenditure. The annual reports often do not disclose this information.

airports at Frankfurt and Munich have the highest charging revenues per work load unit. For Berlin, only the group's revenues are published, combining the rather high charges at Tegel with the significantly lower charges at Schönefeld.

Except for Frankfurt, Munich, and Berlin, average revenues per work load unit show little variation over the respective period. In Frankfurt, an increase by almost 25% can be observed since 2010. The unit charges have been increased significantly in order to finance capacity enhancements, especially the fourth runway and the new pier at Terminal 1. In Berlin, charges we significantly increased in 2015. A lawsuit by Lufthansa against this increase was not successful due to a formality (Gellner 2016). Between 2008 and 2018, a real increase in average charges can only be observed at Frankfurt airport,[21] Stuttgart is the only airport with a nominal decrease in every year after 2014, leading to a lower average charge in 2018 when compared to 2008.

With respect to the charging structure it has been criticized that congested German airports make very limited use of peak load pricing, therewith not providing incentives for an efficient use of the existing infrastructure (Niemeier und Müller 2013). However, the largest German airports (in particular Frankfurt, Munich, and Dusseldorf) are congested almost throughout the entire day, limiting the potential effects of peak load pricing. Moreover, shifting traffic towards the uncongested early morning or late evening might increase external costs associated with aircraft noise.

The ATRS benchmarking reports also calculate the variable factor productivity, taking into account labor and other non-capital costs. Within the group of large airports (more than 15 m passengers), Frankfurt, Munich, Dusseldorf, and Berlin-Tegel[22] usually can be found at the end of the ranking. In 2015, Frankfurt and Munich were the least efficient airports when compared to all European airports with more than 25 m PAX. Within the group of medium-sized and small airports, in 2014 as well as in 2015 Berlin-Schönefeld was considered to be the most inefficient airport in the sample; Cologne-Bonn and also Hamburg were below the mean efficiency value.[23] The only German airport for which ATRS calculated an efficiency value above or close to the mean is Hanover. On the contrary, in another benchmarking study, Hanover is classified as one of the most inefficient airports (Liebert 2011). This contradiction might be explained by the respective methodological approach or by differences in the dataset.

[21] Increase of average charges between 2008 and 2018 compared to the overall inflation rate (consumer price index) in this period.

[22] Due to its passenger growth, Berlin-Tegel is classified as a large airport since the 2013 report.

[23] In 2015, the five German airports in the group of airports with a passenger number between 10 and 25 m are the five least efficient airports in the ATRS report.

15.4 Conclusions

An analysis of airport regulation and airport efficiency in Germany has to distinguish between different types of airports as well as between a short-term and a long-term perspective. The following conclusions can be drawn:

Germany has a large number of underutilized airports. To some extent, this is caused by decentralized political responsibilities. In order to promote regional economic development, some states invest in airports, even if the respective airport competes with an underutilized airport in a neighboring state. Examples for this type of overinvestment include Kassel as well as Zweibrücken (which has been closed in the meantime). As a German peculiarity it has to be taken into account that after the end of the “cold war” many military airports in rural regions became obsolete and have been converted into civil airports (e.g., Hahn, Zweibrücken, Altenburg). The new EU framework on state aid to airports may limit the options for this type of overinvestment.

Moreover, some peculiarities of the German airport system even go back to the time of Germany’s division into two states. This is not only relevant for Berlin, but also for Hanover airport which is often quoted as an example for overcapacity. However, all major runway investment at this airport took place before the German reunification, when the importance of Hanover airport was much bigger than it is today.

On the other hand, the largest German airports are characterized by capacity constraints rather than by overcapacity. Due to adjacent residential areas, no options for significant airside capacity expansions exist at Dusseldorf as well as Stuttgart. At Frankfurt, a new runway has been built and construction of a new terminal has begun. However, the location of the new runway has been determined to a large degree by environmental objectives rather than by operational considerations. At Munich, a public referendum in the city of Munich at least postponed the construction of a third runway.

With respect to variable costs, in particular the ATRS benchmarking studies suggest that German airports in general are less efficient than airports in other European countries. This may be caused by shortcomings in the regulatory framework (no clearly independent regulator, no consistent incentive regulation). However, the (usually not very profitable) ground-handling activities of German airport companies may to some degree explain the inefficiencies. Though, for publicly owned airports, it may be very difficult to dispose of this business segment where a large number of workers is employed.

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Chapter 16
Airport Market Power: Schiphol 10 Years After the Assessment

Volodymyr Bilotkach and Jürgen Müller

Abstract This paper evaluates changes in the market position of Amsterdam airport Schiphol over the last decade. Assessment of Schiphol market power was conducted in 2009. Examining the key developments, we suggest that the airport has probably strengthened its position on the markets for provision of infrastructure to both origin-and-destination and transfer passengers. At the same time, several recent studies have documented increasing competition between the airports in the European context. We suggest therefore that a new investigation of market power of Schiphol airport is in order.

Keywords Market power · Competition · Policy making · Regulation · Schiphol

16.1 Introduction

We are writing this paper as the aviation is going through the biggest crisis it has ever experienced. In fact, it is difficult to imagine a more serious peacetime calamity than the current pandemic affecting commercial civil aviation. One may therefore be tempted to dismiss such issues as airport congestion, market power, and efficient provision of air navigation services as the present-day equivalent of "first world problems," which should not be given attention at the time civil aviation is in the midst of an existential crisis. It is true that, depending on the severity of the looming global economic recession, it may take years for the commercial aviation to return to its pre-pandemic levels and resume the growth trajectory. Nevertheless, we believe aviation will return to growth, and we will need to return to addressing the pre-2020 problems.

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This chapter deals with the issue of airport market power.[1] It has been long recognized that airports should be treated as firms rather than infrastructure objects. This thinking, along with the trend towards commercialization and privatization of infrastructure industries, necessitates the application of principles of economic regulation and competition policy to the airport sector. While economic regulation of airports is rather commonplace; the issues of airport competition and airport market power are yet to make their way into policy making at any appreciable scale. Airport market power assessments are regularly conducted by the UK Civil Aviation Authority to assist in making determination on whether airports should be subject to formal economic regulation. As a result of such exercises, over the last decade, the UK CAA has determined that Manchester and London Stansted airports find themselves in a sufficiently competitive market environment, which means that direct regulation of aeronautical charges set by those airports was no longer warranted (UK Competition Commission 2009). Presently, only two UK airports (London Heathrow and London Gatwick) are subject to direct economic regulation.

Outside of the UK, the issue of airport market power has been given serious consideration by the policy makers in Ireland, Australia (note that in this country airport charges are subject to monitoring rather than direct economic regulation), and the Netherlands. In the latter case, an evaluation of the Aviation Act of June 29, 2006, was started in 2009 and a new Act has come into force as of July 1, 2017. External consultants were engaged to assist with the process.[2] In this connection, we were also involved in a study of the market power of Schiphol airport.[3]

As contributors to the original market power assessment exercise of AMS we are providing in this paper a short evaluation of the current state of affairs, addressing the question of whether Schiphol airport's market position has weakened or strengthened over the 10 years that have passed. Our evaluation of the changes that occurred over the decade since the 2009 market power assessment suggests that Schiphol has probably increased the extent of its market power on both origin-and-destination and transfer markets. The airport has likely strengthened its market position in the market for transfer passengers relative to other European gateways, and it has attracted

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[1] In our area study, be differentiated between market for airlines serving O&D passengers, for airlines serving transfer passengers, for local and instruction flights and for airlines offering cargo transportation

[2] In the preparatory phase of this legislative amendment, there were consultations with the airlines, Schiphol, the industry association for airlines BARIN and The Schiphol Airline Operators Committee (SAOC) . In addition, there have been intensive consultations with the NMA, the Authority for Consumers and Markets, with a view to optimizing the feasibility and enforceability of the regulations , see Economic Regulation: Aviation Act, https://www.schiphol.nl/en/schiphol-group/page/economic-regulation/

[3] Müller, Jürgen, Volodymyr, Bilotkach, Frank Fichert, Hans-Martin, Niemeier, Erich Pels, Andreas Polk, (2010): The economic market power of Amsterdam Airport Schiphol, Study commissioned by the Netherlands Competition Authority (NMa).

services of some of the key LCCs, which have previously served the area via alternative gateways for the airlines serving O&D passengers.

On the other hand, the last decade has seen two comprehensive reports on airport competition in Europe (Copenhagen Economics 2012; Oxera 2017). Both reports have concluded that airport competition has intensified recently, owing to developments both in the European airline markets (growth of LCCs) and outside Europe (where Turkish Airlines and the Gulf Carriers have expanded their networks). These conclusions are echoed by the very recent survey of airports, reported by Bilotkach and Bush (2020). On the other hand, Wiltshire (2018) suggests that passengers' preference to travel from their local airports, coupled with the airlines' switching costs, will imply that secondary airports will not be able to provide effective competition to primary gateways in the metropolitan areas. In case of Schiphol, the nearby airports, whether operating (such as Eindhoven and Rotterdam) or planned (Lelystad) are at least part owned by Schiphol group. This can reinforce Schiphol airport's power on the origin-and-destination market.

With this in mind, we suggest the time has come for the authorities to revisit the issue of market power of Schiphol, potentially commissioning a new investigation on this topic.

16.2 Schiphol Market Power Study, 2009

The Schiphol market power assessment was commissioned in 2009 by the Netherlands Competition Authority within the framework of a scheduled review of the legislation governing economic regulation of Amsterdam Airport Schiphol.

The first issue to address in the study was defining the relevant markets. We have defined the key market as that of provision of infrastructure to the airlines. We have further divided this market into the market for provision of infrastructure to origin-and-destination passengers separately from that for transfer passengers. This approach is different from that taken by the UK CAA in its market power assessments—the UK CAA does not make such a distinction. In making this delineation, we were guided by the case of a departure tax, which has been introduced by the Dutch Government several years before we conducted our study. Analysis of the relevant data revealed that the tax has impacted (decreased) the number of origin-and-destination passengers, while having no effect on the number of transfer passengers at Schiphol (Gordijn and Kolkman 2011). This suggested to us that there is no substitutability between the two markets; thus, market for provision of services to origin-and-destination passengers should be treated separately from that for the transfer passengers. We have also separately identified the market for provision of infrastructure to the cargo airlines, along with several smaller-scale markets, which will not be covered by this study.

Our analysis included several approaches. In addition to extensive interviews with the key stakeholders, we have conducted the analysis of supply side substitutability on both origin-and-destination and transfer passenger markets; as well as analysis of overlapping catchment areas between Schiphol and key competing airports on several segments of both passenger markets. For the origin-and-destination market, we have identified several competing airports, whose catchment areas overlapped with that for Schiphol. Those were both larger gateways, such as Brussels and Duesseldorf airports, as well as smaller airports, such as Rotterdam, Eindhoven, Charleroi, and Weeze (the latter two airports are located in Belgium and Germany, respectively). Smaller airports have at the time been extensively used by low-cost carriers (most notably—Ryanair) as alternative gateways to the respective metropolitan areas.

Our analysis (details of which can be learned from Bilotkach and Mueller 2012) has demonstrated that Schiphol was a clearly dominant airport on the market for provision of services to origin-and-destination passengers in the area. For the transfer passenger market, the three hub airports we have identified as competitors (London Heathrow, Paris Charles de Gaulle and Frankfurt) were generally found to provide some competitive pressure on Schiphol. At the same time, we discovered that around 40% of one-stop routes available via Schiphol through guided connections (defined as connections within the same airline or alliance) were not available via either of the other three hub airports. While many of those markets represented thin routes—in particular, some of the one-stop markets on which connections were available only via Schiphol were related to KLM's dominant position at UK's regional airports; we have concluded that there is a degree of market power possessed by Schiphol on the transfer passenger market. While cargo market is generally considered more competitive than the passenger market segment, due to more extensive overlaps in the airport catchment areas for cargo; discussions with stakeholders have suggested that Schiphol does possess market power on this segment as well.

Our discussions with the stakeholders suggested that the airline customers do not appear to have any appreciable degree of countervailing power against the airport. Schiphol is the only airport in the Netherlands that has the kind of infrastructure KLM requires to run its hub. Furthermore, existing regulatory environment, coupled with the attachment of KLM to its home country would make the idea of moving the airline's key hub outside of the Netherlands a non-starter. Even though KLM has been a part of Air France—KLM group since the merger between the two carriers in 2005; the carrier has retained its identity and a degree of autonomy in decision-making. The airport's largest low-cost carrier customer (easyJet) also indicated to us that it was not planning to abandon its base at Schiphol, as the airport provided very convenient access to the metropolitan area to its customers, allowing the carrier to attract both business and leisure traffic. While easyJet did have some issues with the self-connecting passengers being treated as origin-and-destination traffic (and therefore being ineligible for the transfer passenger discounts on airport charges); this did not cause the airline to consider using an alternative airport in the area.

16.3 Key Developments Since 2009

One comprehensive study of airport competition since 2009 was the report by Copenhagen Economics (2012) on the state of affairs with this issue in Europe. Among other things, the authors of the Copenhagen Economics report have identified five indications of competitive constraints for an airport.

- If many local departing passengers have a choice, they can switch away.
- If many transfer passengers have a choice, they too can switch away.
- If the airport is hosting a multi-hub carrier, there is scope for buyer power.
- If one carrier is very large, there is scope for buyer power; and
- If there are many inbound tourists, there is scope for destination switching.

In case of Schiphol, we can say that the second and the fourth of the above indicators are present to a considerable degree. Whether Schiphol can be considered an airport that is hosting a multi-hub carrier is not a very easy question to answer: as we noted above, KLM does retain a certain degree of decision-making autonomy within the Air France—KLM group. However, the alliance between operators of Schiphol and Charles de Gaulle airports could potentially limit the scope of competition between the gateways for the transfer passenger traffic.

We have noted above that our analysis in 2009 demonstrated that Schiphol was clearly a dominant airport for the origin-and-destination passengers. We will see here that over the last decade Schiphol has clearly strengthened this position.

The situation with the transfer traffic is less clear—while Schiphol has fared much better than other key European hubs, competition outside of Europe has grown stronger. Increasing share of low-cost carriers means Schiphol's traffic is a bit more diversified than it was a decade ago. If countervailing power of the largest airline was not a major issue 10 years ago, it clearly is even less of an issue now.

While Amsterdam has been developing as a major European tourist destination (around 18.5 million tourists are estimated to have visited the city in 2018); we cannot say the Schiphol is solely dependent on tourism traffic—the traffic at Schiphol is diversified in terms of both travel purpose and passenger origin. Unlike with, for instance, seaside tourist destinations, where vast majority of traffic is inbound; a decent share of origin-and-destination trips at Schiphol represent outbound traffic.

We believe the following key facts that summarize developments over the last decade point to increasing market power of Schiphol on the origin-and-destination passenger market.

- In 2010, Schiphol handled 45 million passengers (one of course has to keep in mind that transfer passengers are counted twice, so that 45 million passengers correspond to fewer than 45 million people). In 2018, the airport reported 71 million passengers.
- In the global ranking of airports by passenger traffic, Schiphol went up from number 15 in 2010 to number 11 in 2018. This makes Schiphol the only European

airport among the global top-20 to have risen in the global ranking by passenger count.

- Over the last decade, Schiphol has moved from being Europe's fifth busiest airport to third, behind only Heathrow and Charles de Gaulle.
- Share of origin-and-destination traffic at Schiphol has increased over the last decade (from 55% in 2009 to 65 in 2019).
- European traffic has grown faster than intercontinental routes, in terms of the number of passengers. Share of European traffic increased from 66% in 2010 to 70% in 2019.

Development of Schiphol airport over the last decade has been driven to a considerable extent by the growth of the point-to-point carriers in the so-called LCC segment. At the time of the original market power study in 2009, easyJet already was Schiphol's second largest customer (third largest if we consider Transavia—an Air France–KLM-owned airline specializing in leisure traffic—a separate customer from Air France – KLM group). EasyJet has over the last decade doubled the number of seats offered on its services out of Schiphol (around 100% increase in the number of seats compared to around 65% cumulative increase in total passenger traffic at Schiphol over 2009–2019 time period). Another important development at Schiphol was the entry of Ryanair in 2015. This airline was—and remains—the key player in the smaller nearby airports competing with Schiphol for the origin-and-destination traffic. Entry of Ryanair into Schiphol suggests a higher degree of substitutability between Schiphol and nearby airports now than 10 years ago. One could suggest that higher degree of substitutability between AMS and nearby airports could be a sign of diminishing market power of Schiphol. However, we do not see the airlines relocating to nearby gateways from Schiphol.

Speaking about the transfer passenger and the cargo market segments, we should point to the following facts:

- Competition between hub airports for long-haul Europe-Australasia traffic has intensified considerably over the last decade, with the development of the hubs in Istanbul and the Gulf Area.
- On the transatlantic market, at the same time, we have seen increasing consolidation following the approval of joint ventures in 2008–2010. We can expect lower degree of competition between the airlines, and consequently the key hub airports on this segment.
- London Heathrow airport will likely become a stronger competitor on the transfer passenger segment when/if the third runway is built (currently scheduled to open by 2030, a date that can be moved further into the future by the current pandemic).
- On the cargo segment, Schiphol has moved down in the global rankings from 17th to the 20th busiest globally. However, this movement is in line with other European airports, which have all descended in the global cargo rankings as Asian and Middle Eastern cargo hubs were growing.

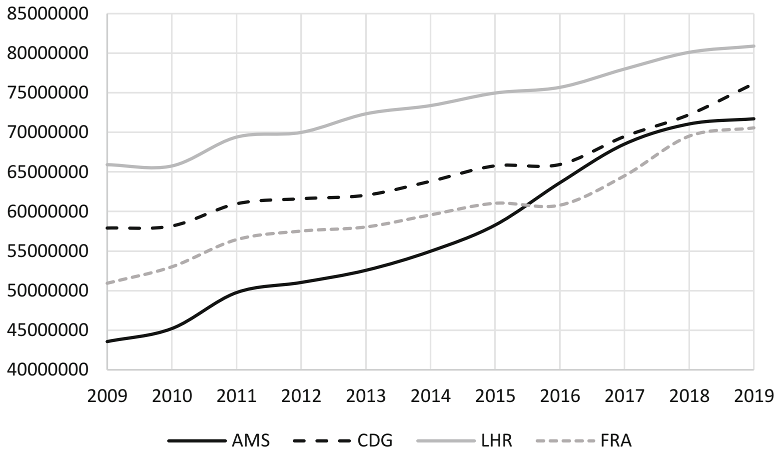

Fig. 16.1 Annual passenger traffic at Schiphol versus major European hubs

We therefore can say that on the cargo market, the situation remains largely unchanged as compared to what it was a decade ago (see also Fig. 16.3). The situation on the transfer passenger market is somewhat unclear. On the balance, we believe Schiphol's market position might have worsened; however, additional analysis using more detailed data on both airline schedules and passenger flows would be required here.

The following five figures are included to visualize the key developments we have discussed thus far. Figures 16.1, 16.2, and 16.3 show the trends in passenger numbers, aircraft movements, and cargo volumes, respectively, for Schiphol versus the three key European hubs which have been identified in our original market power assessment as Schiphol's key competitors (London Heathrow, Paris Charles de Gaulle, and Frankfurt airports). Figures 16.4 and 16.5 demonstrate the dynamics in passenger counts for most of the airports we have identified as Schiphol's competitors on the market for origin-and-destination traffic. Traffic for Brussels and Duesseldorf airports is in Fig. 16.4, while Fig. 16.5 shows the traffic for the four smaller gateways (Eindhoven, Rotterdam, Brussels Charleroi, and Duesseldorf Weeze). Differences in scales between Brussels and Dusseldorf on the one hand and the four smaller airports on the other made representation of all the six airports on a single diagram impracticable. All the diagrams cover the time period from 2009 till 2019, and use the data consolidated by CAPA Center for Aviation. The following airport codes are used in the legends:

- AMS—Amsterdam Schiphol
- LHR—London Heathrow
- CDG—Paris Charles de Gaulle
- FRA—Frankfurt
- BRU—Brussels Zaventem

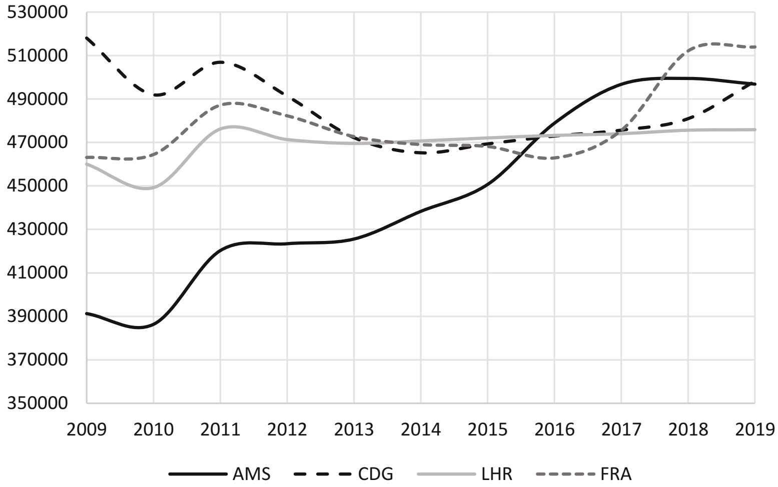

Fig. 16.2 Annual aircraft movements at Schiphol versus major European hubs

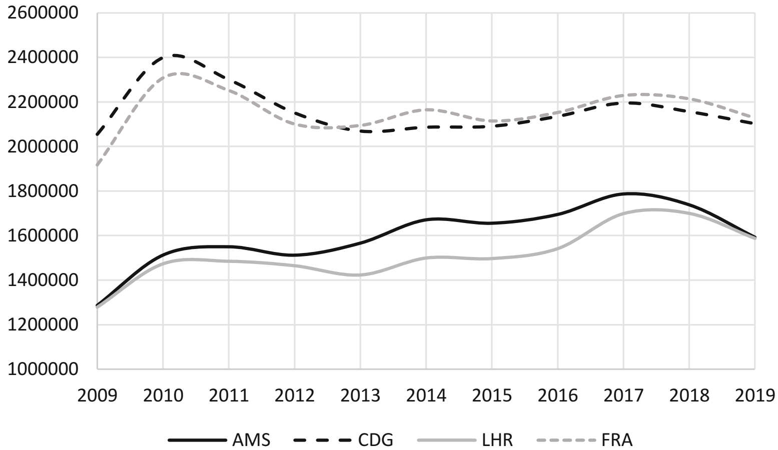

Fig. 16.3 Annual cargo volume (tons), Schiphol versus major European hubs

- DUS—Duesseldorf International
- EIN—Eindhoven
- RTM—Rotterdam the Hague Airport
- CLR—Brussels Charleroi
- NRN—Duesseldorf Weeze

Table 16.1 additionally ranks the ten airports we are covering in this short analysis by their cumulative passenger growth over the 2009–2019 time period.

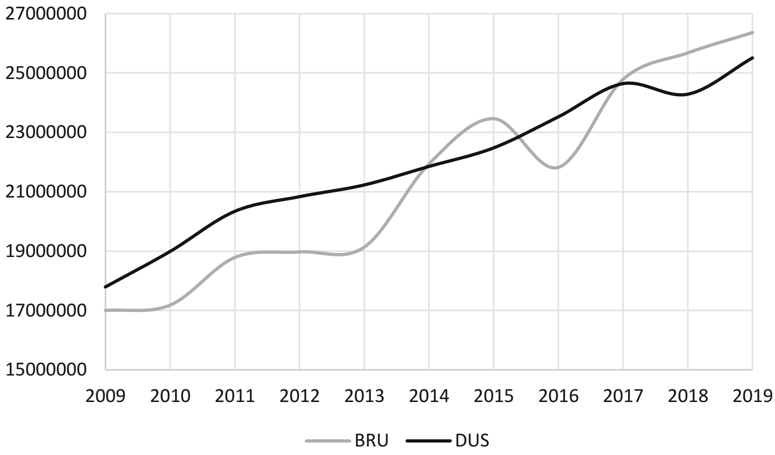

Fig. 16.4 Annual passenger traffic, BRU and DUS airports

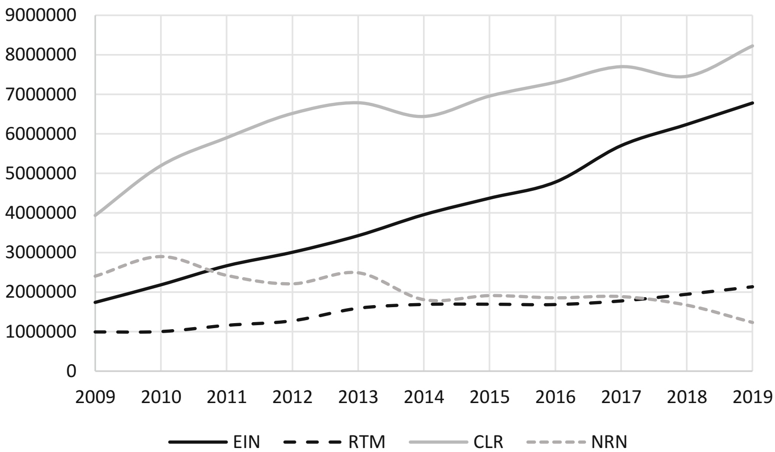

Fig. 16.5 Annual passenger traffic at small airports within AMS catchment area

We can see from the table that Schiphol has over the last decade grown much faster than other comparably sized airports. While the three smaller airports have shown remarkable growth in passenger numbers, focusing mostly on leisure traffic and taking advantage of Schiphol's limited capacity (Eindhoven and Rotterdam) and Ryanair's rapid development (Charleroi); the three airports combined handle less than a quarter of Schiphol's passenger traffic. Moreover, Schiphol group partly owns both Eindhoven and Rotterdam airports; this creates the potential for Schiphol operator to limit effective competition between AMS and these two gateways for the origin-and-destination traffic. Note that UK Competition Commission's (2009)

Table 16.1 Cumulative passenger traffic growth rates, 2009–2019

Airport	IATA Code	Passengers in 2009, millions	Passengers in 2019, millions	Cumulative 2009–2019 Passenger Growth (%)
Eindhoven	EIN	1.74	6.78	290
Rotterdam the Hague	RTM	0.99	2.13	115
Brussels Charleroi	CLR	3.94	8.22	109
Amsterdam Schiphol	AMS	43.57	71.71	64.6
Brussels Zaventem	BRU	17.00	26.36	55.1
Duesseldorf International	DUS	17.79	25.51	43.4
Frankfurt	FRA	50.94	70.56	38.5
Paris Charles de Gaulle	CDG	57.91	76.15	31.5
London Heathrow	LHR	65.91	80.88	22.7
Duesseldorf Weeze	NRN	2.40	1.23	–48.7

Source: Computed from the data compiled by CAPA Center for Aviation

decision to require BAA to divest of either Heathrow and Gatwick airports was driven by the concerns for limited competition between the two area airports under the same ownership.

Lelystad airport (LEY)—the largest general aviation airport in the Netherlands—is currently being expanded with the view of accommodating commercial passenger traffic as Schiphol is reaching its capacity. Here we again will run into the common ownership problem: as Schiphol group has owned LEY since the 1990s, its incentives to develop this otherwise well-located gateway into a commercially viable enterprise might be limited. We suggest the Dutch government should evaluate the option of requiring Schiphol group to divest of its ownership interest in Lelystad to bring about more competition between the airports in the area.

Several more interesting facts can be inferred from the figures above. First, Schiphol has increased its ranking among the European airports by both passenger volume and the number of aircraft movements. Moreover, in 2016 and 2017, Schiphol handled more aircraft movements than any other European airport. Note also how vividly Heathrow's capacity constraints appear in Fig. 16.2. Second, while all four major hubs exhibit similar dynamics in terms of the cargo volume; the gap between Schiphol and Heathrow on one hand and Frankfurt and Charles de Gaulle on the other has narrowed somewhat over the last decade. Third, note the downfall in passenger traffic at Duesseldorf Weeze airport, which is not very surprising, given how far it is located from major metropolitan areas.

16.4 Schiphol Regulatory Environment

N.V. Luchthaven Schiphol operates/ Amsterdam-Schiphol airport under the „Schiphol Group" trade name. It was corporatized as a limited company in the early 1950s under the form of a public company owned by the Dutch Government and the municipalities of Amsterdam and Rotterdam. Schiphol Group also controls the second and third busiest Dutch airports—Rotterdam and Eindoven, respectively. But the latter handle less than one million passengers annually, versus more than 70 million for Amsterdam-Schiphol.

Following the merger of Air France and KLM , Schiphol engaged in an alliance in 2008 with Air France's hub o perator Aéroports de Paris (ADP). Each company acquired an 8% stake in the other.[4] The Dutch government allowed the merger between Air France and KLM on the condition that the dual hub network is secured between the merger partners in the medium term.[5]

Traditionally, the Minister of Transport was in charge of reviewing and approving aeronautical charges. But, in the absence of clearer mechanisms and policy, this framework created some frictions between the Dutch airport operator and its users, who felt that their voice was not heard in the regulatory process. At the End of the 1990s, airlines began to criticize the increases in charges, especially at Amsterdam-Schiphol, that they considered to be an abuse of dominant position by the airport operator. These critics were further expanded by several judicial decisions, which accused the Dutch public authorities of approving alleged abuse of monopoly power by the airport operator (ICAO 2013).

The regulatory framework (Aviation Act of June 29, 2006,) designed and implemented in the 2000s, is built on the "negotiated access" or "regulated access" principle that was also implemented for other Dutch network industries.[6] After a lenghty review, the new Aviation Act came into force July 1, 2017. The Act stipulates that the aviation charges for aircraft, passenger, and security must be set in a non-discriminatory, transparent and wholly cost-oriented way under the Authority for Consumers and Markets (CMA).

In the context of the evaluation during 2011–13, it was noted that there is room for improvement in a number of areas, but the government did not consider any major systemic changes to be necessary.[7] The dual till system, in which only aviation

[4] The ownership structure of theSchiphol Group is thus as follows: State of the Netherlands, 70%; Aéroports de Paris, 8%; and the cities of Amsterdam and Rotterdam, 20% and 2%, respectively.

[5] The Dutch government's sudden and unexpected acquisition of a 13% stake in Air France-KLM in February of 2019 prompted the French government to accuse the Dutch one of acting like an "unfriendly" corporate raider. Now, it has emerged that Royal Schiphol Group may consider increasing its stake in Groupe ADP, the operator of the Paris airports, during the operator's privatization process. https://blueswandaily.com/are-the-dutch-and-the-french-get-closer-or-further-apart-as-it-emerges-royal-schiphol-group-may-increase-its-stake-in-groupe-adp/

[6] Information on the economic regulation of Amsterdam airport Schiphol can be found at www.nma.nl/en/regulation/transport/aviation/aviation.aspx.

[7] Letter of April 4, 2012, (Parliamentary Papers II, 2011/12, 33 231, No. 1)

activities are regulated, was retained and improved through better consultation, a multi-year plan for charges and conditions (i.e., for a 3-year period), a settlement equalization system for reducing fluctuations of charges, new efficiency incentives including regards for network quality[8] and a mandatory financial contribution to aviation activities from non-aviation activities, with the aim of obtaining a reasonable return on invested capital.[9] Budget overruns (difference between actual investment expenditure and the investment project budget) in a certain period will be fully absorbed by the airport operator, while cost advantages in a certain period will be shared equally between the airport operator and users.[10]

In accordance with the new Aviation Act governing the operation of Schiphol, the charges will no longer be fixed annually, but every 3 years. This change has taken effect for the 2019–2021 period. Another change is the introduction of a mandatory contribution from non-aviation activities to aviation activities, the level of which is determined by Schiphol's shareholders. Non-aviation activities at Schiphol are not subject to the economic regulations. This constitutes a departure from dual till to a hybrid till regulatory approach. Such a change should result in lower aeronautical charges for the airlines.

A significant sustainability element is built into the new charges structure, as Schiphol's pricing mechanism differentiates in technology. The objective is to get the best technology to reduce emissions and noise. Landing and take-off charges therefore give preference to aircraft that are quieter and more environmentally friendly.

Capacity pricing at Schiphol is currently not an issue. Most traffic in the peaks is from KLM, for which hub development and connectivity are still key. KLM even wants to increase the peak capacity at Schiphol. The biggest issue at Schiphol is instead the increase in average fleet size. Schiphol now lacks connected wide-body positions in the peak and uses the slot coordinator's mechanism to limit the number of wide bodies in the morning peak.[11] This according to the industry experts is far more efficient than peak pricing. However, the ministry of transport has announced it will consider the possibilities for secondary slot trading.

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[8] The system of efficiency incentives for investment projects was adjusted by extending the duration of the incentive from a single 3-year charge period to two of those periods, and by introducing a percentage which must be reached before

[9] The letters of June 5, 2013, and September 2, 2013, (Parliamentary Papers II, 2012/13, 33 231, Nos. 2 and 3) elaborated on these topics in greater detail.

[10] This means that the efficiency incentive will be applied only for significant discrepancies (see House of Representatives, 2014–2015 Session, 34 197, No. 3). Once the difference between the actual expenditure on an investment project and the investment budget reaches or exceeds five percent (as a positive or negative amount), the efficiency incentive will apply and the differences can be fully offset (in the case of higher-than-budgeted expenditure) or partially offset (in the case of lower-than-budgeted expenditure).

[11] For information on capacity at Schiphol: please refer to the independent slot coordinator's site. https://slotcoordination.nl

16.5 Concluding Comments

The issue of airport market power remains understudied. The application of the airport market power concept in policy making is also sporadic and inconsistent. Needless to say, such more subtle issues as measuring the concentration of airport markets, evaluating intensity of competition between the airports and potential anti-competitive conduct of airports have been given limited consideration in either academic or policy research. Generally speaking, the issue of airport competition has not been clearly placed by the regulators within the standard structure-conduct-performance framework used in competition policy.

The UK (and to a certain extent, Australia) remain the only two countries which implement regular analysis of the issue of airport competition, acknowledging the obvious fact that changed in the industry may necessitate a review of the previous findings. We have noted above that over the last 15 years or so, UK Civil Aviation Authority has determined that increasing competition between the airports made further economic regulation of aeronautical charges at Manchester and Stansted airpors no longer necessary.

In this short paper, we are revisiting the conclusions of an airport market power study conducted 10 years ago. We then participated in market power assessment of Amsterdam airport Schiphol. We see that a series of developments over the last decade point to a potentially stronger Schiphol's market position on the market for origin-and-destination passengers. In addition to the strong position that Schiphol has retained, we note that Schiphol Group's partial ownership of nearby operating airports (Eindhoven and Rotterdam) could limit development of effective competition for origin-and-destination traffic. Over the longer term, there is a potential for turning the general aviation Lelystad airport into a commercial aviation gateway. Here we again run into the ownership problem—Schiphol Group owns Lelystad. We suggest the Dutch government take a closer look into this issue.

The situation on the transfer passenger market is a bit less clear, as the external developments (most notably, the growth of the Gulf Carriers and Turkish Airlines) have increased the hub competition on the Europe-Asia routes. At the same time, an alliance between Schiphol Group and Aeroports de Paris (operator of Paris Charles de Gaulle airport) could have softened the competitive environment in Europe on this market segment. We have not done the more in-depth analysis of competition for transfer passenger traffic, as was included in our study a decade ago. We however believe that such an investigation would have demonstrated that a certain degree of Schiphol's market power on this market has been preserved. The situation on the cargo market appears unchanged from 10 years ago.

Several studies of airport competition in Europe over the last decade have suggested that airport competition has intensified. Both Copenhagen Economics and Oxera reports suggest that large hub airports are no longer as immune from the airport competition as before. On the other hand, our quick look at the issue as it applies to Schiphol airport points to increasing market power on some market segments. This paradox clearly calls for a new market power assessment.

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Chapter 17
Changing Governance and Regulation of Airports: A Comparison of Austria, Denmark, Italy, Hungary, Portugal, and Spain

Peter Forsyth, Jürgen Müller, and Hans-Martin Niemeier

Abstract All airports serve a region and some also serve a nation. This chapter considers regional aspects of the evolution of airport governance and regulation over recent decades. This chapter both widens the scope of academic scrutiny to many countries previously neglected in the academic literature, but also considers how these changes may have been applied and had different impacts at the regional rather than at the national level. In changing the focus in these ways, we retain the economist's concern for the impact of the changes on the incentives for cost and allocative efficiency. The chapter focuses on the major airports in core regions as most of these airports still have persistent market power and are regulated. Small airports in peripheral regions face different problems such as covering fixed costs. Regulation is here less of a problem. The paper shows that privatization has set out mixed incentives for efficiency. Even though competition has increased for some airports, the major regional airports retain substantial market power, in part because market structure has rarely changed with privatization. This puts a heavy importance on regulatory incentives.

Keywords Market power · Competition · Privatization · Regulation · Governance

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17.1 Introduction

More than 30 years ago, in 1986, the UK government introduced the Privatization Act for the British Airport Authority, which led to substantial changes in the way airports were governed. First of all, as most UK airports were privatized by the 1990s, and countries like Australia followed the UK, privatization was seen as a role model for other countries. However, those European countries which followed this trend did not fully privatize their airports, but only partially. Secondly, the step-wise liberalization of European airline market from 1987 to 1999 put increasing pressure on airports to compete for airlines and also for the commercial revenue they create. Thirdly, in the UK the number of regulated airports has slowly been reduced to two. In Australia, price cap regulation was abolished in 2001–02 and currently only four airports are subject to light-handed regulation with monitoring. Again other European countries were reluctant to follow the UK or Australia, and the member states of the European Union still rely heavily on regulation. The price cap regulation of BAA airports developed in the 1990s was also regarded initially as a role model, but again price cap regulation was only slowly adopted and very often in a heavy-handed way, thereby reducing the incentives for efficiency.

While these changes in governance have been intensively discussed for the UK and Australia (see in particular Graham 2008; Forsyth 2008; Littlechild 2018), this paper focuses on six European states, namely Austria, Denmark, Italy, Hungary, Portugal, and Spain, which have been less well researched. We analyze how the changes in governance alter the incentives for cost and allocative efficiency. We firstly outline the effects of privatization of airports; then we analyze competition among airports, and thirdly we discuss regulation in more detail. Thereafter we summarize the results and draw some policy conclusions.

The paper shows that privatization has set out mixed incentives for efficiency. Even though competition has increased for some airports, the major airports still have persistent market power, because market structure has not changed with privatization. This puts a heavy importance on the incentives from regulation. Some states like Denmark and Hungary have reformed regulation effectively, thereby intensifying efficiency incentives for airport operators, while others such as France and Spain have not. The paper shows that only a few countries obey the principle of "good" regulation and that only a few are capable of setting strong incentives.

17.2 Privatization of Airports

The six countries differ substantially in how they have privatized their airports. Firstly, the speed and timing are different. In the early 1990s, "there was little evidence of definite moves towards privatization" writes Anne Graham (2014, p. 13) "with the notable exceptions of Vienna and Copenhagen airports."

Governments sold 36.5% of Vienna airport in 1992 and 26% of Copenhagen airport in 1994. Privatization took off in 1996 when it became "a much more popular option in many areas of the world (ibid)." Italy was part of this wave of privatization, in as much as in 1997 Naples and Rome, in 1998 Florence, and in 2000 Turin were partially privatized, all with a private majority share. Other Italian airports followed later (see Table 17.1).

The economic crisis of 2001 slowed down privatization in many countries. In December 2005, BAA purchased a 75% minus one share stake in Budapest Airport for US$2.19bn. However, following the acquisition of BAA by a consortium led by Ferrovial of Spain 6 months later, Budapest Airport was put up for sale again. BAA sold its stake in the airport to a consortium led by the German airports' group, Hochtief AirPort GmbH for 1.9bn € in June 2007. A few years later in 2011 Budapest airport was fully privatized.

In other countries, the economic crisis of 2007 stopped or delayed privatization, at least for a number of years, but later on, the austerity programmes in Southern European States led to reduction in public debt by selling public assets, among them airports.[1] Maximizing the revenues from the sale of state assets became the major driver of privatization. Other objectives of privatization, such as the transfer of management know-how, cost efficiency and opening industry to competition became less important. The dominance of the revenue generation objective is well documented for Portugal by Cruz and Sarmento (2017). The privatization of the Portuguese airport system ANA, with the two major hubs Lisbon and to a lesser degree Porto, and eight other airports, was finalized in 2013. In Spain the first attempt to sell part of the nationwide airport group, AENA, namely the two largest airports Madrid and Barcelona failed in 2012, but 2 years later in 2015, 49.1% of AENA was sold as a single entity (Table 17.1).

Secondly, the countries differ in the extent to which they give up control. As a consequence some countries fully privatized their airports while others sold a minority or a majority share. Privatization changes the principal agent relationships. In a world of complete long-term contracts, this would not matter,[2] but in a world with transaction costs, ownership does matter. Given the view of airports as being long-term relation-specific investments with incomplete contracts, privatization can change incentives for economic efficiency for the better or worse. Proponents of privatization argue that privatization increases the cost efficiency through profit making with better cost control, and that that some or all of these gains are finally passed on to the consumer via lower prices. The size of cost savings depends very much on the inefficiency of the public airport before privatization. If the airport was run as a public bureau without proper cost accounting and control, the cost reduction

[1] For a critical discussion of the macro economic effects see Stiglitz (2016) and Wolf (2014, especially pp 266–271). Stiglitz criticizes the political economy of the privatization of Greece regional airports for its conflict of interest, as the German government was leading the Troika and at the same time had political influence on the winner of the bid, FRAPORT which is a majority state owned airport.

[2] On the neutrality theorems of privatization see the overview by Walker (2016)

Table 17.1 Ownership of major airports in six EU countries

	Public	Privatization		
	Corporatized	Minority private	Majority private	Fully privatized
Austria	Linz, Graz, Klagenfurt, Salzburg	Vienna (1992)		
Denmark	Billund		Copenhagen (since 2000)	
Italy	Palermo, Catania	Bologna (2015) Cagliari, Milan Malpensa & Linate & Bergamo (in 2011)	Florence (2000) Naples (1997) Parma (2008) Pisa (2007) Rome (1997) Turin (2000) Venice (2005)	
Hungary				Budapest (since 2011)
Portugal				ANA with Lisbon, Porto, Faro & 7 airports (2013)
Spain		AENA with 49 airports (2015)		

Source: Compiled by authors from various sources

potential is large. However, almost all airports in the six countries under investigation had commercialized their operation so that profit making and cost control have already become a more prominent objective of management.[3]

The strength of the incentives for cost efficiency becomes more questionable in the case of partial privatization with only a minority private share, where the private sector is more seen as a source of capital than the source of management know-how and influence, which is the case for Austria with Vienna,[4] Italy with Bologna, Brescia, Cagliari, Milan Malpensa and Linate, Verona and Spain with AENA.

[3]Note that we are not implying that corporatized airports are efficiently managed. Commercialization of airport has not been very well assessed by benchmarking studies. Anecdotal evidence is mixed. For example Schiphol is a commercialized airport which is supposed to be better managed than some private airports

[4]Some sources (e.g. ACI 2016) treat Vienna airport as majority private owned because the city of Vienna and the state Lower Austria each hold 20 per cent of the shares, while AIRPORTS GROUP EUROPE S.À 39.9%, 10.2% are free floating and the employee foundation holds 10%. The decisive question is how to treat the employee foundation which is formally private, but which depends on the city and state and has always voted with them. As Verfassungsgerichtshof Austria (2018) showed the legal contracts have been so designed that the city and the state have the majority.

When the state still has a large[5] minority share, as with the Italian airports of Florence, Naples, Parma, Turin, Venice (but not Rome[6]) and the Danish airport of Copenhagen (40%), there might be weaker incentives for cost efficiency than under full privatization. This depends also on the nature of the contract and the behaviour of the state, which might differ from case to case. In general empirical performance studies (Oum et al. 2006, 2008; Adler and Liebert 2014) have suggested that partial privatization is the most problematic form of ownership in terms of cost efficiency. Only Hungary with Budapest and Portugal with ANA[7] have avoided this problematic ownership form and have fully privatized their airports.[8]

The welfare gains of privatization depend also on the pricing policy of the airports, as well as the cost efficiency gains. Privatization strengthens incentives for cost efficiency, but it also strengthens the incentive to use market power to reduce output and increase prices. Welfare gains can be achieved if the pressure to increase prices is blocked by intense competition or effective regulation. However this source of efficiency gain has been stymied by the monopoly of ANA and AENA has been maintained, by political choices. Also, in the case of three airports in the Milan region, separation of the airports, which could resulted in competition, has not been achieved.[9] Safeguarding monopoly against competition is not a new phenomenon. In the UK, the Thatcher government privatized the BAA airports as a group without any restructuring and in France, the Chirac government partially privatized the two Paris airports jointly. Spain and Portugal, under budgetary pressure to raise revenues, have followed this pattern, since maintaining the current market structure would yield higher sale prices than a more competitive market structure.

[5]Partial privatized airports with minority share have not been studied intensively. For example it is unclear if a private share of 10% makes a difference compared to a 40% share.

[6]In the case of Aeroporti di Roma the state share has been stepwise reduced to 2%. Atlantia S.p.A holds currently 98%.

[7]Originally the government of Portugal intended to give the employees a share of 5%. However, the employees declined the offer and Vincy bought 100% of 50 years long concession of ANA for 3.08 billion € (SDG 2017, 3.304).

[8]Partially privatized airports raise a number of interesting questions like why public bodies prefer to have control via ownership and regulation to influence decision-making within the company and why some private firms prefer to have the state directly involved as an owner although the state is regulating the airport. Wolf (2003) has argued that private firms will secure their investment in a relation-specific long-term investment by letting the state own part of the asset to avoid opportunistic behaviour if regulation is not clearly defined and independent like for example in the UK. Most of the analysed states have not established such regulation for reasons not known. Instead they have partnered up with different types of airport investors such as purely financial investors.

[9]This is because the city of Milan is still is the majority owner of the two Milan airports and holds 31% of Bergamo airport

17.3 Airport Competition

The reports on airport competition[10] by Copenhagen Economics (2012) and by OXERA (2017) have led to a debate on the intensity of competition on a European level in policy and academia (Bush and Starkie 2014; Thelle and Sonne 2018; Wiltshire 2018). While many issues seem to be difficult to resolve, the parties seem to agree at least that the strength of competition needs to be assessed on a case-by-case basis. In this respect the report abstains from any clear assessment. This chapter relies on the results of Maertens (2012) for the year 2010. Maertens developed an index based on the major forces of competition. The index ranges from 0 indicating no market power, to 100 indicating pure monopoly power. The results are reported in Table 17.2. The first value gives the market power from the perspective of passenger, and the second from the perspective of the airlines. Maertens does cover most, though not all airports analyzed in this chapter. In our comments, we also take into account common ownership of adjacent airports and the effects of other events which occurred after Maertens completed his study in 2010.

In all countries, most of those airports which were partially or fully privatized have persistent market power. The exception is Venice, which has only moderate market power. The results for regions with multiple airports, such as Milan and Rome,[11] show that common ownership restricts potential competition. The same is true for the Portuguese and Spanish airport systems—Barcelona and Madrid airport could compete for long haul flight if under separate ownership and Girona airport could be a substitute for Barcelona in the short haul leisure market. At the time of the privatization there was no good substitute for Lisbon airport, but there were plans to build a second airport, which have been finally approved by the environmental agency in October 2019. However, airport competition is ruled out as the concession for the second Lisbon airport has been given to ANA.

From our point of view, the 2010 results of Maertens are still current, even if LCCs have increased their market shares so that demand becomes, ceteris paribus, more elastic which would reduce the index values slightly (except where there is still a monopoly provider as in Spain and Portugal). The case of Budapest airport is similar. In 2012 Malev went bankrupt. This has led to a short temporary reduction of passengers for Budapest airport but returned to its old growth path as LCCs entered on most of the former Malev routes (Bilotkach et al. 2014; The Economist 2013)

In each country, at least one airport has market power, but of course further studies need to be done to assess rigorously which airports have persistent market power and which should be regulated (as was done, for example, in the UK and Australia). On the other hand, in these countries, there are airports like Venice, Graz, and Innsbruck, which are facing more or less intense competition. In such situations, the relevant regulatory authorities should conduct a study on the market power of

[10] This debate has its roots in the papers by David Starkie (2001, 2002).

[11] For Rome the market power of Rome Ciampino with currently 6 million passengers is not reported.

Table 17.2 Airport competition

	Airports	Market power based on Maertens (2012)	Assessment
Austria	Vienna	High (94/49)	
Denmark	Copenhagen	High (98/80)	
Hungary	Budapest	High (100/100)	Malev failed in 2012. LCCs took over. Still high market power
Italy	Rome Fiumicino	High (90/ 100)	Persistent market power through joint ownership
	Rome Ciampino	N/A	
	Milan Linate	Low (35/36)	Persistent market power through joint ownership
	Milan Bergamo	Low (32/45)	
	Milan Malpensa	High (58/59)	
	Venice	Medium (70/43)	
	Catania	High (97/100)	
Portugal	Lisbon	High (100/100)	ANA Airport system with persistent market power
	Faro	High (100/100)	
	Porto	NA	
Spain	Madrid	H 100/100	AENA: Airport system with persistent market power
	Barcelona	H (84/50)	
	Palma	H (100/100)	
	Malaga	H (100/100)	
	Alicante	H (85/50)	

each airport, and then decide which airports should be regulated. Such a study should have also been done in the case of the Portuguese and Spanish airport systems, but as Cruz and Sarmento (2017) point out, horizontal separation was not really considered in Portugal due the budgetary pressures. Also in Spain, the structure of the national airport operating company AENA was never put in question. According to Steer Davies Gleave (2013, p.64), in Europe, only the CAA UK and Dutch Competition Authority analyzed the market power of airports to determine which airports should be regulated on not. The six countries under study are no exception to the common practice in EU member states of regulating airports out of tradition and/ or because the EU directive on airport charges has set an arbitrary threshold of five million passengers (see below).

17.4 Regulation of European Airports

This section analyses firstly, the regulatory institutions, and secondly structure of regulation, for the six countries under consideration.

17.4.1 Regulatory Institutions

One important institution which is applicable to the airports in these countries is the EU Directive on Airport Charges (EU Com 2009). The principles of good regulation demand, among other things, that a country should avoid conflicts of interest by separating ownership and regulation—this separation should prevent regulatory capture. This principle has been reflected in the EU Directive (EU Com 2009). But there are different interpretations. The extreme is the German notion of interdependence which even allows an airport owned by the Treasury to be regulated by the Department of Transport of the same government. In other countries such as France,[12] the EU directive has led to some notable changes. This is also the case in the six countries under study.

There are two distinct concepts of separating ownership and regulation. The first one is that the regulator is part of the government which has no ownership share in the regulated airports. This model has been practiced in Austria since 2001, when the Federal Republic of Austria sold its 17% share. Initially, in 1992, the Federal State held a share of 27%. Regulation was only loosely defined, and the regulator could not really act as an arbitrator, as Wolf (2003, p. 245) pointed out. At that time airlines complained that regulation favoured the airport so that no agreement between airports and airlines was reached on the proposed price cap with a traffic risk mechanism (see below). In reaction to these problems, and with the discussion on the EU Directive of airport charges in mind, Austria has clarified and codified regulation (Bundeskanzleramt Österreich 2017) so that the independence of Austrian regulator is not seen as critical by the airlines (SDG 2017). Similarly, at the beginning of the privatization of Budapest airport, the Hungarian government had not separated these functions, but with full privatization in 2011, separation has been achieved. In spite of this, airlines are still critical as the airport seems to be politically influential, thereby affecting the regulator. Because of such fears, the second model was developed. Here the regulatory agency is independent from the government. It has a clear statute and is responsible to the parliament. This model has been practised in the UK, Ireland, and Australia, but not much in continental Europe. The independence of the Autoridade Nacional da Aviacao (ANAC) in Portugal has been controversial discussed between airlines, airports, and policy. The airlines association submitted an official complaint to the EU COM that Portugal is violating the

[12] The criticism of the airlines that the regulator was part of the DOT resulted in a decision the Conseil d'État to establish an independent regulator (29 April 2015).

charges directive (SDG 2017, 3.340), but this complaint has been turned down, because the concession agreement fixes key factors of the regulation only for a short period.

An interesting case is Italy which at the beginning of the privatization process in 1997 was criticized by the OECD (1998) for not having separated ownership and regulation. The Italian central government reacted by providing the regulatory power to ENAC which is a body of the Department of Transport and by selling off the shares in airports. So ENAC was independent, but not in the sense of a truly independent regulator with a mandate and separated from the ministry. The independence was questioned (in particular by airlines). Therefore in 2013, the Transport Regulation Authority (TRA) was established by law which is an independent regulator for all transport modes including airports (Cambini and Perrotti 2015). However, TRA did initially not regulate the five major airports which have been previously privatized under a concession agreement and which were still regulated by ENAC. The EU Commission reacted with a formal infringement procedure in July 2013 although ENAC was more independent than other European regulators. The objective of the infringement was either to separate economic regulation from the other regulatory duties of ENAC or to establish TRA as the sole regulator (SAVE 2017, p.31). Since 9 May 2019 the issue has been now resolved as TRA is also regulating the airports under a concession contract. What remains unresolved is that TRA prefers a hybrid price cap model, while the concession agreements foresee a dual till.

Typically, the EU member states have implemented neither of the two models of an independent regulator. The airlines quite rightly fear regulatory capture, and this seems to be especially the case in Spain and in Italy (see Table 17.3). In Spain the competition authority "Comisión Económica de los Mercados y la Competencia" (CNMC) was established in 2013 as a regulator, but with limited power. It can only comment on the regulation. The decision is taken by the Directorate General of Civil Aviation (DGAC) and approved by the Council of Ministers of the Government of Spain.[13] The rule that poor design of regulatory institutions will lead to regulatory capture and poor incentives for efficiency seems to have one exception. This is Denmark, where the regulator is part of the Department of Transport which has also a minority share in Copenhagen airport, but where a form of light-handed incentive regulation has been practiced for many years with success and with acceptance by the airlines. This case will be discussed in the next section.

[13] SDG (2017, E.494) reports with a critical undertone: "while, at least formally, it could seem like the CNMC has been properly empowered according to the Directive, the fact is that the CNMC has no influence over the actual level of the charges, given that the scope to act is limited to minor adjustments within the parameters which have either already been set in the law or will be set by the DGAC/Council of Ministers in the quinquennial regulatory framework."

Table 17.3 Institutions of airport regulation

	Airports	Regulator	Independent	Issues
Austria	Vienna	Federal Ministry for Transport, Innovation & Technology	Yes, no conflict with ownership	"Independence was not highlighted as an issue by the airlines" SDG (2017, E.16)
Denmark	Copenhagen	Danish Transport Authority	No	Not criticized by airlines
Hungary	Budapest	National Transport Authority	Yes, no conflict with ownership	Airlines doubt whether NTA is effectively independent from the Airport. SDG (2013, p. 93)
Italy	5 major airports	Regulated by ENAC, but since 5/2019 by TRA	Yes, but infringement procedure from EU COM	Airlines question independency of ENAC SDG (2013, p. 128)
	3 classes: >5 mill 3–5 mill <3 mill Pax	Transport Regulation Authority (TRA) est. 15 Jan 2014	Yes	Not criticized by airlines
Portugal	ANA	Civil Aviation Authority (INAC)	No, concession agreement limits power	Airlines charge Portugal to violate Directive, but infringement was closed
Spain	AENA	Prior 2012 DGAC, 2013 Commission of Airport Economic Regulation, After 2013 National Commission of Markets & Competition	No, conflict between regulator & ownership. Government decides. DORA 2017–2021	"All airlines and their associations quoted Spain as the most problematic of all Member States for transparency" SDG (2013, p. 66) "Airlines do not view the Spanish ISA as independent" SDG (2017, E.502)

Source: Compiled by authors from various sources

17.4.2 Structural Regulation

In this section, we first discuss how regulation sets incentives for efficiency and secondly how commercial revenues are regulated.

17.4.2.1 Efficiency Incentives

Ideally, the regulator should use a method which leads to economic efficiency, which has the following aspects:

- Cost-efficient provision of services with a defined quality
- Allocative efficiency
- Optimal investment

How the six countries handle these aspects will be discussed in turn.

Cost Efficiency and Quality of Service

In Hungary, Italy, and Spain the regulator adopted a UK style price cap, which is based on the costs of the airport. Such a hybrid price cap sets weaker incentives than a pure price cap, based on benchmarking,[14] but not on the costs of the regulated firms. Compared to the traditional cost-based regulation, such a hybrid price cap is an improvement in regulation and sets incentives at least in the right direction—that is, towards cost savings instead of gold plating.

It should be noted that the speed of reform of regulation differs between these three countries. It reflects the speed of the privatization process and also the political struggles to establish regulation with incentives. In this respect Hungary reformed regulation earlier and more clearly than Italy and Spain. For Budapest airport, the initial price cap for the period 2006 to 2011 reduced the price level by more than 20%. This was combined with a traffic risk mechanism[15] with a dead band of 6–10%. For the next two regulatory periods from 2012 to 2017 and 2017 to 2021 the cap depends on yearly traffic growth and equals zero change at a growth rate of 14% which has never been realized.

In Italy, in which airport charges were frozen from 2000 to 2008 and even for some airports such as ADR up to 2011, the regulator categorized in the three classes and implemented a hybrid price cap airport by airport. The X-factor was a result of a discussion and bargaining process between regulator, airport, and airlines. Benchmarking techniques were used as additional information for understanding the potential gains in operational efficiency. With the change to the new regulator benchmarking might also be used in a more systematic way. ART has proposed for the forthcoming regulatory period to use stochastic frontier analysis (SFA) for the large airports to determine the x-factor for operation costs. For the smaller airport, the x-factor should be based on a list of key performance indicators provided by ART. Airports are sceptical about the robustness of SFA, but the regulator seems to be confident as he has been used this method in other regulated industries.

In Spain AENA was traditionally regulated on a cost basis. The attempts to reform regulation began in parallel with the attempts to privatize AENA. The legal framework was laid down in the Act 18/2014 of 15 October to improve growth,

[14] Note, that most of the countries do not use benchmarking to evaluate the cost efficiency of the airports.

[15] For discussion in terms of allocative efficiency see below.

Table 17.4 Scope and method of airport regulation

	Airports	Incentive	*X*-factor time period	Benchmarking	Quality
Austria	Vienna	Cap with traffic sharing mechanism	Zero since 1995	No	Neither regulated nor monitored
Denmark	Copenhagen	Light-handed Regulation	+ 1 for 2010–2015 0 for 2015–2019	N.A.	Voluntary penalty System
Hungary	Budapest	Hybrid Price Cap with traffic sharing mechanism	–5% for 2007 & 2008, –3% for 2009–2011 Max 0 for 2012–2017 and 2017–2021	No	Yes, penalty system
Italy	Major	Hybrid Price cap		New proposal for SFA	Yes, by bonus malus system
	Catania, Bologna, Naples	Hybrid Price cap		Yes, as additional information	No
Portugal	ANA	Hybrid revenue Cap with traffic risk-sharing mechanism	+ 0.5 for 2014–2022	Yes, of charges. Part of cap formula	Regulated with penalties
Spain	AENA	Hybrid revenue cap	–2.22% for 2017–2021	Not used	Regulated with incentives & penalties

Source: Compiled by authors from various sources

competitiveness, and efficiency. This Act capped the revenues per passenger for AENA for the period 2015 to 2025 and set a maximum level of investment at 450 million € for the 2017–2021 and for 2022–2026. It also established the regulatory framework of airport regulation, DORA, out of which a decrease of charges resulted (see *X*-value in Table 17.4). However, these caps have to be carefully evaluated because there is some evidence that, at least for Madrid Airport, charges were substantially increased by more than 50% in 2011 and 2012 (SDG 2017, 3.267).

Portugal also uses now a hybrid price cap and sets a cap for a period of 10 years. A cap of 10 years offers guarantees for the private investors that the profits from cost saving can be kept for about double the length in the usual regulation period. In addition Portugal benchmarks the level of charges with a sample of other European airports. This provides some additional information, but not as much as benchmarking in terms of efficiency could offer to reduce the information asymmetry between regulator and regulated firms. Overall, Portuguese regulation seems to offer stronger incentives than regulation in Hungary, Italy, and Spain.

The UK style hybrid price capping has been criticized for having become increasingly bureaucratic and costly over time (Littlechild 2018). There are two countries which have abstained from basing their regulated prices on this approach: Austria and Denmark.

Austrian regulation is unique in as much as it fixes the cap at an X value of zero. In real terms, the cap simply changes allowable price with traffic growth (see below). This cap was established in 1995 and confirmed in 2012, with the revision of charges. On the one hand, it sets strong incentives, as the regulated airports cannot influence the price through strategic actions and all profits from cost savings can be kept—i.e., it is a pure price cap. On the other hand, as the level of charges is relative high and was not set initially at a level close to costs (Zulinsky 2013), the partially privatized airport, with a government minority share, does not appear to act like a purely profit-maximizing firm. Regional policy impacts might be influential additional factors. The airport might also maximize internal rents and be X-inefficient. Vienna has always had relative high charges (Wolf 2003; ATRS 2017) and benchmarks have shown that it has high operating costs. Overall, while there are strong incentives for efficiency, the airport does not respond to them since it has objectives other than profit.

The light-handed regulation of Copenhagen airport has evolved in different phases (Adler et al. 2015). In the first phase up to 2003, charges were loosely regulated, with the explicit aim of leaving efficiency gains with the airport for a certain not specified time (Wolf 2003). In the second phase from 2003 to 2008, an explicit price cap was introduced, allowing overall for an increase of charges of about 5% over the period. In third phase starting in 2008, regulation was reformed under the principle that the airport and its users should negotiate, and only if no agreement is reached, regulation of a hybrid price cap with a mixed till sets in. After an initial 4.2% yearly increase of charges in 2009–2010, airlines and the airport reached an agreement for the period 2010–2015 of a price cap of CPI plus 1% and for the second period, April 2015–31 March 2019, charges remain constant in real terms. However, there are signs that Danish light-handed regulation is entering a fourth phase. In July 2017 the Danish Government announced its “Aviation Strategy for Denmark” to reform partially the regulatory model by the end of 2018 and to “encourage Copenhagen Airport to investigate all possibilities for reducing the charges level for domestic operators within the framework of the EU Directive” (Ministry of Transport, Building, and Housing, Denmark 2017, p. 85).

Lars Nørby Johansen, Chairman of Copenhagen Airport reacted on 8 December 2017:

> In July, the government presented the new aviation strategy focused on strengthening Denmark’s international connectivity and Danish domestic aviation. As a result of the aviation strategy, we have new regulation, which will not take full effect until April 2019. Both from the political side and from airlines, there has been a wish for lower airport charges. We’ve listened to that. At the same time, we want to respond to the new regulation now and create a good common starting point for the upcoming charges negotiations.

> Therefore, we will be reducing charges from April 2018 through two specific initiatives. Firstly, we are reducing the charges that all airlines pay to use the airport. Furthermore, we are introducing a special incentive scheme that will make charges 35% lower for frequent feeder flights between regional airports and CPH. On average, CPH's charges will be 10% lower from April 2018. (CPH 2017)

Compared to the magnitude of the X-factor, the 10% decrease indicates a substantial change. This direct political intervention questions whether the dependent regulator will be really in a position to act as a mediator between the airport and its users and whether regulation can be carried on it a light-handed way.

Cost savings can also be achieved through lower quality (Kahn 1970/1971[16]) and a regulator might set the regulated price so low that the airport is even forced to reduce quality to match the price. Some form of regulation of quality is therefore needed—in this respect the countries differ. Austria does not regulate quality, which seems to be less problematic as the price level is so high that the airport is not forced to reduce costs by cutting quality.[17] In Denmark quality has not strictly been part of regulation. The airport has become very proactive in establishing service level agreements with airlines which includes penalties which so far has worked well and has been accepted by airlines (SDG 2017, E.121) However, in the Aviation Strategy, the government announced it would institute measures "to make an analysis of the need and the possibilities for introducing service level targets for the waiting time at baggage reclaim" (Ministry of Transport, Building, and Housing, Denmark 2017, p. 93).

In Italy, ENAC is regulating the quality for the major airports through the concession contract. Quality is an explicit term of the price cap formula with a bonus and malus system (ADR 2016). Since 2007 the regulator of Budapest airport has added a penalty of to 5% of the price cap if the airport provides lower quality. The penalty depends on the availability of the infrastructure and customer satisfaction. Both criteria are given equal weight. In Portugal quality is regulated by a penalty system. Quality is measured by indicators for service to airlines and to passengers. More weight is given to the delivery of services in peak times in the airports of Lisbon and Faro. The maximum penalty amounts to 7.5% of regulated revenues (Ribeiro and Gonçalves 2013). In Spain quality is explicitly part of the revenues cap per passenger (DORA 2017). Quality is defined by 11 indicators for passengers such as cleanliness in the airport and airlines such as availability of boarding air bridges. For each standard a target level with a certain range (dead band) is defined. If the level is below this range a penalty is charged, if it is above a bonus is

[16]Kahn argues that quality of service is often given not enough attention, which is a mistake as "price really has not meaning except in terms of an assumed quality of service; price is a ratio, with money in the numerator and some physical unit of given or assumed quantity and quality in the denominator. Price regulation has no meaning except in terms of an assumed quality of service." (Vol I, p. 21)

[17]While airlines have been critical to some aspects of the regulation like the dual till principle they have not criticized the quality of service. Furthermore, the airport has won awards for offering best quality of service.

given. The total bonus and malus cannot exceed 2% and –2% of the maximum annual revenue per passenger. As this has been practiced for the first time, it is not possible to assess the effectiveness of these measures.

Allocative Efficiency

Cost-based regulation has been criticized for not setting any incentives for peak and congestion pricing (Kunz 1999; Niemeier 2002). Price cap regulation can in principle set incentives for more differentiated pricing.

Traditionally, airport charges consist of weight-based landing charges and passenger charges. Weight-based charges are regarded as a rough proxy for Ramsey pricing, which is an efficient price structure at airports with adequate runway[18] capacity. The efficiency of weight-based charges gets lessened if the airport becomes more highly utilized, and peak and congestion problems arise, and as larger aircraft pay more than smaller aircraft and scarce time is not priced. In this situation, the charges are not allocatively efficient. With airports, there is an additional mechanism, namely the slot system, which applies in Europe and some other continents. Excess demand is managed by the slot system. In most of Europe, most slots are administratively rationed—and secondary trading is only practised in the UK, and the slot allocation lacks a market-based instrument in these countries and is therefore inefficient. For periods of excess demand, the appropriate structure of charges is a movement charge, and weight-based charges are inefficient (Forsyth and Niemeier 2008) (Table 17.5).

While in principle, many price caps set incentives for allocative efficiency, it is important to note that not all forms of them do so. This is particularly the case when the cap has a traffic risk-sharing mechanism, which sets the level of charges inversely to demand. Austria was the first one to adopt this mechanism in 1995 for Vienna airport. It became very influential and has been copied by many airports such as Budapest airport, the Paris airports and Hamburg airport. As a result, we discuss this concept in its historic version. In the meantime, the cap with a traffic risk sharing only applies to airports below five million passengers, and in a modified form to Vienna Airport[19] (Bundeskanzleramt Österreich 2017).

Figure 17.1 shows how level of charges for a year (in this case 2009) changes inversely with traffic growth. If traffic grows by 2% the nominal charges would increase by 2%. If traffic growth is stronger—for example by 13.5%, the nominal charges would have to be reduced by 2%. In addition, the traffic risk-sharing mechanisms sometimes include a floor for negative traffic growth, which creates

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[18] Airports can be constrained due to many factors besides runway capacity. Terminal, apron and even ATC are sometimes the limiting factor. Typically these constraints can be relaxed easier than the runway constraint. Allocative efficiency demands here as well some form of peak and congestion pricing. In the following analysis we confine ourselves to runway constraints and not the other constraints.

[19] The currently applied traffic risk mechanism for Vienna has been changed by limiting the risk-sharing mechanism to traffic growth. In the case of reduction of traffic, the charges stay constant instead of being raised. This slightly lessens the risk to the airlines and shifts it back to the airport, but a normal market reaction would be to lower charges.

Table 17.5 Capacity and pricing

Country/ airport	Slot coordination level	Coordinated movements			Capacity Problem	Weight based charges	Peak Pricing	Discounts/incentive scheme
	2017	2000	2017	% change				
Austria								
Vienna	3	60	68	13	Peak	Yes	No, but fixed charge for small aircraft up to 46 MTOW	Yes
Linz	2 Winter 3	N/A	N/A	N/A	No	Yes	N/A	N/A
Graz	2	N/A	N/A	N/A	No	Yes	N/A	N/A
Klagenfurt	2	N/A	N/A	N/A	No	Yes	N/A	N/A
Salzburg	2	20	20	0	No	Yes	N/A	N/A
Denmark								
Copenhagen	3	81	83	2.5		Yes	No	Yes
Billund	3	32	32	0		Yes	N/A	N/A
Hungary								
Budapest	2	40	60	33.3				Yes
Italy								
Bologna	2	24	24	0		Yes		Yes
Cagliari	3	10	16	60		Yes		Yes
Catania	3	12	20	66		Yes		Yes
Milan Bergamo	3	24	26	8		Yes		N/A
Milan Linate	3	32	18	–43		Yes		N/A
Milan Malpensa	3	44	70	59		Yes		Yes

Naples	3	27	30	11		Yes		Yes
Palermo	3	20	21	5		Yes		Yes
Parma	N/A					Yes		Yes
Pisa	2	14	14	0				Yes
Rome Ciampino	3	NA	12			Yes		N/A
Rome Fiumicino	3	68	90	32.4		Yes	Yes, Peak plus 15 per cent of average Off-peak- 15%	Yes
Turin	3	24	27	12.5		Yes		Yes
Venice	3	24	32	33		Yes		Yes
Portugal								
Lisbon	3	30	40	33.3	Excess demand	Yes	No, but minimum charge of 121 €	No
Porto	3	14	20	42.8	Excess demand	Yes	No, but minimum charge of 279 €	Incentives for new routes, operating base (SDG 2017, L3.326)
Spain								
Alicante	Level 3		30		No	Yes	No	Route Development Programmes are allowed (DORA 2017, p. 56)
Barcelona	Level 3		72		No, but terminal	Yes	No	
Madrid	Level 3	50	100	100	No, but terminal	Yes	No	
Malaga	Level 3		44		No	Yes	No	
Palma	Level 3	26	65	150	Yes	Yes	No	

Source: Compiled by authors from various sources

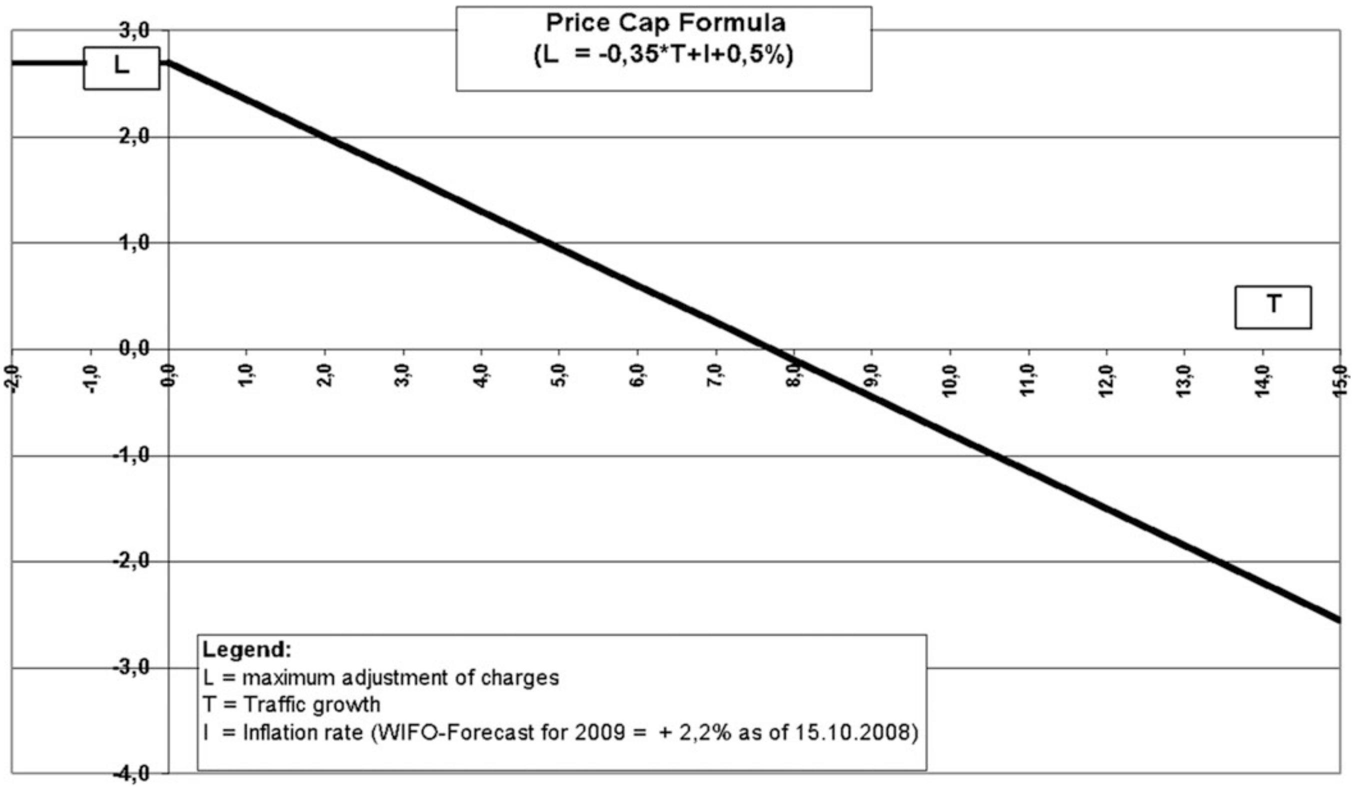

Fig. 17.1 Price cap with traffic risk mechanism for Vienna Airport for 2009. Source: Müller and Niemeier (2013)

an asymmetry. If, for example a negative demand shock occurs in an economic crisis and traffic shrinks by 5%, nominal charges would not fall, but stay constant in real terms. With traffic fluctuations this could lead to very different results compared to constant growth rate. This happened at Hamburg airport, but the traffic risk-sharing mechanism was later changed to a symmetric mechanism. Even a symmetric risk-sharing mechanism sets negative incentives for efficiency because revenues are stabilized and do not depend much on traffic growth. The price cap becomes similar to a revenue cap. The negative side effect is that traffic risks are reduced (but not eliminated)[20] for the airport, (though not for the airlines and their passengers) and thereby also the incentives to manage demand and capacity efficiently, for example by offering lower charges in the off-peak and higher charges in the peak. The airlines, and ultimately, the passengers bear the risks created by economic fluctuations.[21] Risk-sharing mechanisms have other effects which should be noted. Airports are typically more financially stable than airports and thus they have more ability to bear risks—to this extent, risk-sharing price structures would be less efficient than non-risk-sharing structures. On the other hand, since airlines are closer to the passengers, they may be better at managing risks—for example they have more ability to develop new routes (very relevant in the case of smaller airports). In this case, there are advantages in putting more of the risks on the airlines rather than the airports. Whichever approach is adopted, the fact that airports have been able to impose a price structure which is detrimental to the airlines is another reflection of their market power.

The negative effects of the above form of revenues cap on efficiency are limited in the case of airports[22] with adequate capacity if demand is inelastic and the price structure is an approximation of Ramsey pricing. However there are issues when the airport faces peak capacity problems. In this case the revenue caps in Portugal[23] for the congested airports of Lisbon and Porto are problematic, but currently not so much for Spanish airports. In the first decade of this century, the airports of Barcelona and Madrid were seriously constrained, but capacity has been significantly extended. Both have excess runway capacity, but terminals are getting close to capacity at peak times at Barcelona and Las Palmas.Vienna airport has planned a new third runway since 2000. At peak times capacity has become scarce. The airport has nevertheless kept the weight-based structure, but in order to incentivize larger aircraft, it has charged small aircraft up to 46 MTOW a fixed charge and is practising peak pricing for general aviation.

A notable exception from the industry practice of not pricing scarce capacity is the case of Rome airports. The concession contract of 2012 for ADR allows the

[20] Please, note that the Vienna airport is encouraging larger aircrafts and incentivizes new routes.

[21] The traffic risk mechanism raises further questions on hedging risks which have so far not been analyzed.

[22] Such as the small airports in Austria.

[23] According to SDG (2017, 3.309) the revenue cap can increase at a maximum of 2% if travel falls below a deadband.

airport to charge peak and off-peak prices plus and minus 15% of the average. The objective is to better utilize the scarce slots at Rome Fiumicino (GEMINA 2012). Also, the regulator encourages peak pricing. However, Soleri (2019) has shown that regulation provides a rather rigid cost-based structure for the charges, so that differentiation provides only 6% lower turnaround costs for airlines in the off-peak hours.

Discounts and route development programmes provide evidence that compared to cost-based charges where the structure is strictly cost orientated the price structure of airports becomes more demand orientated. In 2009 33% of the top 200 European airports offered incentives (Malina et al. 2012). Graham (2014) argues that such incentive schemes are increasingly used and have become standard in airport marketing. In our sample, most airports do so and follow this trend. There is some evidence that the strong traffic growth at Vienna airport is also enhanced by the incentive programme.

Investment

With growing demand the timing of investment becomes crucial. Traditional cost-based regulation has been criticized for setting incentives for extending capacity too early, too much and to be too costly (Averch and Johnson effect). However, price cap regulation also has problems with regulation of investments as it might lead to under investment (Helm and Thompson 1991; Helm 2009). In practice regulators have developed different approaches. In the hybrid price cap model, investments increase the regulatory asset, and prices vary by the depreciation charge on this amount valued with the weighted average cost of capital base. In addition some regulators have adopted bonus and malus systems in case investments differ from the planned.

While Austria, Hungary, Denmark, and Portugal do not regulate investment separately, Spain and Italy, for some airports, do. In Italy the three major airports in Milan, Rome, and Venice have been regulated by ENAC through concession contracts which include penalties for delays in projects up 3% on regulated revenues per year (Oxera 2013).

In Spain investment is directly regulated through the revenue cap model as it increases the regulated asset base (RAB) on which the cap is set. If AENA invests less than what is planned for the regulatory period, the regulated asset base will be downward adjusted. In the case of overinvestment the RAB will not be adjusted. DORA entails a detailed investment programme for each year of the period 2017–2021. The progress of all investments must be reported and will be scrutinized by the Spanish CAA under certain criteria such as that so-called strategic investments are made or that investment costs have increased due to regulatory changes. If the total investment is within a threshold of plus/minus 3% the revenue cap remains unchanged (DORA 2017, p 147).

17.4.2.2 Regulating Commercial Revenues

Traditionally airports have been regulated on a single till basis (Gillen and Niemeier 2008). With privatization and commercialization, the profits from commercial activities became an issue, and have led to a heated debate about dual versus single till between the airlines and airports (for an overview see, Starkie 2008). In this debate, the stakeholders very often mixed the question of the *scope* with the *result* of regulation in fixing the level of charges. Ceteris paribus, the charges for an airport are lower under a single till system, but the regulator can easily change the ceteris paribus assumption, and set the same level of charges either in a single or dual till system. This happened in 2001/2 when the UK CAA proposed to switch from a single to a dual till, though the Competition Commission blocked that change (ibid.).

The single versus dual till issue is really about the scope of regulation. The question whether or not to regulate activities such as sale of food and beverages or car parking which may be, perhaps, contestable, should be the key to determine the scope of regulation. At least in Austria it has been—the Austrian regulator argues that it preferred the dual till on the grounds that regulation should be restricted to activities with persistent monopoly power.

The single till has also the disadvantage that it acts like a tax on commercial activities of an airport. As airports have been privatized, partly with the motive of increasing commercial revenues, taxing them by subjecting them to regulation would contradict this effort. This might be another factor why, in the sample of airports here, all countries have moved from single to dual till, with the exception of regulation of the smaller, mostly public Italian airports (see Table 17.6).

In summary, adopting a dual till increases the incentives to increase commercial revenues and profits. Given the tradition of single till, the change in most countries to a dual till is remarkable given the vehement opposition by airlines. In the recent discussion of a reform of the EU directive, the airlines argued for single till to be mandatory. Airports prefer a dual till (SDG 2017). Given this conflict, regulation has, in some countries like France, compromised in from of a mixed till. In our sample, this is the case with Portugal and Denmark, but in the latter case only if airport and airlines do not reach an agreement. In such a case 10–50% of commercial revenues are required to contribute to lower the charges (Ministry of Transport, Building, and Housing, Denmark 2017).

17.5 Conclusion

Governments some of them under the pressure to balance the budget, have privatized their airports, either partially or fully. Austria, Denmark, Italy and Spain chose partial privatization, whereby they could raise revenues, and still keep influence on airport policy directly through being on the board of the airports. As benchmarking studies have shown, this is a form of ownership which does not set strong incentives

Table 17.6 Regulating commercial revenues

	Airports	Till	Airline view
Austria	Vienna	Dual	Criticized by airlines
Denmark	Copenhagen	Mixed dual till	Only if airport and airlines do not reach an agreement
Hungary	Budapest	Dual	Criticized by airlines
Italy	major	Dual, but TRA proposes hybrid	Criticized by airlines
	Catania, Bologna, Naples	Dual or mixed	Criticized by airlines
Portugal	ANA	Mixed Dual till	ANA claims it to be a hybrid till, but airlines view it as a dual (SDG 2017, 3.3.08)
Spain	AENA	Dual	Criticized by airlines

Source: Compiled by authors from various sources

for cost efficiency, although there might be exceptions like Copenhagen airport, which performs well in ATRS benchmarking studies (see, for example ATRS 2017). Hungary and Portugal have chosen full privatization, which sets clearer incentives through the profit motive for cost efficiency. With privatization as well as with commercialization of public airports, the profit motive is strengthened but also the incentives for using market power are strengthened as well. To prevent airports from producing less output and charging high prices intense competition or effective regulation is needed, or otherwise economic welfare will be reduced.

Although airport competition has increased, most (major) airports in the six countries still have persistent market power. In these regions, there are no good substitutes for the major airports, and barriers to entry have prevented entry. However, more competition could be achieved, for example in the Milan and Rome region. Restructuring and horizontal separation has not been part of the privatization process, so that Portugal and Spain sold their system a whole instead of breaking it up. This lack of competition puts a lot of weight on the incentives from regulation being strong—and the evidence is that this is not the case.

How well does regulation work in the six countries? Regulatory capture due to a lack of independent regulator has so far not much of a problem in Denmark, but this might change with the new aviation strategy of the current government. Regulatory capture is certainly is a major problem in Spain. Italy has two independent regulators and the EU Commission has asked for clarification. Austria and Hungary have separated regulation from ownership and avoided this conflict of interest. It is also an issue for Portugal, although it has adopted the UK model of an independent regulator controlled by the parliament; this regulator is to a large degree constrained by the concession contract.

All countries have adopted some form of incentive regulation which is, given the prevalence of cost-based regulation in Europe, a remarkable achievement. In terms of cost efficiency, the incentives from price caps depend also on the objectives and behaviour of the partially privatized firm. Here Denmark, with a form of light-handed regulation, seems to work better than Austria which has a generous (relatively pure) price cap but with an X of zero. Both countries do not regulate quality, while the others have established penalties.

In terms of allocative efficiency, the results are negative, but there are some positive developments. In principle, the traffic risk mechanism and revenue caps do not set the right incentives. Capacity problems are not managed well through adjusting the price structure, so that congestion is only managed through the slot system, which however lacks secondary trading and thus provides questionable incentives for the allocation of capacity. Given these inefficiencies which have a long tradition in airport management, it is remarkable that Vienna has at least penalized small aircraft and even adopted peak pricing for general aviation. Similarly, ENAC has favoured peak pricing and has set upper and lower boundaries. In addition discounts for route development have become wide spread and this is another sign that the price structure becomes more flexible. Investment is not separately regulated in Austria, Denmark Hungary and Portugal, but in Italy and Spain by a penalty system in order to deliver investment as planned.

In a nutshell, the paper shows that while some progress has been made, policy still lacks a coherent system of privatization, regulation and competition.

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Chapter 18
Private Participation and Economic Regulation of Airports in Latin America

Victor Valdes and Tolga Ülkü

Abstract This article overviews the state of private participation and economic regulation of 118 airports in 6 major countries in Latin America. It was found that concession contracts, regional companies, system of airports and revenue-sharing clauses with the government are common features among airports. Under the body of rules needed to enforce regulation, regulatory agencies exhibit low levels of governance and weak economic regulation. Rate of return regulation is more common than price cap regulation as the type of economic regulation at airports under study. Alternatives to existing type of regulations and their pros and cons are discussed.

Keywords Private participation · Economic regulation · Airports · Latin America · Privatization · PPPs · Airport systems · Revenue-sharing · Rate of return regulation · Price cap regulation · Negotiate-arbitrate regulation

18.1 Introduction

Private participation and economic regulation of airports are growing fields of interest for practitioners because the type of economic regulation and ownership and control ultimately affect the level of aeronautical charges, airport efficiency and investment decisions. ACI (2017) considers private investment in the airport sector a need to address the challenge of airport infrastructure in the long run, while IATA (2018) urges caution on airport privatization. Yet, the correct choice of privatization model is determined by many factors (ACI 2018). Private participation is the intervention of a private company in the provision of public assets or services, in

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which the private party bears significant risk and management responsibility and remuneration is linked to performance.[1] Economic regulation, on the other hand, is a public policy to constrain firm behavior regarding prices, quantity, and the number of firms in order to restrain market power and to foster efficiency. Economic regulation attempts to mimic the conditions that would be observed under competitive markets. Although private airports tend to set higher prices without a proper economic regulation than public airports due to their private maximization objective (Oum et al. 2004; Adler and Liebert 2014), regulation of public airports is also essential to secure an efficient market. In this paper, however, the focus is given to the economic regulation of airports with private participation and regulation of publicly owned airport is not analyzed.

Private participation in the Latin American (LA) airport sector is one of the highest in the world. In 2016, Latin America and the Caribbean handled 60% of their passengers in 153 airports with some degree of private participation. This region was the second only after Europe, which handled 75% of its passengers through airports in this condition (ACI 2017). Almost all airports with private participation are subject to some form of economic regulation in LA.

Although literature exists on private participation (or Public-Private Partnerships) in the airport sector in the LA region (Diaz 2017; Estache 2001; Guasch 2004; Guasch et al. 2008, 2014) and economic regulation of airports has been extensively studied in Europe, North America and Australia (Adler and Liebert 2014; Adler et al. 2015; Assaf and Gillen 2012; Forsyth et al. 2017), private participation and economic regulation have not been studied jointly in the LA airport sector. Further literature attempts to identify the factors that influence the success of Public-Private Partnerships (PPPs). Since most of the private participation at LA airports takes this form, it is vital to understand these factors when analyzing both the successful examples as well as the failures. Zhang (2005) underlines the risk allocation, favorable investment environment, economic viability, reliable consortium and sound financial package for successful implementation of PPPs. Osei-Kyei and Chan (2015) add political/public support and transparent procurement to the factors in their extensive review of studies.

Despite government's initial objective of attracting private financing into public projects, it should be ensured that future contingencies are documented very carefully before the PPP starts, and potential risks are allocated in a definite manner. Failure of these results in renegotiations of contracts between the government and private firms after the project started. Another possible reason for potential renegotiations is found to be the inappropriate form of economic regulation of the transport infrastructure. Stern (2012) explains the crucial role of external regulation in contracts. Domingues and Zlatkovic (2015) present various cases of PPPs and explain the role of economic regulation. Henckel and McKibbin (2017) criticize insufficient

[1]This definition is based on World Bank's definition of Public-Private Partnerships (World Bank 2017). Note that this article is not about privatization, a type of private participation whereby the government fully transfers ownership and control of assets to a private company.

use of (ex post) economic regulation of PPP contracts. To sum up, while some research ignores economic regulation as a success factor of PPPs, some mention it in relation to use of PPPs, yet a clear conclusion cannot be drawn regarding the role of economic regulation in successful PPP projects.

In the light of previous research, aim of this article is therefore to begin to fill a gap by describing private participation processes and common features in the airport sector in six major countries in the LA region as well as the institutional framework available in each country to enforce economic regulation. We describe the state of airport sector in Argentina, Brazil, Colombia, Chile, Peru, and Mexico in terms of the aims of private participation, the type of concession contracts, the bidding processes, the private companies involved, the body of rules to enforce regulation, degree of governance by regulatory agencies and the type of economic regulation. The contribution of this article is threefold: (1) it describes private participation in the airport sector in the LA region and identifies features that should be considered for efficiency and market power assessments; (2) it identifies the types of economic regulation in LA airports and their possible unwanted effects and (3) it presents an overview of alternatives to existing type of regulations and discusses the pros and cons of these.

The remainder of the article is organized as follows: Sect. 18.2 describes private participation processes in the countries under study; Sect. 18.3 identifies common factors of private participation processes such as the types of concession contracts, private companies, the systems of airports and government revenue-sharing clauses; Sect. 18.4 discusses the body of rules governing airports with private participation, certain institutional features of regulatory agencies, the type of economic regulation these agencies seek to enforce and possible avenues for economic regulation improvement. Finally, some conclusions are drawn in the last section.

18.2 Private Participation in the LA Airport Sector[2]

According to the World Development Indicators of the World Bank, passengers carried in Latin America and the Caribbean grew by 11.6% annually in the period between 1990 and 2017. This fast growth rate placed a great deal of pressure on air transport infrastructure to meet growing demand. Most countries in the region also suffered from weak public finances, which made them unable to develop infrastructure projects on their own. Sooner or later, most countries in the LA region have chosen to allow private participation in the airport sector to meet the airport infrastructure challenge.

[2]This section builds on information from the Private Participation in Infrastructure Database of the World Bank and the following papers to describe private participation in the countries under study: Lipovich (2008) for Argentina, Galeana (2008) for Mexico, Neto et al. (2016) and ANAC (2018) for Brazil, Olariaga (2017) for Colombia and Espejo (2014) for Peru.

Due to time-consuming nature of collecting information on features of concession contracts, regulatory agencies, laws, and the type of economic regulation for each airport in the LA region, this study focuses on 118 airports in 6 major countries in the region: Colombia, Argentina, Mexico, Peru, Brazil, and Chile. A chronological description of the private participation processes in these countries in the past 20 years is given below.

In Colombia, the government signed a lease contract for the Rafael Nuñez International Airport in the city of Cartagena in 1996. Since 2000, the government has signed five concession contracts: Cali Airport in 2000; Bogotá International Airport in 2006 and 2010; two sets of six regional airports in 2008 and Barranquilla International Airport in 2015. There were basically two winning criteria in competitive bids: lowest tariffs for users and the highest percentage of revenue share with the government.

In 1998, Argentina allowed the largest private participation in the airport sector in the region by granting Aeropuertos Argentina 2000 a 30-year concession for 33 airports, including Ezeiza and Aeroparque airports in Buenos Aires. Aeropuertos Argentina 2000 is currently owned by an airport consortium, Corporación América, which in 2001 also won a 20-year concession for Neuquen regional airport. London Supply S.A. is the second airport group operating in Argentina. It received three concessions for Trelew, El Calatafe and The Falkland Islands airports. The main reason to allow private capital in Argentinean airports was to attract investment for airport expansions to meet long-term needs. In the case of the concession of 33 airports to Aeropuertos Argentina 2000, the winning criterion in the bidding process was the highest annual concession fee to be paid to the government (US $171.1 million at the time). This concession contract was re-negotiated in 2006 because of the difficulties encountered in meeting payment of the annual concession fee. The renegotiation set new parameters for the contract relationship in the following way: (1) it replaced the annual concession fee with a 15% share of concession revenues; (2) it recognized the concessionaire's losses in the period 1998–2005 due to regulatory decisions; (3) the government received 20% of the concessionaire's stake; (4) new investment commitments were set for the following years.

Private participation in the Mexican airport sector began in 1998 and was undertaken in three stages. In the first stage, Mexican airports were grouped into five clusters, in which each airport received a 50-year concession. Three out of the five airport groups were given over to private participation between 1998 and 2000: the Southeast Airport Group (ASUR) with nine airports, the Pacific Airport Group (GAP) with 12 airports and the Central-Northern Airport Group (OMA) with 13 airports[3]; via tenders, 15% of the stake of each airport group was allocated to private investors. The winning criterion in the tender processes was the highest bid. Lastly, years later, the remaining stake of each airport group was allocated through

[3] Each airport group has a flagship airport: Southeast Airport Group, Pacific Airport Group and Central-Northern Airport Group have Cancún, Guadalajara and Monterrey airports, respectively.

stock markets in Mexico City and New York City. The goals of private participation were threefold: to attract investment to fund airport expansions, to transfer management to private companies to improve operational efficiency and to raise money for government expenditure.

In Peru, private participation in the airport sector began in 2005, when the government awarded a 30-year concession for Jorge Chávez Airport in Lima to Lima Airport Partners, whose main shareholder is now FRAPORT. In 2006, Aeropuertos del Perú won a concession for 12 regional airports and in 2011 Aeropuertos Andinos won a concession for six. The length of contractual periods ranges from 25 to 30 years. The winning criterion in the case of Lima Airport was the highest share of gross revenue to be paid to the government, whereas in the case of the other two concessions, the criterion was the lowest payment by the government to the concessionaires. The goal of the Peruvian Government was to foster airport infrastructure development and to bring regional airports up to international standards.

In the case of Brazil, private participation in the airport sector began in 2011. Ten of the largest airports in the country now allowed private participation through concession contracts[4]: Natal airport in 2011; Brasilia, Guarulhos, and Campinas Viracopos Airports in 2012; Belo Horizonte and Rio de Janeiro Airports in 2013; Salvador, Florianópolis, Porto Alegre and Fortaleza airports in 2017 (ANAC 2018). In each case, the winning criterion for the competitive biddings was the highest payment for concession rights. The length of concessions ranges from 20 to 30 years and the terms of the contracts included investment commitments. The aim of private participation was to attract investment to meet growing demand and to enable the hosting of the 2014 FIFA World Cup and 2016 Olympic Games in Rio de Janeiro.

In the case of Chile, Engel et al. (2018) claim that there are several airports in major cities under concession contracts. However, due to limited access to public information regarding private participation in the airport sector in Chile, only Santiago International Airport is considered in this study. In 2015, the Chilean government awarded a 20-year concession contract to Aéroports de Paris (ADP) to operate Santiago International Airport.

18.3 PPPs, Private Companies, Airport Systems, and Revenue-Sharing Clauses

This section identifies similarities between private participations in the LA airport sector. These include the types of concession contracts, private companies, airport systems, and government revenue-sharing clauses. The aim of this comparison is to understand key issues in airports with private participation in the LA region, which

[4]These airports are under federal regulation. There are small and regional airports with private participation that are beyond the scope of this study.

Table 18.1 Number of airports by type and country (concession contracts in parenthesis)

	Lease contract (LC)	Rehabilitate, operate, and transfer (ROT)	Build, rehabilitate, operate, and transfer (BROT)	Build, operate, and transfer (BOT)	Total
Argentina		34 (2)	3 (3)		37 (5)
Brazil			9 (9)	1 (1)	10 (10)
Chile				1 (1)	1 (1)
Colombia	1 (1)		15 (5)		16 (6)
Mexico			35 (35)		35 (35)
Peru		12 (1)	7 (2)		19 (3)
	1 (1)	46 (3)	69 (54)	2 (2)	118 (60)

Source: Private Participation in Infrastructure Database and own research

should be taken into account to evaluate economic regulation; in other words, these issues should be considered when assessing airport efficiency and market power.

As mentioned earlier, the LA region has been rapidly growing its air transport market for almost three decades, as a result of which airport infrastructure has been insufficient to meet growing demand. A common solution for addressing this challenge has been to allow private participation in the airport sector through Public-Private Partnerships (PPPs), a generic term used to refer to a broad, complex spectrum of contracts which accept private intervention in infrastructure ownership and management. Although there is no consensus on the typology of PPP contracts, the World Bank has made the most systematic effort to classify and collect information on PPP infrastructure contracts worldwide. PPPs can assume a variety of forms, from management contracts to concession contracts, among others. In the LA region, concession contracts are the most common form of private participation in the transport infrastructure sector (Guasch et al. 2008).

Ranking PPP contracts by degree of private participation in ascending order, contracts in the sample can be classified as: Lease or management contract (LC); Build, rehabilitate, operate, and transfer (BROT), Rehabilitate, operate, and transfer (ROT) and Build, operate, and transfer (BOT).[5] In all cases, ownership remains within the government and private companies must return facilities to the government at the end of the contract period. Under BROT and ROT, private companies rehabilitate the facility and operate them at their own risk; under BROT, private companies also build an add-on to an existing facility. According to Percoco (2014), ROT and BROT can be considered concession contracts. Finally, in BOT, a private company builds a new facility and subsequently operates the facility at its own risk.

The airports under study display the following spectrum of PPP contracts (see Table 18.1): 1 LC with 1 airport; 54 BROT contracts involving 69 airports, 3 ROT contracts concerning 46 airports; and 2 BOT contracts with 1 airport each. Consequently, concession contracts are also the most common type of PPPs in the LA

[5]For a more complete description of PPP contracts, see Percoco (2014).

Table 18.2 Number of airports by concessionaire and country (concession contracts in parenthesis)

Company	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Total
Corporación América	34 (2)	2 (2)				6 (1)	42 (5)
OMA					13 (13)		13 (1)
GAP					12 (12)		12 (1)
ASUR					9 (9)		9 (1)
FRAPORT		2 (2)				1 (1)	3 (3)
INVEPAR		1 (1)					1 (1)
ODINSA				1 (1)			1 (1)
ADP			1 (1)[a]				1 (1)
CCR		1 (1)					1 (1)
VINCI		1 (1)					1 (1)
CHANGI		1 (1)					1 (1)
Others	3(3)	2 (2)		15 (5)	1 (1)	12 (1)	33 (17)
Total	37 (5)	10 (10)	1 (1)	16 (6)	35 (35)	19 (3)	118 (60)

Source: Private Participation in Infrastructure Database and own research
[a]VINCI is also part of the consortium that operates Santiago airport

airport sector in the countries under study, with 97% of the airports in the sample being operated under concession contracts.

Regional private companies have the greatest presence in the LA airport sector. Corporación América is the largest private company by number of airports, with 34 airports in Argentina, two in Brazil and six in Peru.[6] Mexican airport groups OMA, GAP, and ASUR have 13, 12, and 9 airports respectively.[7] Major private companies with one airport include INVEPAR and CCR in Brazil and ODINSA in Colombia.[8] The rest of the regional private companies have a total of 33 airports. International companies with private participation have recently entered the LA airport industry. FRAPORT has two airports in Brazil and one in Peru. VINCI and CHANGI have one airport each in Brazil and ADP has one in Chile.[9] Table 18.2 gives the number of airports by concessionaire and country.

Implication of private participation and effect of managerial decisions on prices and efficiency is worth examining, especially in conjunction with the type of PPPs. There is some evidence suggesting the positive effects of private participation on the efficiency of the world's major airports, but only if it comes with majority private

[6]Corporación América has also a concession agreement to operate Bahía Blanca airport in Argentina and undertake operations in other countries in the LA region such as Uruguay (Carrasco and Punta del Este airports) and Ecuador (Guayaquil airport).

[7]ASUR and GAP oversee operations in San Juan, Puerto Rico and Montego Bay, Jamaica, respectively.

[8]CCR and ODINSA hold shares in Quito airport and CCR holds shares in San Jose, Costa Rica and Curazao.

[9]International private companies have also operations in other countries in the LA region, such as VINCI in the Dominican Republic and Chile.

participation (Oum et al. 2008). Effects of private participation on the efficiency of LA airports have been investigated to some extent. Valdés and Sour (2017) find that the OMA airport group set lower aeronautical charges than the other Mexican airport groups controlling for type of economic regulation, downstream competition, operational variables and demographics. Fernandes and Pacheco (2018) find out that performance of airports in Brazil decrease after the concessions. According to Aguirre et al. (2019) those Peruvian airports granted with concessions show higher traffic figures and better economic development in the area. Olariaga and Moreno (2019) employ a data envelopment analysis (DEA) to a sample of Colombian airports and find out that private airports achieve higher levels of efficiency than public airports, although this can be a result of scale economics since private airports have higher air traffic levels. Hence, it remains ambiguous whether private participation has a significant effect on the efficiency of Colombian airports. Such findings should be taken with caution since some research suggest that economic regulation (Assaf and Gillen 2012) and competition (Adler and Liebert 2014) must be considered together with private participation in promoting airport efficiency. Nevertheless, current literature fails to study the effects of various types of PPPs on airport efficiency. Although the type of PPPs should be chosen based on the needs of airports, an efficiency comparison of various types of PPPs could clarify the decision criteria and promote a more effective private involvement in the future. Estache and Saussier (2014) also claim that according to evidence from worldwide projects, overestimation of demand (and hence the project size) is a common phenomenon, and PPPs cannot help reducing this problem. Private suppliers of such infrastructure projects could even profit from this and might have no incentives to warn against the problem. To conclude, the type of private participation, the type of economic regulation and problems stemming from PPPs with respect to project size are therefore key issues to be considered to assess airport efficiency in the LA region.

Besides the type of PPPs and choice of private firm, another key decision for governments to allow private participation is whether to sell each airport independently or to sell them as a system (an airport group), in other words, to impose cross-ownership restrictions (Neto et al. 2016) or to assemble airports as a system (Galeana 2008; Lipovich 2008) before the bidding process takes place. Two main factors play a role in this decision. First one is the amount of fees paid to the government for the concession agreement and the second is the consideration of airport competition and market power.

By selling airports as a group, the financial situation of the airport group can be enhanced (Galeana 2008) and thus the fees received by the government can also be increased. By grouping small, unprofitable airports around a large profitable one (Galeana 2008; Lipovich 2008), the government can allocate airports that would not otherwise be attractive to private investors and shift the financial burden. Another rationale behind grouping small and large airports together might be to keep possible operational network benefits such as a more effective coordination of spoke-hub systems with the airlines. This is, for instance, the case with the privatization of 33 airports in Argentina in 1998 (OECD 2011). A third option could be to assign a group of small unprofitable airports (Cáceres 2012) in exchange for government payment, which could decrease government' losses due to more efficient management by private firms. Another benefit of privatizing small regional airports as a group is to allow private companies to act according to specific regional needs, which require special knowledge that can be realized by sharing expertise among the managers of group airports. Two privatization processes in Peru with Aeropuertos del Perú (12 regional airports) and Aeropuertos Andinos (six regional airports) as well as two processes in Colombia with Aeropuertos de Oriente (six regional airports) and Airplan (six regional airports) are examples in LA airport industry.

Assessment of market power could be done before or after the bidding process takes place. Airports clustered in groups before the bidding process have been a common phenomenon in the countries under study. Defining the relevant markets and evaluating the competitive position based on the definition of markets (Polk and Bilotkach 2013) is especially challenging for clustered airports and raises concerns about the choice of an appropriate regulatory framework. For example, Argentina placed 33 airports into one group; Mexico put 13, 12 and 9 airports into 3 airport groups; Peru divided 6 and 12 airports into two groups and Colombia created two sets of six airports. The exception in the region is Brazil, where the government-imposed cross-ownership restrictions that prevented a private company from bidding for more than one airport during the first round of concessions (Neto et al. 2016). In the last round of concessions, the Brazilian government relaxed restrictions, allowing FRAPORT to win two concession contracts (Porto Alegre and Fortaleza airports).

If airports cannot compete since they are part of an airport system or because they are natural monopolies, there is a possibility that airports will abuse their market power. This scenario builds the case for government intervention through economic regulation. Accordingly, a type of economic regulation must be adopted, and a regulatory agency appointed. For example, in the case of Mexico, once airport groups were assigned to private companies and assessments of market power were undertaken by the Mexican competition authority, the Secretariat of Communication and Transportation (the regulatory agency) adopted price caps as the type of economic regulation.

Another common feature among airports with private participation in the LA airport sector is revenue-sharing clauses with the government. For example, in the case of Aeropuertos Argentina 2000, the government now receives 15% of concession revenues per year since renegotiation of the contract, although the concession was initially awarded in exchange for annual concession fees. In Mexico, in addition to initial payments to win concessions, Mexican airport groups OMA, GAP, and ASUR transfer 5% of gross revenues per year to the Mexican government. In Brazil, apart from initial payments and fees during the life-cycle of the concession, FRAPORT must pay the Brazilian government 5% of commercial revenues per year. In the case of Lima International Airport, FRAPORT must transfer 46.5% of gross airport revenues to the government. A similar instrument was used at Bogota International Airport, where ODINSA is obliged to pay 51.16% of airport revenue to the government every 6 months.

Table 18.3 Airport regulators by independence status

Regulator	Country	Status
Organismo Regulador del Sistema Nacional de Aeropuertos (ORSNA)	Argentina	Independent
Agencia Nacional de Aviacao Civil (ANAC)	Brazil	Independent
Dirección de Aeropuertos, Ministerio de Obras Públicas	Chile	Non-Independent
Unidad Administrativa Especial de Aeronáutica Civil (AeroCivil)	Colombia	Non-Independent
Dirección General de Aeronáutica Civil, Secretaria de Comunicaciones y Transportes (DGAC)	Mexico	Non-Independent
Organismo Supervisor de la Inversión en Infraestructura de Transporte De Uso Público (OSITRAN)	Peru	Independent

Source: Serebrisky et al. (2011) and authors

Since it is common practice for the government to participate in airport revenues, the government benefits from private companies' revenue maximization. If there is not enough independence between the government and the regulatory agency, there could be incentives to relax economic regulation and allow the exercise of market power when the government has a substantial interest in the regulated company.[10] Another key issue while assessing economic regulation should therefore be to consider the independence of the regulatory agency. Political influence on budget, partisanship of nominations, revolving door or other phenomena affect rulemaking, monitoring, and sanctioning, which are key factors for economic regulation.[11]

Table 18.3 displays the independence status of the airport regulators in the countries under study. Although Argentinian regulator (ORSNA) is formally independent, its degree of autonomy in decision taking is relatively low compared to Brazil and Peru (Serebrisky et al. 2011). And even though a formal assessment of the degree of independence of regulatory agencies and its effects on economic regulation are out of the scope of this chapter, we argue that most countries under study have weaker institutional conditions and might be subject to political influence from the government, which could offset the pursuit of economic regulation goals such as efficiency. For example, in Chile, Colombia, and Mexico airport regulators are within a branch of the government and their budgets and appointments depend on governmental and political decisions.

[10] Edwards and Waverman (2006) find evidence of this for the telecommunications industry.

[11] For a detail discussion on factors affecting the operationalization of independence of regulatory agencies.

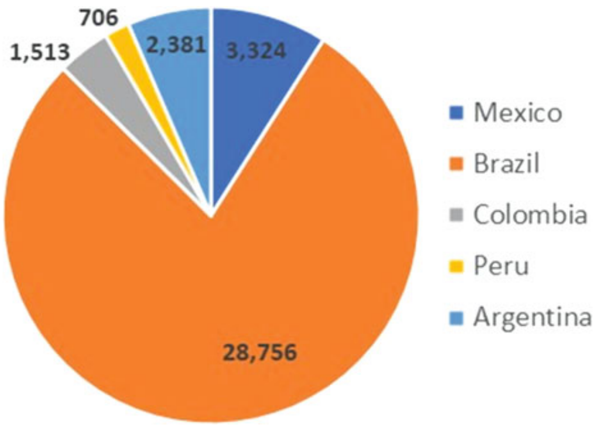

Fig. 18.1 Airport investment by country (in US$ Millions). Source: PPI database, World Bank

18.4 Laws, Contracts, Regulatory Agencies and Economic Regulation

The wave of structural reforms in Latin American economies in the 1990s, including the introduction of private participation in the airport sector through PPP contracts to foster infrastructure, drove the need to create rules and institutions to allocate and enforce these contracts. To compare the challenge with other regions, according to the World Bank, between 1990 and 2018, airport investment through PPPs in the countries under study accounted for US$36,680 million. This amount is below Europe and Central Asia, but way above East Asia and the Pacific with US $50,106 million and US$8,229 million, respectively. Figure 18.1 shows airport investment in countries under study. Guarulhos and Rio de Janeiro airports are flagship projects in the region and account for 54% of total investment.

This section distinguishes the body of rules, degree of governance of the regulatory agency and type of economic regulation under which airports with private participation operate in the LA region. Finally, for the region, we discuss some possible avenues to improve economic regulation.

Countries in the region enacted laws and administrative procedures to allocate concession contracts, such as Law 23,969 and Decrees 375/97 and 842/97 in Argentina (Lipovich 2008); Laws 105 and 336, Decree 2724 and Aeronautical bylaws in Colombia (Olariaga 2017) and the Mexican Airport Law, its bylaw and the general guidelines for the participation of the airport sector in the Mexican Airport System in Mexico (Galeana 2008). Conversely, through concession contracts, countries established clauses regarding the ownership and management of assets, investment commitments, quality of service, price rules, revenue risk assessments, labor costs and so on (Guasch 2004). In short, these laws, decrees, guidelines, and contract clauses constitute the body of rules for regulating private companies in the airport sector.

A key decision in institutional design was to create an independent regulatory agency from the government or to create a branch of the government to regulate the industry. Serebrisky et al. (2011) point out that although most countries in the region created regulatory agencies (both dependent and independent), the overall governance indicators of airport regulators in the region are well below the threshold of good governance.[12]

In the context of these weak institutional conditions and the body of rules that regulate concession contracts, regulatory agencies were appointed to enforce concessions, which in many cases include issues regarding operational, economic and safety activities. In other words, regulatory agencies enforce many types of regulations such as administrative, safety and economic regulation using instruments such as laws, bylaws, decrees and concession clauses.

Administrative regulation is performed by the State through the adoption of rules and the use of coercive power to enforce them (Diaz 2017). For example, regulatory agencies must undertake administrative duties on a regular basis such as assessing and approving airports' master development plans or enforcing investment commitments by airport operators (Guasch et al. 2014; Lipovich 2008; Olariaga 2017). Safety regulation is concerned with operational risks whereas economic regulation "... typically refers to government-imposed restrictions on firm restrictions over price, quantity and exit and entry." (Viscusi et al. 2005).

Although the focus of this document is economic regulation, it is essential to realize that regulatory agencies face trade-offs to allocate their own resources between the different types of airport regulation. It is a well-known fact that they expend a significant amount of resources addressing safety regulation.[13] This might be one reason why in most countries in the LA region, with the probable exception of Peru, regulatory agencies do not regularly undertake rigorous economic assessments of prices, market entry, efficiency benchmarking or competition conditions, even if they are included in laws, regulations, or concession contracts.[14]

Peru undertakes economic studies on a regular basis to reset price caps such that the caps from one group become a reference for other groups: a sort of benchmarking economic regulation (Cáceres 2012). The lack of technical analysis performed by other regulatory agencies in the LA region to deliver solid economic regulation is confirmed by Serebrisky et al. (2011).[15] For example, the author claims that in the case of Argentina, economic regulator statutes do not establish minimum criteria for board members selection, such as knowledge of economic regulation principles. Olariaga (2017) states that the Colombian regulator sets prices using price caps and

[12] The authors explain that there are four dimensions of governance of airport regulators: the autonomy of the decision-making process, the transparency of the regulators' procedures, the accountability of the regulator and the quality of bureaucracy.

[13] For example, they must enforce the rules of the International Civil Aviation Organization or the Federal Aviation Administration of the USA.

[14] In Mexico, price cap regulation is included as an annex to concession contracts.

[15] Based on questionnaires applied to airport regulators in LA region, the author found that few of them estimate the average weighted cost of capital or conduct financial and economic audits.

undertakes economic and financial audits on a regular basis; however, there is no evidence that suggests that these tasks are done under sound economic regulation practice and on the contrary, it underlines the lack of transparency of regulators. Therefore, it can be concluded that there are serious deficiencies regarding economic regulation in the airport sector in the LA region.

Recall that the main concern of economic regulation is prices, in other words, the possible abuse of market power from the regulated company. Therefore, the different types of economic regulation establish schemes for companies to set prices. Administrative regulation, which can also be considered a type of economic regulation since it can deal with price-setting rules. For example, in Mexico, airports subject to this type of economic regulation increase aeronautical charges based on a predetermined percentage set by the Secretariat of Finance rather than by the regulatory agency, which suggests that price-setting rules are driven by public finance goals rather than by market power or efficiency assessments.

The most commonly known types of economic regulation are rate of return and incentive regulation. In rate of return regulation, prices are set in order to achieve a "fair" return on capital invested, providing few incentives for the regulated company to control costs. Incentive regulation on the other hand seeks to address the cost issue and according to Adler et al. (2015) there are three broad forms of incentive regulation: (1) price caps, (2) revenue caps and revenue sharing agreements and (3) benchmarking and yardsticks. Price cap regulation, first envisaged in the UK in the 1980s by Littlechild, means that a firm is given a price cap path, based on the principle of RPI-X,[16] which sets the maximum price, it may charge subject to efficiency gains. As the firm lowers its costs, it may keep the extra profits, making this type of regulation a powerful incentive for efficiency. However, this type of regulation could also lead firms to reduce service quality level to achieve higher profits. Some airports around the world, for example, in the UK, India, Ireland, or Australia, are subject to quality regulation, which sets service levels to avoid the problem (Suárez-Alemán and Jiménez 2016). Nevertheless, to the authors' best knowledge, price cap regulation practices used at airports in LA do not consider any form of service level regulation. In revenue cap and revenue sharing, there is a cap on revenue and once revenue exceeds this cap, the difference must be shared by the firm and its clients.[17] Benchmarking and yardsticks were developed by Shleifer (1985); the regulator sets prices based on the cost of comparable firms rather than its own costs. These three forms of incentive regulation can be mixed. For example, benchmarking may be used to estimate efficiency factors rather than prices in a price cap formula (Elliott and Ong 2018); yet the application requires a sound methodology due to heterogeneities at airports as well as a good database (Reinhold et al.

[16]The RPI-X represents that prices would be pegged to the Retail Price Index (RPI) subject to firm efficiency gains (X).

[17]Revenue sharing agreements are different to revenue sharing clauses included in concession contracts. In the latter, there is no revenue cap and the government receives a certain amount of revenue.

2010). Light-handed regulation (LHR) is a type of regulation less intrusive with regulated companies in terms of it does not rely on direct ex ante determination of airport prices or other terms and conditions by an external regulator. This approach relies on increasing the transparency of company performance and incorporation of a credible threat of regulation if monopoly abuse occurs. Therefore, two key components of LHR are good quality information and a credible threat of stronger regulation. A sub-type of LHR which has been applied in Australia is negotiate-arbitrate regulation (NAR), where commercial parties, airports, and their customers, engage in negotiation to determine the terms of their relationship; this negotiation is affected by the prospect of a potential arbitration by the regulator. These types of regulation incur in less administrative costs than RoR or price cap regulation. The main differences between LHR and NAR are: (1) that the latter does not require rigorous information and institutional capacity required for interpreting and assessing information disclosed and (2) the threat of regulation under LHR implies strong institutional capabilities to impose penalties whereas under NAR it implies arbitrate capabilities.

In addition to the type of economic regulation, a key decision in setting prices for aeronautical services is whether all facilities or services should be considered, both aeronautical and non-aeronautical (single till approach), or only the aeronautical facilities (dual till approach). In the single till approach, profits from non-aeronautical services may be used to offset growth in aeronautical prices, whereas under the dual till system, the two branches of the airport are separated out and growth in aeronautical prices are independent of commercial activities (Czerny 2006). As traffic increases, prices in the single till approach tend to be lower than under the dual till approach.

Once the different types of economic regulation have been reviewed, rate of return regulation is the most popular form of economic regulation in the LA airports under study followed by price cap regulation and administrative rules. A total of 45%, 39%, and 16% of the 118 airports in our database are regulated through rate of return, price caps and administrative rules, respectively. Rate of return is the dominant type of economic regulation in Argentina and Colombia, whereas price cap is the preferred option in Mexico and Brazil and is also present in Santiago International Airport in Chile and Lima International Airport in Peru. Regarding the till approach, Mexico adopted the dual till whereas Brazil chose the single till approach (see Table 18.4).

Although lack of good governance and weak economic regulation are two common features of regulatory agencies in the LA region, a key question is what the effects of the different types of economic regulation will be in the LA region in their current form. Given the current state of economic regulation and in the light of limited existing research in LA airport industry, we discuss some possible avenues for improvement. In particular we attempt to address the pros and cons of alternative types of economic regulation for the airports in LA.

Moving away from RoR can be argued based on the deficiencies of this type of regulation: inefficient choice of inputs which would produce an expansion of the capital base to increase profits; inefficient price structure that would lead to charge a

Table 18.4 Number of airports by economic regulation and country (concession contracts in parenthesis)

	Administrative regulation	Price cap—dual till	Price cap—single till	Rate of return	Total
Argentina				37 (4)	37 (4)
Brazil			10 (10)		10 (10)
Chile			1 (1)		1 (1)
Colombia				16 (6)	16 (6)
Mexico	1 (1)	34 (34)			35 (35)
Peru	18 (2)		1 (1)		19 (3)
	19 (3)	34 (34)	12 (12)	53 (10)	118 (60)

Source: Private Participation in Infrastructure Database and own research

monopoly price at off-peak times and thus justify capital expansion and regulation of price structure according to book-keeping principles (Forsyth et al. 2017).

To our knowledge, there is no research to test the validity of the conventional notion that incentive regulation is superior to rate of return regulation to improve efficiency and to restrain market power for the LA airport industry. The institutional, political, and cultural context in which price cap regulation takes place has also received less attention. This is probable because price cap regulation was crafted in countries with strong institutional conditions that are not necessarily present in developing countries. However, there is some evidence of the undesirable effects of price caps in the LA region. Guasch et al. (2008) found that concessions in water and transport sectors regulated by price caps proved consistently more fragile than rate of return regulation and led to a higher probability of renegotiation and a greater difficulty of contract enforcement. According to the authors, firms "… kept the efficiency gains when business was good and renegotiated when it was poor… by endogenizing the review period, renegotiations tended to transform many price caps into rate of return regimes in bad times, delegitimizing the price cap regime."[18] In short, under weak institutional conditions and weak economic regulation, incentive regulation is not necessarily better than rate of return regulation since it increases the likelihood of undesirable phenomena such as renegotiations. In addition to institutional issues, heavy costs to implement price caps such as having a well-trained staff, high administrative costs and asymmetric information with respect to commercial parties are also shown in previous research (Littlechild 2012). These drawbacks raise the question whether light-handed regulation would be a more preferable option than price cap regulation for some airports in the LA region.

[18]The reason why so many countries adopted price cap regulation is suggested by Guasch et al. (2008): "… the general prevalence of price cap in developed countries that led the way to privatization in the 80s, together with the institutional constraints faced by poor countries lacking previous experience with regulation, account for the fact that in most cases governments willing to quickly attract private investment in infrastructure were left with price caps as the only readily viable option."

Table 18.5 Latin American hubs and dominant carries

Airport	Country	Dominant carrier	Share of flights at Hub (%)
MEX	Mexico	Aeromexico	46
GRU	Brazil	LATAM Airline Group	31
BOG	Colombia	Avianca	58
PTY	Panama	Copa Airlines	89
LIM	Peru	LATAM Airline Group	49
EZE	Argentina	Aerolíneas Argentinas	29[a]

Source: Megahubs International Index 2018, OAG
[a]Share of departing passengers

According to Arblaster and Hooper (2015), negotiate-arbitrate regulation (NAR), or a variant of it, [19] could be an option for airports in Less Developed Countries because it takes their ongoing institutional capabilities into account. Their claim is based on successful arbitration experiences in Australia, where commercial parties have had incentives to resolve disputes instead of proceeding to arbitration and facing regulated outcomes. The benefits of NAR could not be reached if NAR is applied to airports where the aviation markets are not competitive due to the risk of collusive vertical relations. Hence, implementation of NAR would be feasible, where competitive condition will emerge strong in the upcoming years. Table 18.5 shows the market share of dominant carriers in LA hub airports. Although, the current market concentration is high, both in upstream and downstream markets; for example, LATAM Airlines Group and Avianca Airlines held 45% market share of upper South America's seat capacity in 2018 (CAPA 2018); there is wave of expansion of LCCs that can decrease market concentration in downstream markets over the coming years. Therefore, some hubs in Argentina, Brazil, and Mexico are more competitive or will become more competitive in the downstream market than other airports in the region. For the vast majority of the airports, where competitive conditions will remain weak, price cap regulation seems to be a second-best solution due to the administrative costs to enforce this type of regulation and the institutional requirements for this type of regulation to be effective.

Therefore, strengthening institutional, financial and legal capabilities are necessary conditions for effective price cap regulation in order to monitor and to assess performance. One of these necessary conditions is to guarantee the independence of the regulator over the entities they supervise (Arblaster and Hooper 2015; Forsyth et al. 2017).

[19] Arbitration by panels of experts (Jadresic 2007) or sharing skilled expertise between countries.

18.5 Conclusions

Although the economic regulation of airports has been extensively studied in Europe, North America and Australia (Adler et al. 2015; Assaf and Gillen 2012; Forsyth et al. 2017) and private participation in the airport sector has been analyzed in the LA region (Diaz 2017; Estache 2001; Guasch 2004; Guasch et al. 2008; Guasch et al. 2014), private participation and economic regulation have not been jointly studied in the LA airport sector. In this article, 118 airports in 6 major countries (Argentina, Brazil, Colombia, Chile, Peru, and Mexico) are analyzed in terms of the state of private participation and economic regulation.

We found that concession contracts are the prevailing form of private participation in the region. Although regional companies dominate the LA airport sector, some international companies have entered in recent years. Prior to competitive bids to allocate airports to private companies, many countries chose to create a system of airports rather than selling airports separately and many concession contracts included revenue-sharing clauses with the government. Airports with private participation are subject to various rules such as laws, bylaws, decrees, and clauses within concession contracts. This body of rules is enforced by regulatory agencies that exhibit low levels of governance and weak economic regulation (Serebrisky 2011; Serebrisky et al. 2011). Rate of return regulation is the preferred form of economic regulation followed by price cap regulation. Although the usual idea that incentive regulation is superior to rate of return regulation to foster efficiency and restrain market power has not been tested for LA airports, there is some evidence of undesirable effects such as renegotiation, which have a greater likelihood of occurrence under the price cap approach (Guasch et al. 2008). Due to weak institutions light-handed regulation rather than incentive regulation could be implemented at airports in LA; though only given a competitive downstream market, where airlines do not have any market power. We present a series of issues that appear to be relevant for the LA airport sector, which should be considered when assessing airport efficiency and market power: the type of concession contracts, the independence of the regulator, revenue-sharing clauses, the system of airports approach and PPPs biases. Further research on the joint effect of private participation, economic regulation and market power on efficiency of airports in LA is feasible and could explain these issues discussed in this paper.

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Chapter 19
Conclusion

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Recent developments in aviation markets, policy, and the literature concerning regulation and benchmarking necessitate a new overview about the current debates concerning benchmarking and regulation. This book offers this overview, focusing on theoretical aspects (Part I), benchmarking (Part II), and case studies (Part III).

The first part of the book focusses on the rationale behind airport regulation. Chapter 2 points out that in many cases, airports are selling their products into competitive markets, so there is no strong reason why these airports need to be regulated to limit their use of market power. According to Chap. 2, most medium to large airports have substantial monopoly power, while others are clearly competitive. In between these, there is a grey area of airports which "may warrant regulation, but may not". Chapter 3 shows that the majority of hub airports in Europe have a dominant position both on the origin-destination and in the transfer market, but market concentration has been decreasing steadily for the majority of European hub airports. Based on these two chapters, we may conclude regulation *may* be necessary. Chapter 4 argues that the textbook primary economic objective of price regulation is the reduction or elimination of the deadweight loss due to monopoly

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power abuse. The chapter argues, however, that regulators often do not behave as though minimising deadweight loss is their primary concern. An alternative approach to regulating airports focuses on the need for customers to make sunk investments to extract the value from the monopoly service. Rather than the control of deadweight loss, Chap. 4 argues that the primary natural monopoly problem is "the design of a governance mechanism to protect and promote the sunk investment of customers". Chapter 5 also touches upon the customer side of regulation, and argues that regulation may reduce the airport's ability to gain rents, but potentially leaves the rents to its customers, which may have market power themselves.

Chapter 6 extends the discussion by including non-aeronautical services, and concludes the regulator may set the price of non-aeronautical service lower than its marginal cost to counteract a high airport charge, if it can regulate non-aeronautical service. Furthermore, privatisation with price-cap regulation on aeronautical services could reduce airport charge, but also introduces underinvestment in airport capacity, which could lower social welfare.

The main conclusions to be drawn from these chapters are that (1) not all private airports have significant market power that should be regulated; (2) the objective of regulation is not straightforward, because airport customers (airlines) need to invest themselves to benefit from airport services, and may have market power themselves; and (3) there is no form of regulation that always is "best" in achieving the goal of reducing the deadweight loss. "Light handed regulation", in the form of monitoring, is conducive to good productive efficiency, since there is less regulatory intervention which has the effect of dampening the ability of firms to produce efficiently. Its drawback is that it enables the use of market power. In efficiency terms, this is likely to be a problem in the sense that economic efficiency is not achieved (after all, there is a deadweight loss), but this is likely to be less of a problem than possible productive inefficiency if airports face low demand elasticities. But when prices may be high, governments often are willing to impose regulation, not for efficiency reasons but for distributional and political reasons. Stronger forms of regulation, however, automatically mean more regulatory intervention which has the effect of dampening the ability of firms to produce efficiently. The central problem for all forms of regulation is that the regulator has asymmetric information about the demand and cost functions. Therefore, the regulator must design a contract to set incentives for the regulated firm. Given the information asymmetry, the regulator will receive the information from the regulated firm only if the firm can keep some of its informational rents. This is an important conclusion. No type of regulation can achieve first-best outcomes in all circumstances. Also, "light handed regulation", faces this asymmetry. Like other forms of regulation, it should be evaluated as to whether it can set strong incentives for efficiency. From an academic perspective, and based on economic theory, we therefore see some unresolved and potentially controversial issues. One reason might be that a sharp distinction between light and strict regulation is not very useful in understanding regulation, but that one should look at the power of regulation in terms of incentives.

Chapter 7 discusses light-handed regulation in more detail. A key objective of this type of regulation is reducing regulatory costs, another is reducing the inflexibility of traditional regulation. Light-handed regulation is less clearly defined than traditional regulation. Nevertheless, there are several features which tend to be present in LHR regulatory systems. Often it is an ex post form of regulation. There is often a greater tolerance of higher prices, and there is an emphasis on promoting resolving problems by contracts between the airport and the airlines.

Chapter 8 concludes regulation is complex because the regulator is seeking to optimise on several fronts: short-run efficiency, keeping costs low, service quality, and investment. Regulators rely heavily on prices to address these potentially conflicting tasks. Thus, it is not surprising that simple regulatory solutions are unsatisfactory, especially given the information asymmetry and incentives discussed above.

Chapter 9 analyses progress in airport reform in Europe. In some aspects, airports perform well, while in others they are poor. The performance in the different aspects is not unconnected. The same institution which gives European airports good performance in moderating delays is also the one which gives them the ability to produce at high cost, and is linked to the unwillingness of some airports to invest in much needed capacity. So again, there is the question of whether the correct incentives are given. Chapter 9 makes a critical distinction between crowded airports and airports with adequate capacity. This distinction was found to have a clear effect on potential market power abuse in Chaps. 2 and 3. Demand at busy airports is not rationed by price, as a result of the workings of the slot system. There is a strong case for the reforms such as slot trading. European airports perform poorly in terms of cost efficiency. In the short run, airlines have an interest in airports producing efficiently and keeping costs low. Also, airlines have an interest in keeping capacity low, since they enjoy the rents from scarce capacity. This suggests an implicit contract between the airlines and the airport is possible. If the airlines can share some of the slot rents with the airport, perhaps enabling them to produce inefficiently, they will dampen the interest of the airport to invest in capacity, even when it is economically justified. The combination of all of these will perpetuate poor performance and aversion to reform.

Regulatory systems offer a rich and diverse field for benchmarking analysis, analysed in Part II of the book. Chapter 10 reviews benchmarking studies and concludes that incentive regulation is superior to cost-based regulation. In particular, dual-till price caps are better than cost-based regulation for airports with persistent market power. The review shows also clearly the limitations of the empirical work. Regulation is assessed in terms of cost efficiency, but not in terms of overall economic welfare. Furthermore, it is far from clear which forms of incentive regulation (price caps versus light-handed regulation) perform better. This conclusion was also drawn in Part I of the book, albeit on different grounds. Another important policy question about which benchmarking studies have so far not provided an answer (largely due to lack of data) is the issue of independent regulator. Incentives can only work if the regulated firm cannot capture the regulator. Price caps and light-handed regulation need to be executed by an independent institution. From theory, principles of good regulation have been drawn and these principles have even been adopted by many OECD countries, although Part I points out these principles do not necessarily apply to all airports and all cases. In practice, the EU tried to stimulate the adoption of an independent regulator in each country. Some countries set up independent regulators, but not every country followed suit. The reform process makes slow, but steady progress, which might be the result of effective rent seeking of airports. Alternatively, it might be a more political issue, and potentially controversial problem, because changing the legal status of the regulator also implies changing the level of influence of the various actors in the regulatory process.

Another unresolved problem is the benchmarking process. The benchmarking studies available usually do a good job given the data available to independent researchers but as pointed out in Chap. 11, one of the main challenges in benchmarking airport performance remains obtaining workable data. In the interpretation of the outcome of the benchmarking process one must take into account the limitations of the methodology and the underlying data. If the data are not of sufficient quality to help in the calculation of a price cap, the outcome can still be of use to the airport in question, even if it is only to improve the quality of the data collected. Chapter 12 discusses some of the practical issues facing a regulatory office seeking to use benchmarking to set a price cap at an airport. Amongst other things, the chapter points out that airports are reluctant providers of information to regulators, highlighting the point about information asymmetry made earlier in this conclusion. Airport users will sometimes demand cost reductions with an equally less-than-solid base of evidence.

Part III contains case studies of European and Latin American countries. The conclusion is that there is strong market power in most European cases studied, but the regulator is not independent in quite a few of the European countries. From a policy perspective, this means there is room for improvement, but as mentioned above, this is a political and potential controversial issue. In Latin America, concession contracts and revenue-sharing clauses with the government are common features among airports. Under the body of rules needed to enforce regulation, regulatory agencies exhibit low levels of governance and weak economic regulation, as might be expected from the discussion in Part I. The revenue-sharing contracts may indicate that the regulator is not always completely independent, as we also see in a number of European countries.

An interesting question is whether the Covid crisis affected the role or need for regulation. The Covid-19 crisis shows how much the aviation sector depends on national, regional, and global economic developments. We have seen state support for many airlines, often major airlines, flying international and intercontinental routes. The common rationale is that hubs and hub airlines contribute to the local and national economy, even though these may not be the airlines most resilient to external shocks, as evidenced by the fact that airports with a relatively high share of national traffic were hit, relatively speaking, less hard. Low-cost and regional airlines often have to survive on their own, which caused Ryanair to start 16 court cases over state support.

Now that many airlines receive state aid, it is even more important to also consider the market power issue. In “normal times”, the hub airports are congested, and often are the airports accused of market power abuse. When the sector returns to “normal times”, once the crisis is over, new airlines may enter the market because of the expected growth after the crisis. This increases competition between airlines, although scale effects and competition will lead to an eventual decrease in the number of airlines again, as we have seen in the past. But the support for the major airlines also helped major airports to maintain their long-run position as firms with potential market power, with uncertain economic impacts for the regions accommodating smaller airports. The current attention for the Covid-19 crisis, although understandable, could imply less attention for regulatory issues that were important before and will be important after the crisis. This book contributes to the literature on airport regulation and the practice of airport regulation by highlighting the importance of considering incentive regulation. The theoretical part of the book concludes that the central issue with all forms of regulation is that the regulator has asymmetric information about the demand and cost functions. Ignoring this asymmetry will lead to suboptimal outcomes when the firm’s incentives to maximise profits, or other objectives, and keep informational rents, are ignored. Therefore, the regulator must design a contract to set the proper incentives for the regulated firm. A sharp distinction between light and strict regulation is not very useful in understanding regulation, and one should look at the power of regulation in terms of incentives. A major challenge for the future, both for academics and practitioners, will be to consider the incentives facing individual airports, taking into account the fact that a regulator often is not independent, even though optimal “first-best” regulation requires an independent regulator. Benchmarking often is part of the regulatory process, and here we see the effects of information asymmetry. The methods may be well developed, and the main challenge in benchmarking airport performance is obtaining workable data.

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