Yuji Honjo *Editor*

Competition, Innovation, and Growth in Japan

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Editor
Yuji Honjo
Faculty of Commerce
Chuo University
Hachioji, Tokyo, Japan

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Preface

If I have seen further, it is by standing on the shoulders of giants.

From a letter from Isaac Newton to Robert Hooke

The role of a book is to convey the history of lessons learned from predecessors. Without exception, authors have learned through books written by those with experience and knowledge. Authors' learned lessons can be passed on to future generations through newly published books just as culture is passed on and inherited from ancestors. This process is essential to the development of research fields.

Three books—*The Theory of Growth in a Corporate Economy*, *Growth Through Competition, Competition Through Growth*, and *Technology and Industrial Development in Japan*, written by Professor Hiroyuki Odagiri, co-author of this book—have had a significant impact on the field of business and economics in Japan. The first book emphasizes firm behavior in the economy while targeting the growth of the national economy. The second book discusses the relationship between competition and growth by highlighting the resources of the firm, and the third book introduces innovations in Japan from the perspective of Japanese technological and economic history using six industrial case studies. These three books offer wisdom represented by three essential economic concepts—competition, innovation, and growth. This book is an attempt to achieve the interplay of competition, innovation, and growth based on the three concepts debated in the three books.

In many places, the interplay of components can often generate further creative works. Jazz music is an example. The interplay of various music instruments such as base, drums, and piano (or trumpet or saxophone) can create new artificial works. Each instrument represents a different sound source, but one instrument's sound encourages that of another instrument to create an extraordinary sound. The interplay of sounds generates changes in standards, which then become established jazz sounds to be recreated in other works.

This book is for scholars and students and elucidates the importance of the three concepts—competition, innovation, and growth—by providing cases and empirical studies on firms and industries from different authors. While competition, innovation, and growth are variable components in the economy, the interplay of competition, innovation, and growth can also play a significant role in stimulating the economy. Such interplay is expected to reverse the trajectory of former strong economies that are now stagnating, such as that of Japan.

This research project was made possible through the efforts of many people. On behalf of all the participants in this project, I would like to express sincere thanks to Professor Noriyuki Doi for his devotion to reviewing preliminary manuscripts, his attendance at research workshops to give constructive advice for every chapter, and his encouragement throughout the endeavor. In these workshops, each author also received comments and suggestions from other project members. Therefore, although each chapter is based on an author's individual contribution, the resulting book is the fruit of our collective efforts. Additionally, I acknowledge the financial support received from the Japan Society for the Promotion of Science (JSPS) (Grant-in-Aid for Scientific Research (B), No. 26285060). Last but not least, I thank Juno Kawakami of Springer for her constant encouragement and patience. I wish her all the best.

Hachioji, Japan Yuji Honjo
Spring 2017

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Chapter 1
Introduction

Yuji Honjo

Abstract This chapter provides an overview of this book, which presents three important concepts of competition, innovation, and growth. Using unique cases and data for firms and industries, this book offers a comprehensively discussion on these three important themes in Japan and other countries.

Keywords Competition • Growth • Innovation • Japan

1.1 Three Concepts Derived from the Stagnant Economy

Sharp and Hon Hai Precision Industry (also known as Foxconn) held board meetings on March 30, 2016, and both announced that they had finalized a deal that will see the Taiwanese electronics contract manufacturer purchase the struggling Japanese electronics company for about 389 billion yen (3.47 billion US dollars) in newly issued equity shares.[1] Sharp had emerged in the market by developing various innovative products, such as a mechanical pencil with a metallic shaft (widely known as the "sharp pencil" in Japan), and then continuing to develop creative consumer electronics, such as a liquid-crystal display television. However, because of massive deficits, Sharp needed capital and was forced to restructure. Sanyo Electric was another major electronics firm in Japan that was developing creative electrical products, such as a rechargeable battery, but it was forced into a merger with Panasonic because of poor performance.

[1]For more details, see the Nikkei Asian Review website.
http://asia.nikkei.com/magazine/20150604-Cast-away/Business/Sharp-at-the-beck-and-call-of-lenders [accessed on August 26, 2016].
http://asia.nikkei.com/Business/Deals/Sharp-Foxconn-finalize-merger-deal [accessed on August 26, 2016].

Y. Honjo (✉)
Faculty of Commerce, Chuo University, 742-1 Higashinakano, Hachioji, Tokyo 192-0393, Japan
e-mail: yhonjo@tamacc.chuo-u.ac.jp

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Many industries, particularly in the manufacturing sector, rapidly expanded in Japan after World War II. The development of these industries was underpinned by firms' successful activities including innovations. During a period of rapid growth, Japanese firms expanded and gained market share while competing with domestic and foreign rivals. At the same time, a substantial number of creative products developed by Japanese firms emerged and dominated the market. For instance, a low-cost motorcycle developed by Honda explored a new small-engine motorcycle market. Additionally, many electronics products, such as a transistor radio and a portable audio player, were developed by Sony. Moreover, some so-called blockbusters—for example, candesartan (Blopress®), developed by Takeda Pharmaceutical, and donepezil (Aricept®), developed by Eisai—were introduced worldwide as new chemical compounds in the pharmaceutical industry.

However, many industries stagnated during the so-called lost few decades after the collapse of the bubble economy. As Japanese firms' innovations became inactive, the firms gradually lost global competitiveness in industries. During the lost few decades, creative innovations in Japan have seemed less visible in the market. Although many large established firms have global brand recognition, some can no longer adapt to changes in the business environment. Eventually, firms that have lost global competitiveness, including Sharp and Sanyo Electric, are obliged to reorganize and restructure. Based on these historical cases, it is quite likely that reduced competitiveness is significantly associated with inactive innovations, which may result in stagnant growth in industries.

This book consists of three parts, each addressing one of the three concepts: competition (Part I), innovation (Part II), and growth (Part III). We consider that competition, innovation, and growth are indispensable to the economy and that these three concepts play a vital role in an economy's ability to climb out of stagnation and achieve economic recovery. Figure 1.1 illustrates the outline of discussions in this book, which will be introduced in the following subsections. As Fig. 1.1 shows, this book highlights competition, innovation, and growth, and discusses subjects in each chapter while considering the interaction between them.

Competition, innovation, and growth have been investigated in the literature, and the interaction between them has been debated since the days of Schumpeter (Schumpeter 1934, 1942). While "creative destruction," advocated by Joseph Schumpeter, extinguishes the preferred positions of existing firms and products, and the jobs and dreams of unsuccessful entrepreneurs and researchers, competition and innovation are considered to simultaneously induce growth in industries. Odagiri (1992), for example, argued that competition is enhanced by growth preference, and competition, in turn, makes growth feasible. Odagiri also emphasized that the two key concepts of growth preference (maximization) and competition become complementary. Aghion and Howitt (1992) proposed a mode of economic growth based on Schumpeter's process of creative destruction and showed that growth results exclusively from technological progress, which in turn results from competition

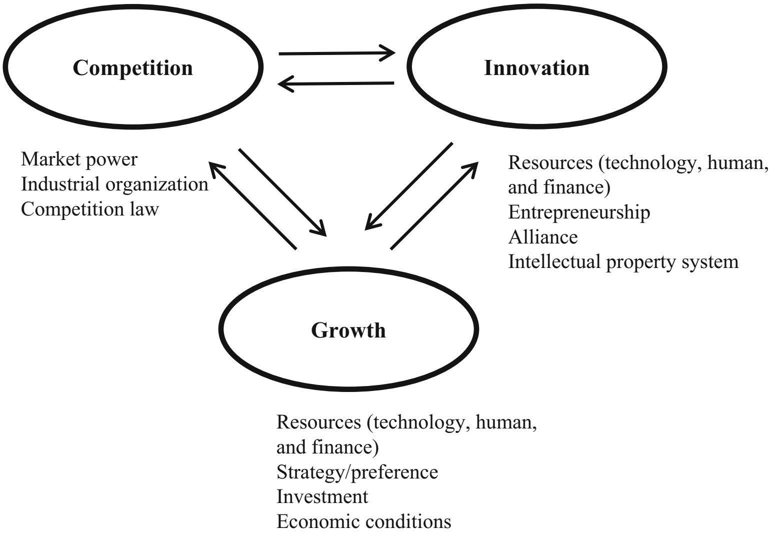

Fig. 1.1 Competition, innovation, and growth: basic view

among research firms that generate innovations.[2] According to these arguments, it is likely that both competition and innovation relate to growth, and the interplay of competition, innovation, and growth occurs in industries.

Meanwhile, competition possibly reduces incentives for innovation and growth if it reduces monopoly rents for a successful innovator. In this respect, strong patent protection that leads to less imitation increases incentives for innovation. Therefore, the extent to which competition significantly affects innovation and growth depends heavily on market conditions, including competition and intellectual property rights policies that play a key role in promoting competition and innovation in the economy. Hence, this book covers these policies.

This book contains special features. First, the book employs various cases and available data to discuss the three concepts: competition, innovation, and growth. As already mentioned, competition and innovation have been investigated in the literature. However, it is not easy to capture competition and innovation dynamics, whereas patent data have traditionally been used to investigate innovation outcome in the literature (e.g., Griliches 1984). Additionally, the identification of competition directly affects competition policy, and attention to the measuring of competition is essential. Therefore, this book also covers how to measure

[2]Aghion et al. (2005) found clear nonlinearities in the form of an inverted-U shape between competition and innovation. The interplay between innovation, competition, and growth was discussed in the OECD (Chandra et al. 2009).

the three concepts. Second, some chapters highlight the nonmanufacturing sector, including industries using electronic commerce (e-commerce) and biotechnology. Traditionally, the manufacturing sector has been investigated in the literature of industrial organization. However, the possibility of innovation and growth in the nonmanufacturing sector is expected to be higher than in the manufacturing sector in most developed countries. This book, therefore, covers firms' behavior and performance in the nonmanufacturing sector. Third, merger and acquisition (M&A) and alliance with external organizations, which are often regarded as the boundaries of the firm, are discussed in this book because these strategies can achieve efficient innovation and growth, particularly in high-tech industries in developed countries such as Japan. The subjects, including joint research and development (R&D), also matter for competition policy.

Moreover, this book targets firms and industries in Japan. From the historical perspective, Odagiri and Goto (1996) argued that competition among rival firms has been intensive in many industries in Japan and that Japanese firms have been exposed to intense potential or real competition against domestic rivals as well as foreign, supposedly technologically superior rivals in both domestic and international markets. In the past, firms' competitiveness exerted their innovative activities, including patent races, and competition and rapid changes in industrial structure played vital roles as external threat for survival. More importantly, rapidly growing markets induced entries, thereby intensifying competition. Consequently, such competition is considered to have contributed to rapid growth in Japanese industries. In addition, even though corporate governance for shareholders is widely recognized, as Odagiri (1981, 1992) indicated, managers had growth preference under the premise of agency problems and, similarly, researches had innovation preference. Such preference was also essential to generating competitiveness and innovative capabilities in Japan.

According to the above historical perspective, the interplay of competition, innovation, and growth has been prevalent in Japan. While such interplay may have been effective only during the catch-up period when Japan imported and adopted foreign technologies, we expect this still acts as a catalyst for stimulating the stagnant economy. For this reason, this book sheds light on competition, innovation, and growth in Japan, and we expect that the cases and empirical studies in this book include implications for economic policies and management strategies. A better understanding of competition, innovation, and growth would provide the tools to reinvigorate the stagnant economy in Japan and to reinforce the economy in other countries where the period of rapid growth has ended.

1.2 Competition

The first part of this book, which addresses competition, is divided into three chapters. As shown in Fig. 1.1, competition policy, based on the Antimonopoly Act, is imperative to a discussion on competition and its effects in industries. This part includes competition policy and the detection of collusion using cases and empirical studies. Additionally, we examine whether competition affects firm performance while shedding light on global competition. A better understanding of competition, including the detection and prevention of anticompetitive behavior and the effects on competition, innovation, and growth, will contribute to an understanding of how competition policy is implemented.

Chapter 2 gives an introductory account of competition policy in Japan, both from legal and economic standpoints, and provides several illustrative actual cases. This chapter presents a general introduction, from an economist's perspective, of Japanese competition policy and the associated law, the Antimonopoly Act, without excessive legal detail. Second, this chapter shows how competition policy can be implemented in a way that promotes innovation and dynamic competition. Certain forms of collaboration among competitors may be beneficial to competition, such as joint R&D, patent pooling, and standard setting. This chapter discusses how these forms of collaboration should be assessed from the perspective of competition policy.

Chapter 3 provides empirical evidence useful for the detection and prevention of collusion. Specifically, this chapter identifies which factors are related to the probability of collusion using cartel cases detected and prosecuted by the Japan Fair Trade Commission. This chapter highlights vertical integration between upstream and downstream firms as a factor potentially influencing the incentive to collude in addition to well-known factors such as the number of firms and asymmetry among firms. The estimation result is that the extent of vertical integration is positively related to the probability of (upstream) collusion. This empirical finding supports the antitrust authority's concern that vertical integration facilitates collusion.

Chapter 4 examines whether domestic competition enhances competitiveness in international markets for Japanese manufacturing industries. This chapter analyzes the effects of competition in Japanese industries, measured as the price–cost margin compared to that in US industries, on export and output market shares in OECD countries. The results show that relative price–cost margins negatively affect both export and output market shares, suggesting that competition contributes to international competitiveness. In addition, high-tech industries in Japan are more likely to have strong competitiveness in international markets in terms of both export and output market shares.

1.3 Innovation

The second part of the book, which addresses innovation, is divided into four chapters. First, this part attempts to construct innovation indicators using various data sources because it is not easy to capture innovation. This part also discusses the relationship between innovation outcome and organizational design of R&D activities, including human resource management (HRM), because innovation is significantly influenced by organizational and human resources, as well as technological resources of firms. Additionally, alliance with external organizations is more effective for engaging in innovation when the firm's resources are limited. This part highlights not only R&D alliance but also university–industry collaboration of high-tech start-ups while considering open innovation.

Chapter 5 examines the interdependence between various measurements of firms' innovation outputs. This chapter summarizes innovation indicators by linking the firm-level microdata of the Japanese National Innovation Survey to other microdata sources related to innovation in firms, such as patent, trademark, design registration, and press release on new product announcements. The empirical results show that firms with product innovation register more trademarks and firms with radical new products register more trademarks. Patent data reflects the R&D activity of firms, while design registrations reflect the self-reported design innovations and design activity measured in the innovation survey. In addition to patent applications and trademark registrations, press releases on new products, technological developments, and organizational changes increase the market value of a firm.

Chapter 6 elucidates the relationship between innovation outcome and organizational design of R&D activities including HRM within a firm. This chapter reviews the related literature on the interaction between organizational and human resource management (OHRM) and innovation. Chapter 6 then focuses on three types of management practices: cooperation and coordination across firm business units or divisions overall, HRM of R&D personnel, and restructuring the organization of R&D. This chapter also provides a detailed overview of the characteristics of Japanese firms' patenting activities and discusses OHRM practices and patent applications as a proxy for innovation outcome.

Chapter 7 examines the relationship between the technological capabilities of firms and the use of external R&D resources via R&D alliances with a focus on how the state of competition affects such relationships. This chapter focuses on the determinants of R&D alliance, the possible effects of R&D alliance on corporate performance, and the relationship with competition by introducing prior research literature. Using a descriptive analysis from a Japanese longitudinal dataset, this chapter examines the relationship between the use of external R&D resources and the state of competition.

Chapter 8 explores high-tech start-ups in the biotechnology industry in Japan. Because high-tech start-ups can more easily adopt new technologies compared to large established firms, novel ideas and technologies may be nurtured in start-up firms rather than large established firms. This chapter provides evidence that many biotechnology start-ups originate from universities and that the emergence of some biotechnology start-ups is significantly associated with R&D activities in universities. This chapter also shows that emerging stock markets in Japan play a critical role in equity financing for biotechnology start-ups. Moreover, this chapter examines whether biotechnology start-ups improve performance by going public. The results reveal that biotechnology start-ups increase equity financing, although they do not improve their performance after initial public offering.

1.4 Growth

The final part of the book, which addresses growth, is divided into four chapters. In Japan, the nonmanufacturing sector is expected to grow faster than the manufacturing sector, and growth often depends heavily on technological progress in the industry lifecycle. This part highlights the growth of nonmanufacturing industries including e-commerce. This part also examines M&A because M&A is an effective strategy for achieving rapid firm growth, particularly in developed economy. Moreover, foreign direct investment (FDI) plays a critical role in promoting economic growth in developed countries such as Japan, and important evidence on economic growth in Japan is provided and compared to the growth in other countries including Asian newly industrialized economies (NIEs). Additionally, some of the chapters estimate the determinants of growth using various measures such as commutative abnormal returns and total factor productivity.

Chapter 9 empirically examines the relationship between e-commerce and employment growth in Japanese firms from 2001 to 2006, using microdata from the Establishment and Enterprise Census. The main findings are as follows. Regardless of which type of technology is considered, larger firms, foreign firms, and multinational firms conduct more e-commerce. e-Commerce has a large positive impact on employment growth. This suggests that new technology, such as e-commerce, complements employment. This chapter provides a first step to understanding the effect of e-commerce on firm performance and examines the effect using a comprehensive firm-level dataset.

Chapter 10 analyzes the effects of the acquisition of foreign firms by Japanese firms on the shareholder value. This chapter estimates the market reaction to 99 announcements of cross-border acquisitions by Japanese firms valued above 50 billion yen between 1996 and 2016. In contrast to the prevailing notion that Japanese firms are not good at overseas acquisitions, the results reveal that the market reaction to the announcement of acquisitions is not negative. In addition, the institutional characteristics and cultural differences of the target firm country affect returns. The market reacts positively to the acquisition of firms located in countries with weak shareholder protection and that are culturally distant.

Chapter 11 examines whether and how the entry of foreign multinational firms affects productivity growth of domestically owned firms, using Japanese firm-level data. Japanese firms are exposed to intense potential or real competition against domestic and foreign rivals. This chapter focuses on the role of foreign entry in the service sector where cross-border trade is often difficult and firms are, therefore, less likely to be exposed to international competition. The results suggest that foreign multinationals perform better than domestically owned firms in many sectors. Moreover, once firm-specific fixed effects are controlled for, the presence of foreign firms in an industry tends to negatively affect the productivity growth rate of domestically owned firms in that industry. However, firms that are catching up toward the productivity frontier enjoy positive FDI investment spillovers, implying that foreign entry accelerates productivity catch-up.

Finally, Chap. 12 examines the effects of FDI outflows on a home country's growth and employment. Previous studies on home country effects have mainly focused on FDI from large developed economies to other countries. However, today's super recipient is a relatively larger economy than its investors, and many of these investors are not classified as "developed economies." The empirical results for Japan and Asian NIEs (source countries) and China (recipient country) show that FDI outflows to China lead to decreases in the relative income between the source country and China and to increases in the source country's unemployment rate. In addition, this chapter shows that FDI outflows to China decrease the exports-to-GDP ratio only for small source countries (Taiwan and Korea), even though higher investment in China raises the ratio of their exports-to-China to China's total imports.

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Chapter 2
Competition Policy and Innovation: An Introduction with Illustrative Cases from Japan

Hiroyuki Odagiri

Abstract This study gives, first, an introductory account of competition policy in Japan, both from a legal and economic standpoint, and provides several illustrative actual cases. The aim is to present a general introduction, from an economist's perspective, of Japanese competition policy and the associated law, the Antimonopoly Act, without excessive legal detail. Second, this study shows how competition policy can be implemented in a way that promotes innovation and dynamic competition. Certain forms of collaboration among competitors may be beneficial to competition, such as joint research and development (R&D), patent pooling, and standard setting. The study discusses how these forms of collaboration should be assessed from the perspective of competition policy.

Keywords Competition policy • Competition law • Innovation • Patent • Standard

2.1 Introduction

This study will give an introductory account of Japanese competition policy mainly from an economist's perspective. Of course, one cannot discuss competition policy without discussing the underlying law, that is, the Antimonopoly Act (AMA). I will also discuss certain legal cases to explain the current Japanese context. As an economist, I have limited capacity to detail the legalities of these cases. Rather, my intention is to offer, albeit briefly and sporadically, economic reasoning to AMA's

The author was a commissioner for the Japan Fair Trade Commission (JFTC) from the year 2012 to 2016; however, all the facts and citations in this chapter are taken from published documents, and any view expressed here is the author's alone. This chapter is partly based on the author's early discussion paper (CPDP-53-E) published from the JFTC's Competition Policy Research Center.

H. Odagiri (✉)
Graduate School of Economics, Hitotsubashi University, 2-1 Naka, Kunitachi,
Tokyo 186-8601, Japan
e-mail: a041254r@r.hit-u.ac.jp

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provisions and to the cases taken up by the Japan Fair Trade Commission (JFTC). I have had several opportunities to discuss Japanese competition policy with foreign audiences and have realized that, except within a limited circle of policy and legal specialists, little is known about the AMA. Moreover, there are only a few related English publications.[1] This chapter hopes to fill this void.

First, I will briefly discuss the economic rationale for competition policy.

All economics textbooks suggest that a lack of competition in a market causes its price to be higher and the quantity produced and consumed to be smaller. Thus, consumers' surplus is decreased along with social welfare (consumers' surplus plus producers' surplus). This loss of welfare is referred to as deadweight loss.

In addition to this static effect, there is also a dynamic effect, that is, the effect on innovation, such as investment in research and development (R&D). Here too, a lack of competition is likely to result in weaker innovation efforts. For example, a monopolist can indulge in a quiet and safe life neglecting such risky activity as innovation (often called "a quiet life hypothesis") because the monopolist need not worry about competitors that may develop newer and better products or processes. A monopolist, in fact, is likely to find that the development of a new product attracts customers only by having them switch from the firm's existing products. Because of this so-called replacement effect or cannibalization effect, a monopolist has less incentive to engage in R&D.

A counter-argument is that a bigger and more monopolistic firm can be more R&D-intensive because it has greater resources to expend on R&D, can exploit economies of scale in R&D, and can utilize its brands and distribution channels to sell new products. This hypothesis is often called "the Schumpeterian hypothesis" (or the Schumpeter's hypothesis).[2] Several empirical studies have tested this hypothesis with mixed results that, often, conflict with the hypothesis.[3]

Thus, a monopoly (or lack of competition) is detrimental to society because of increased prices and weaker incentives for innovation, which inhibit the introduction of new, improved, or cheaper products and reduce dynamic competition. Therefore, policies are required to maintain and promote a competitive market environment, which is precisely the goal of competition policy (or antitrust policy as it is referred to in the USA).

The following discussion is composed of five sections.

[1]Exceptions are Wakui (2008) and Kameoka (2014). In addition, Lin and Ohashi (2014) give a short introduction to AMA and its historical background. JFTC's official English booklet, titled "For Fair and Free Market Competition," gives a succinct account of AMA and JFTC and is available at the following site: http://www.jftc.go.jp/en/about_jftc/role/index.html. The act itself, as well as all the guidelines of JFTC to be cited in this chapter, can be accessed at http://www.jftc.go.jp/en/legislation_gls/index.html (all the URLs shown in this chapter were last accessed in June 2016).

[2]In my opinion, although Schumpeter (1942) argued that innovation is incompatible with perfect competition as envisaged by economists, the author did not assume a simple relationship between innovation and the degree of monopoly as discussed in the Schumpeterian hypothesis.

[3]See the survey articles by Cohen (2010) and Gilbert (2006).

Sections 2.2 and 2.3 discuss the four major rules stipulated by the AMA: prohibition of unreasonable restraint to trade, prohibition of private monopolization, prohibition of unfair trade practices (in Sect. 2.2), and the regulation of business combination (in Sect. 2.3). Details of these rules will be discussed only briefly. Instead, I will present one or two cases for each rule to provide insight into how the rules are applied.

Sections 2.4 and 2.5 explain how competition policy is related to innovation, including intellectual property (IP) issues, which are predominantly those relating to patents. Section 2.4 describes three interfirm collaborative activities related to innovation – joint R&D, patent pooling, and standard setting – and discusses the JFTC's evaluation of them from the perspective of competition policy. Section 2.5 explains how the concentration of patents should be evaluated in merger regulation. The urgency of these issues has increased in terms of both public policy (such as competition policy and innovation policy) and business strategy because the promotion of innovation is a key policy target for governments and a strategic issue for firms. Section 2.6 concludes the paper with three general remarks.

2.2 The Antimonopoly Act

The AMA Article 1 states the aim of the act as follows:

> The purpose of this Act is to promote fair and free competition, stimulate the creative initiative of enterprises, encourage business activity, heighten the level of employment and actual national income, and thereby promote the democratic and wholesome development of the national economy as well as secure the interests of general consumers...[4]

The AMA was enacted in 1947 soon after Japan was defeated in World War II. The allied powers that occupied Japan intended to "democratize" Japan's economy by, first, forcing several *zaibatsu* (big business groups) to dissolve; second, by forcing 11 dominant firms to split and many other firms to divest businesses and subsidiaries; and third, by enacting the AMA. Japan was the first country in Asia to have a competition law and the third in the world after the USA and Canada. The AMA has been amended several times since its enactment.

The agency that implements the AMA is the Japan Fair Trade Commission (JFTC). The Commission is composed of a chairman, four commissioners, and an administrative office with approximately 830 staff. The Competition Policy Research Center (CPRC) is a center within the JFTC that independently researches competition policy, but not individual current JFTC cases, jointly with academics, namely, economics and law university professors who collaborate with each other and with the JFTC staff on a part-time basis.

[4]English translation as shown in the JFTC website (http://www.jftc.go.jp/en/legislation_gls/amended_ama09/index.html).

The four pillars of the AMA are:

1. Prohibition of unreasonable restraint of trade
2. Prohibition of private monopolization
3. Prohibition of unfair trade practices
4. Restriction of business combination

These pillars will be discussed in turn in the following subsections.

When the JFTC identifies a violation of these prohibitions and restrictions, it issues a "cease and desist order." In the case of unreasonable restraint of trade (cartels and bid riggings), private monopolization, and certain types of unfair trade practices, the JFTC also orders the payment of surcharges. The rate of surcharge varies according to the type of conduct, the industry, and the size of the firm. For a cartel case by a large manufacturing firm, for example, the surcharge is 10% of the sales amount of the products or services in question during the period of violation but can be increased to 15% in cases of (a) repeat offenders or (b) firms in the leading role and to 20% if both (a) and (b) apply. Moreover, when the JFTC considers the violation serious and deserving of criminal sanctions, the commission files an accusation with the Prosecutor General, in which case the court can impose criminal penalties on the violating individuals (imprisonment of up to 5 years or a fine of up to 5 million yen) and the firms (a fine of up to 500 million yen).

A leniency program that immunizes or reduces surcharges applies when firms voluntarily report involvement in cartels and bid riggings to the JFTC and cooperate in the investigation. Since its introduction in 2006, the leniency program has proven effective, facilitating the investigation of many cartel or bid-rigging cases.

2.2.1 Prohibition of Unreasonable Restraint of Trade

"Unreasonable restraint of trade," prohibited in the AMA Article 3, is defined as

> such business activities, by which any enterprise, by contract, agreement or any other means irrespective of its name, in concert with other enterprises, mutually restrict or conduct their business activities in such a manner as to fix, maintain or increase prices, or to limit production, technology, products, facilities or counterparties, thereby causing, contrary to the public interest, a substantial restraint of competition in any particular field of trade. (AMA Article 2(6))

This includes cartels and bid riggings. The following example describes a typical bid-rigging case:

Case 1: Bid Rigging in Snow-Melting Equipment Works for Hokuriku Shinkansen (Tokyo High Court, 2014; Cease and Desist Order, and Surcharge Payment Order by the JFTC, 2015)
Eleven firms participated in the bidding for snow-melting equipment works for Hokuriku Shinkansen (Bullet Train Line) and ordered by the Japan Railway Construction, Transportation, and Technology Agency (JRTT) during the period 2011–2012. Among these 11 firms, a successful bidder was designated for each of the 8 parts of the work and the firms collaborated so that the designated successful

bidders would be awarded the work, which was a violation of the prohibition of unreasonable restraint of trade. The JFTC considered the case to be a serious offense with widespread social impact and indicted eight of the 11 firms under the Prosecutor General. Subsequently, the court ordered these firms to pay 120–160 million yen per firm in criminal fines and the imprisonment (with probation) of the company directors. Following the court decision, the JFTC issued cease and desist orders to the 11 firms and ordered 7 firms (who were successful bidders) to pay 1035 million yen in surcharges. Additionally, the ministry in charge of the JRTT prohibited these firms from bidding for several months causing the firms to lose a substantial amount of work.

The following is a landmark cartel case for the reason stated below.

Case 2: Toshiba Chemical Case (Tokyo High Court, 1995)
Eight manufacturers of paper phenol copper-clad laminates met regularly during the first 6 months of 1987 and exchanged information and opinion on how to prevent the decline of their selling prices and increase their prices. At a meeting on June 10, 1987, the top three manufacturers announced their intention to raise their prices by 300 yen per square meter, or by 15%, and requested the others to do the same. Consequently, all of the manufacturers raised their prices.

In Case 2, the question is whether the information exchange and announcement from the manufacturers have "in concert with other entrepreneurs, mutually restrict[ed] or conduct[ed] their business activities" as the cited AMA Article 2(6) stipulates (my brackets). JFTC decided that it did. One of the defendants opposed the decision and sought a court ruling to negate the JFTC decision. The Tokyo High Court supported the JFTC's decision, stating:

> if an entrepreneur exchanges information of price-raising among other entrepreneurs and, accordingly, takes the same or similar act with others, it is unavoidable for us to presume that the parties had a relationship to expect the concerted act from each other and, therefore, the said 'liaison of intention' exists unless there is a special occasion to show that the price-raising was implemented individually by a company's own decision that the price-raising is capable of meeting price competition in the relevant market, and there is no relationship between that company's price-raising with other companies.

This case has been influential because, while the presence of "liaison of intention" is necessary to satisfy the condition in AMA Article 2(6), the court stated that "explicit agreement to bind upon the related parties is not necessary to prove 'liaison of intention.' In other words, 'liaison of intention' can be proved by showing mutual recognition of other entrepreneurs' price-raising and tacit acceptance of such a price-raising of another. (It is called 'liaison of intention' by a tacit agreement.)"[5]

[5]The parenthesis is in the original. The English translation was taken from the JFTC's contribution to OECD Competition Committee (Global Forum) titled "Cartel Case Studies: Case Submitted by Japan," DAF/COMP/GF/WD(2006)21, January 2006 (http://www.oecd.org/dataoecd/59/48/35935909.pdf).

Economists have often discussed that explicit collusion and tacit collusion can lead to the same outcome, that is, supracompetitive prices, whether there is explicit coordination of actions among firms (explicit collusion), or the firms merely set and maintain their prices at a higher level in fear of retaliation once they deviate from this price (tacit collusion or tacit cooperation).[6] Yet, few economists argue that all such tacit collusion should be illegal because purely independent pricing may result in parallel pricing, which may be mistaken for tacit collusion. Many economists instead believe that only tacit collusion that has anticompetitive intention or method should be punished. The Toshiba Chemical case, in my opinion, extends the scope of AMA to cover such tacit collusion by noting that the company was in the meeting with the competitors who expressed their price hike intentions and then took the same or similar action, thus indicating the presence of "liaison of intention."

2.2.2 Prohibition of Private Monopolization

"Private monopolization" is defined as follows:

> Such business activities, by which any enterprise, individually or by combination or conspiracy with other enterprises, or by any other manner, excludes or controls the business activities of other enterprises, thereby causing, contrary to the public interest, a substantial restraint of competition in any particular field of trade. (AMA, Article 2(5))

That is, restraint of competition by exclusion or control constitutes private monopolization. A typical example is entry deterrence, as the following case illustrates:

Case 3: Hokkaido Shimbun Case (2000)
Hokkaido Shimbun (hereafter HS; *shimbun* is a Japanese word for newspaper) is a newspaper publishing company with a dominant position in the Hokkaido island of Japan. Around 1994, HS learned of the planned entry of a new newspaper company, to be named Hakodate Shimbun, in the area around Hakodate, a major city in the southwest of Hokkaido. To prevent Hakodate Shimbun's entry, HS took several measures; for example, (i) it applied to the Japan Patent Office for "Hakodate Shimbun" and other likely names to be trademarks[7] (ii) to reduce Hakodate Shimbun's advertising revenues, HS offered lower-cost advertising space to Hakodate Shimbun's probable advertisers, namely, small and medium-size firms in the Hakodate area, and (iii) HS asked TV Hokkaido, a TV station and HS's affiliate, not to sell TV commercial spots to Hakodate Shimbun.

[6] See, for instance, Motta (2004).

[7] Following the JFTC's ruling, HS withdrew its application for "Hakodate Shimbun," and thus, the new company could name itself Hakodate Shimbun.

The JFTC considered that these actions were intended to "exclude" the activity of Hakodate Shimbun, thereby causing substantial restraint of competition, and the JFTC concluded that the actions constituted a violation of the AMA.

In this case, with little doubt, HS engaged in entry-prevention tactics, and no theory would explain them as a rational business strategy. In contrast, the next case may appear more ambiguous:

Case 4: Japan Intel Case (2005)
Japan Intel imports central processing units (CPU) from Intel USA and sells them to personal computer makers in Japan. Japan Intel offered discounts (rebates) to PC makers on condition that (i) the proportion of Intel CPU among all the CPUs that the PC maker uses, called MSS, is 100%; (ii) MSS is more than 90%, with the rivals' proportion accounting for less than 10%; or (iii) for the major PC models, they only use Intel CPUs.

JFTC considered that the intention of Japan Intel was to "exclude" the activity of rival CPU manufacturers, thereby causing substantial restraint of competition and violating the AMA.

A bulk discount, that is, a discount offered to buyers of large quantities, is typically considered to be an acceptable commercial practice if the savings in distribution and other administrative costs justify the discount. However, in the Intel case, the firm offered a discount based on share, not quantity. Such a practice is called a fidelity (or royalty) rebate often adopted with the intention of excluding rivals (mainly AMD in this case). The effect was considerable because Intel was a dominant world leader with strong brand recognition among consumers and, in fact, the market share of rivals decreased significantly after Intel initiated the rebate. This fact prompted the JFTC to consider that Intel's conduct had the intention and effect of exclusion, thus violating the AMA.

2.2.3 Prohibition of Unfair Trade Practices

The practices listed below may be considered unfair trade practices under the AMA.

- Refusal to deal (boycott)
- Discriminatory pricing and other discriminatory treatment
- Unjust low price sales
- Tie-in (bundling)
- Resale price maintenance (RPM)
- Dealing on exclusive terms
- Dealing on restrictive terms
- Abuse of dominant bargaining position
- Deceptive customer inducement

Here, I will discuss resale price maintenance (RPM). In a vertical relationship, for example, from a manufacturer to a retailer and then from a retailer to a consumer, the manufacturer can determine the wholesale price, that is, the price it charges to the retailer. If the manufacturer also determines the retail price (that is, the price the retailer charges to the consumer, which is the "resale price" from the manufacturer's standpoint) and forces the retailers to maintain a set pricing, it is termed resale price maintenance (RPM). "It is in principle illegal as unfair trade practices, because it reduces or eliminates price competition among distributors" (*Distribution Guidelines*,[8] Part II, Chapter 1, 1, (1)).[9]

The following describes an RPM case condemned by the JFTC:

Case 5: Coleman Japan Case (2016)

Coleman Japan, a Japanese subsidiary of the US camping equipment supplier, around August every year, set the following sales regulation for retailers selling Coleman's camping equipment in the upcoming season: (a) a sales price of each Coleman's camping equipment should be more than the minimum floor price set by Coleman Japan, and (b) a discount sale of Coleman's camping equipment would be admitted only in a case where either a retailer would conduct the discount sale covering all products including other brands, or a retailer would conduct, without advertising on a flyer and after the date set by Coleman Japan, the discount sale for the purpose of clearing stock at real shops.

Coleman Japan requested retailers, directly or through wholesalers, to sell Coleman's camping equipment in accordance with the sales regulation, and obtained agreements from these retailers that they would sell Coleman's camping equipment in accordance with the sales regulation on the assumption that Coleman Japan would make other retailers also sell in accordance with the sales regulation.

These practices, the JFTC decided, constituted unlawful RPM and violated the AMA.

Manufacturers often claim that RPM is necessary to maintain product reputation and services including display and customer consulting. In fact, there is an economic theory suggesting that RPM can benefit consumers by encouraging retailers to compete by offering better services instead of lowering prices.[10]

In 2015, the JFTC revised its *Distribution Guidelines* and added the following paragraph: "the Antimonopoly Act stipulates that RPM without 'justifiable grounds' is illegal as an unfair trade practice. In other words, RPM is not illegal as an exception on the condition that it has 'justifiable grounds'" (*Distribution Guidelines*, Part II, Chapter 1, 2, (1)).

[8]Formally, "Guidelines concerning distribution systems and business practices under the Antimonopoly Act," first issued in 1991 and most recently revised in 2016.

[9]Exceptions to this rule apply to published works such as newspapers, magazines, books, and music CDs (AMA, Article 23). Thus, these works (domestically produced only) are sold at uniform prices across Japan.

[10]A pioneering contribution was Mathewson and Winter (1984).

Moreover, "'justifiable grounds' might be granted within reasonable scope and reasonable terms in the case where such RPM by a manufacturer will result in actual pro-competitive effects and will promote inter-brand competition, will get demand for the product increased thus benefiting consumers, and pro-competitive effects will not result from less restrictive alternatives other than the RPM. . . . For example, when a manufacturer performs RPM, such RPM will be granted to have 'justifiable grounds' in the case where such RPM actually results in pro-competitive effects through avoiding the 'free-rider' problem, will promote inter-brand competition, will get the demand of the product increased, thus benefiting consumers, and pro-competitive effects will not result from less restrictive alternatives other than the RPM" (*Distribution Guidelines*, Part II, Chapter 1, 2, (2)).

In the Coleman Japan case, the JFTC apparently considered that there were insufficient "justifiable grounds" for its conduct.

2.3 Restriction of Business Combination

The AMA Article 15 stipulates the following:

> No company may effect a merger if any of the following items applies:
>
> (i) if the merger substantially restrains competition in a particular field of trade,
> (ii) if unfair trade practices are employed in the course of the merger.

The JFTC's focus for investigation has been on (i) for the main merger cases. Therefore, I will discuss this issue only.

The same regulation applies to other acts of business combination including the acquisition of businesses, acquisition of shares, cross-holding of shares, integration using a holding company, and cross-directorship. In these cases, the definition of business combination can be tricky because, for instance, a small number of shares may be acquired simply as a financial investment, without the intention or effect of combining businesses. In its *Merger Guidelines*,[11] the JFTC states that if (but not only if) the shareholding ratio exceeds 50%, or if it exceeds 20% and is the largest among the shareholders, the JFTC will review such shareholding as a business combination as stipulated in the AMA.

The shareholding relationship can be complex. In a case reviewed in 2015, company A, majority-owned by company X, was planning to acquire over 50% of company B. Companies A and B were competitors in a market (a certain type of steel product). Among the other competitors in the market were companies C and D, which were minority-owned by the same company X (a major producer of other types of steel but not the type of steel in question). The JFTC thus investigated the possible lessening of competition by an A-B combination and the extent of

[11] Formally, "Guidelines to Application of the Antimonopoly Act Concerning Review of Business Combination," first issued in 2004 and most recently revised in 2011.

management independence of C and D from X (and, therefore, A) to determine if C and D can be real competitors to A-B. The JFTC concluded that C and D, in this case, are, and therefore, the A-B combination would not substantially restrain competition.[12]

A difficult question of course is whether a certain merger (or acquisition) will have the effect of "substantially restraining competition" and to determine the "particular field of trade." The JFTC, in its *Merger Guidelines*, announced how it intends to interpret these conditions. For instance, the JFTC clarifies the so-called safety harbor conditions in terms of the level and change of the Herfindahl-Hirschman index (HHI).

The Cournot oligopoly theory suggests that unless the entry threat is sufficiently strong, a merger reduces the number of competitors and results in a higher price, a lower level of production and, therefore, an increase in welfare loss.[13] Therefore, the JFTC (or any other competition authority) is vigilant as to whether a certain merger is likely to result in the predicted effect, that is, "substantially restraining competition in a particular field of trade." When such an effect is likely, the JFTC may prohibit the merger or allow the merger subject to "remedies," namely certain actions to be undertaken by merging partners to reduce the expected anticompetitive effects, for instance, divestiture of a part of business or a commitment to license their patented technologies on fair, reasonable, and nondiscriminatory (FRAND) terms.

In many cases, merging firms justify their merger by arguing that the merger would introduce production, distribution, and R&D efficiencies that reduce costs and increase social welfare.[14] The following case is an example.

Case 6: Merger Between Japan Airlines (JAL) and Japan Air System (JAS) (2002)

JAL announced plans to merge with JAS in 2002. This merger, for many Japanese domestic flight routes, would decrease the number of competitors from three (JAL, JAS, and ANA, i.e., All Nippon Airways) to two (the combined firm and ANA), or from two (JAL and JAS) to one (the combined firm). Thus, in preliminary consultations, the JFTC warned that the merger could be considered anticompetitive and a violation of the AMA. In response, JAL and JAS proposed the following remedies to minimize the anticompetitive effects: (i) to relinquish landing slots at the congested Tokyo Haneda Airport (the slots would be re-allocated to new entrants), (ii) to have the new entrants use their airport facilities, such as check-in counters, at reasonable fees, and (iii) to decrease ticket prices for most routes by 10% and

[12]This is the case of the share acquisition by Osaka Steel of Tokyo Kohtetsu; JFTC's report was published in January 2016 (http://www.jftc.go.jp/en/pressreleases/yearly-2016/January/160128.files/160128.pdf).

[13]See Farrell and Shapiro (1990), Odagiri (2008), and Whinston (2007).

[14]Williamson's (1968) now famous "welfare tradeoff" argument suggests that even if the price increases because of a merger, the cost saving may be large enough to offset the reduction of the consumer surplus and increase social welfare.

maintain these prices for at least 3 years. The JFTC assumed that these remedies were sufficient and accepted the merger.

In this case, JAL and JAS emphasized that the merger would enhance efficiency. In the press release, the airlines claimed a 73-billion-yen cost saving, 100-billion-yen investment saving, a reduction in staff of 3000 and a 10% reduction in aircraft. With these savings, the companies claimed they would be able to attain an ROE (return on equity) of 15% in 3 years although they were making losses at the time of the merger proposal.

What really happened? First, despite the pledge of a 3-year price freeze, JAL (the merged company) raised prices the next year. Citing unanticipated rising fuel prices as the reason, JAL raised prices to premerger levels and the JFTC did not object. Second, the actual ROE in 2005 (i.e., 3 years after the merger) was −32%, far below the promised 15%. In 2010, JAL virtually went bankrupt.

Thus, the case teaches two valuable lessons. First, "conduct remedies," such as promises on pricing, are noncredible and inadequate considering changing and uncertain cost and demand conditions. "Structural remedies," such as divestiture, are preferable because they are nonreversible and are, therefore, credible.[15]

Second, the merging firms' claim of efficiency enhancement effects should not be taken at face value because managers tend to overpredict and overstate the efficiency gains. In fact, few empirical studies find efficiency gains from mergers.[16] Accordingly, it is unwise to assume without scrutiny that the benefit of efficiency enhancement (as claimed by the firms) will more than compensate for the damage to consumers that the merger may inflict through reduced competition.

So far, I have only discussed horizontal business combinations, that is, mergers or acquisitions among firms in the same industry. There are also cases of vertical combinations, that is, mergers or acquisitions between upstream firms and downstream firms. In these cases, foreclosure is often the pertinent issue. That is, if an upstream firm (A) to be merged had been supplying inputs to a downstream firm (Y) that is competing against a merging downstream firm (X), firm (A) may, after the merger, refuse to sell to Y or raise the selling price to Y, creating difficulties for Y in competing against X and harming the competition in the downstream industry. This is the issue with foreclosure.[17] The following case, which is a business combination between two providers of digital platforms, is one example.

Case 7: Acquisition of Ikkyu by Yahoo Japan (2016)

Yahoo Japan, a metasearch service provider, planned to acquire a 100% share of Ikkyu, an online travel agent (OTA). Because it is vital that an OTA is listed in search

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[15] For the difference between the two types of remedies, see the US Department of Justice, Antitrust Division, "Antitrust Division Policy Guide to Merger Remedies," June 2011 (http://www.justice.gov/atr/public/guidelines/272350.pdf).

[16] For a study in Japan, see Odagiri et al. (2011).

[17] More precisely, this is the issue of input foreclosure. Additionally, output foreclosure is a possibility for which a merging downstream firm refuses purchase from an upstream firm competing against the merging upstream firm.

results, the likelihood of foreclosure by Yahoo Japan's search service of competing OTAs was a concern to the JFTC. However, there are strong competitors both in the search service market (although Yahoo Japan has a much bigger presence in Japan compared to Yahoo USA in the US market) and in the OTA market (including international platforms such as Expedia and Booking.com). Therefore, the JFTC considered that foreclosing competing OTAs (i.e., refusing to list other OTAs in search results) would only reduce the attractiveness of Yahoo Japan as a search site and, in view of the ease of users' in switching to other search sites, JFTC concluded that Yahoo Japan would not have an incentive for such a foreclosure. The acquisition was thus approved without conditions.

Notably, this case suggests that digital markets and platforms in two-sided markets (in which the platforms face two sets of entities – such as suppliers and customers – with indirect network effects between them) are becoming prevalent issues in Japan's competition policy as in the USA or the EU.[18]

2.4 Interfirm Cooperation in Innovation

Section 2.2.1 discussed that cooperation among firms (i.e., to "mutually restrict or conduct their business activities") is prohibited if it causes "contrary to the public interest, a substantial restraint of competition in any particular field of trade." Such a competition-restraining effect is evident in so-called hard-core cartels, most notably, cartels that fix prices at supracompetitive levels or fix quantities at subcompetitive levels. However, interfirm cooperation can enhance competition if it contributes to cost savings, product or process innovation, or environmental improvement, for example, from which the consumer benefits. Therefore, such cooperation should not be considered *per se* illegal but evaluated based on a rule of reason.

Today, this issue has become particularly common and pertinent in relation to several collaborative acts on innovation and technology. Here, I refer to three types of acts – joint R&D, patent pool, and standard setting – and discuss how they should be considered from the perspective of competition policy.

2.4.1 Joint R&D

Joint R&D can be beneficial in at least two ways. The first benefit is the internalization of spillovers. If not fully protected with intellectual property rights, invented knowledge and technology may spill over to rivals, reducing a firm's incentive to

[18]For competition policy for two-sided (or multisided) markets, see Evans and Schmalensee (2015), for instance.

invest in R&D. By forming joint R&D with these rivals, firms can internalize the spillover enabling them to share both costs and benefits of new inventions.

The second benefit is the combination of complementary knowledge and R&D capabilities across firms, which should contribute to lower R&D costs and a higher probability of successful innovation.

The JFTC thus acknowledges that

> a joint R&D project stimulates and improves the efficiency of R&D activities and encourages technological innovations by (1) helping reduce the costs, distribute the risks or shorten the required time for R&D, and (2) facilitating mutual complementing of technologies and so forth, among firms in different lines of business, and accordingly are regarded as having pro-competitive effects in many cases. (*Joint R&D Guidelines*,[19] Introduction, 1)

However, if all rival firms join under a single R&D project, there is no competition for innovation, and hence, the firms will have no incentive to invent a new product or a new process ahead of their rivals. Thus, the guidelines state as follows:

> Joint undertaking of R&D projects that would pose problems under the Antimonopoly Act would be those competing (including potentially competing, hereinafter referred to as 'competing') firms undertaking R&D projects jointly.

And

> In most cases, joint R&D projects are carried out by a small number of firms and there seems to be not much likelihood that they will pose problems under the Antimonopoly Act. However, in exceptional cases, where, for example, multiple firms in the oligopolistic industry or a majority of 'competing' firms in the product market, in improving a certain product or in developing an alternative product, work together under a joint project, in spite of the fact that this project could be carried out by anyone of the participating firms. This could mean restricting R&D activities among the participants and cause substantial restraint of competition in the technology or product market. (*Joint R&D Guidelines*, Part I, 1)

Of course, if the members of a joint R&D project also cooperate in setting the selling conditions such as prices, quantities, or sales territories for the products they are developing, it is against the prohibition of unreasonable restraint of trade (see Sect. 2.2.1) and violates the AMA. Or, if they undertake unfair trade practices (see Sect. 2.2.3), for instance, selling the products under restrictive terms, this may be deemed a violation of AMA.

So far, there has not been a legal case in which joint R&D was considered illegal in Japan.

[19] Formally, "Guidelines Concerning Joint Research and Development Under the Anti-Monopoly Act," first issued in 1993 and most recently revised in 2010.

2.4.2 Patent Pool

The AMA, Article 21, states that the law “shall not apply to such acts recognizable as the exercise of rights” under the IP laws. To clarify what would be recognized as “the exercise of rights,” the JFTC published *IP Guidelines*[20] in 2007, which state that

> any act that may seem to be an exercise of a right cannot be ‘recognizable as the exercise of the rights’ provided for in the aforesaid Article 21, provided that it is found to deviate from or run counter to the intent and objectives of the intellectual property systems, which are, namely, to motivate entrepreneurs to actualize their creative efforts and make use of technology.

Determining whether a certain act is considered “to deviate from or run counter to the intent and objectives of the intellectual property system” is not an easy task. This determination is even more difficult when such an act is carried out as a collective action of multiple patent holders forming a patent pool and not by an individual patent holder. Although outdated, the following is the only patent pool case that JFTC considered a violation of the AMA.

Case 8: Pachinko Machine Patent Pool Case (1997)
Pachinko is a type of game machine that is popular in Japan. People play in “pachinko parlors” that typically have hundreds or thousands (in big parlors) of pachinko machines. At the time of this case, the pachinko machine manufacturing industry was an oligopolistic industry with the ten largest firms owning more than 90% of the market share. The firms sold machines to pachinko parlors, which had a more divided market structure. The industry was high-tech with frequent model changes, and there were approximately 2000 pachinko machine-related patents at the time.

In 1961, the ten manufacturers jointly established the “Japan Association for Patent Management on Game Machines” (my unofficial translation). The member firms commissioned this association to license their patents, have the licensees show licensing seals on pachinko machines, and collect royalties. In short, the association acted as a patent pool. However, the association licensed to only 19 incumbent firms (including the 10 member firms) and refused to license the patents to newcomers to prevent entry. In 1997, the JFTC ruled that this behavior had substantially restrained competition by excluding the activity of new firms that intended to manufacture pachinko machines. The behavior could not be considered as the rightful “exercise of rights under the Patent Law,” and hence, the behavior violated AMA’s prohibition of private monopolization. JFTC ordered the association to dissolve.

[20]Formally, “Guidelines for the Use of Intellectual Property Under the Anti-Monopoly Act,” first issued in 2007 and most recently revised in January 2016. The quotation in the text is from Part 2, (1).

That is, JFTC concluded that the behavior of the association and the member firms did "deviate from or run counter to the intent and objectives of the intellectual property systems." The *IP Guidelines* published after this case state:

> In a case where entrepreneurs participating in a patent pool refuse to grant a license to any new entrant or any particular existing entrepreneurs without any reasonable grounds, to hinder it from using the technology, the restriction may fall under the exclusion of business activities of other entrepreneurs. (*IP Guidelines,* Part 3, (1), (i), (a))

Typically,

> Restrictions by the right-holder to a technology such as not to grant a license for the use of the technology to an entrepreneur (including cases where the royalties requested are prohibitively expensive and the licensor's conduct is in effect equivalent to a refusal to license; hereinafter the same shall apply) or to file a lawsuit to seek an injunction against any unlicensed entrepreneur using the technology are seen as an exercise of rights and do not, normally, constitute a problem. (*IP Guidelines*, Part 3, (1), (i))

For example, although Intel has a dominant market share in the CPU market and refuses to license its patents to potential entrants, such a refusal has been considered a rightful exercise of patent right.

However, in the Pachinko Machine case, the ten firms that, together, dominated the market undertook collusive action by forming a patent pool and refusing to license to outsiders. It is presumably with this fact that the JFTC concluded that the firms "deviated from or ran counter to the intent and objectives of intellectual property systems."

2.4.3 Standard Setting

Today, in many industries, particularly in information and communication technology (ICT) industries, standards play an indispensable role in maintaining compatibility among the products of various manufacturers and service providers. In many cases, competitors form a standard-setting organization (SSO) to determine a necessary standard. In some cases, a small number of competitors form an SSO, and the standard-setting process is confidential. In other cases, many competitors, as well as the suppliers of complementary technologies or products and, possibly, universities and governments, join to form an SSO, and the standard-setting process is open.

In this sense, standard setting represents collaborative conduct and yet, typically, is socially beneficial. Thus, the JFTC states in its *Standardization and Patent Pool Guidelines*[21]:

> Although the standardization of specifications determines the functions or performances of the products with specifications, by accepting compatibility among the new products it

[21] Formally, "Guidelines on Standardization and Patent Pool Arrangements," first issued in 2005 and most recently revised in 2007. The citation is from Part 2, 2.

> enables speedy commercialization and expansion of demand, and this contributes to greater consumer convenience. As such, standardization of specifications by competitors is not assumed to pose legal issues with the AMA. However if the activity restricts competition in related markets or threatens to impede fair competition with restrictions as follows it poses the regal *[sic]* issues with the AMA.

As such restrictions, the guideline raises (1) restriction of prices of new products with the specifications, (2) restriction of development of alternative specifications, (3) unreasonable extension of the scope of specifications, (4) unreasonable exclusion of technical proposals from competitors, and (5) exclusion of competitors from the activities.

A closely related issue is the licensing of standard essential patents (SEP), that is, those patents that are considered or claimed essential in producing and supplying the products or services that comply with the standards. Typically, to avoid the holders of SEP demanding exorbitant royalties, an SSO requires its SEP holders to declare its intention to license under the FRAND conditions, that is, fair, reasonable, and nondiscriminatory conditions.

A FRAND declaration is a useful practice to avoid the holdup problem, which refers to the disincentive for the implementers of the standard to invest in development and production for fear of receiving *ex-post* unreasonable royalty demands. Therefore, a FRAND declaration is expected to contribute to the widespread implementation of the standard and, consequently, more competitive product markets.

The concern of competition authorities is whether those who declared FRAND are really offering "fair, reasonable, and nondiscriminatory" licensing conditions. Refusing licensing or seeking a court injunction can particularly conflict with the FRAND declaration and cause anticompetitive effects.

The JFTC revised its *IP Guidelines* in 2016 and added the following paragraph:

> Refusal to license or bringing an action for injunction against a party who is willing to take a license by a FRAND-encumbered Standard Essential Patent holder, or refusal to license or bringing an action for injunction against a party who is willing to take a license by a FRAND-encumbered Standard Essential Patent holder after the withdrawal of the FRAND Declaration for that Standard Essential Patent may fall under the exclusion of business activities of other entrepreneurs by making it difficult to research & develop, produce, or sell the products adopting the standards. (*IP Guidelines*, Part 3, (1), (i), (e))

Therefore, such an act may be considered private monopolization and in violation of the AMA. Additionally, if the act impedes fair competition, it may be considered an unfair trade practice (if not private monopolization) again in violation of AMA.[22]

Whether a royalty is "fair, reasonable, and nondiscriminatory" is a moot question. There has not been a JFTC case that answers this question. However, the following private litigation case tackled the complexity of this subject, and the court decision will undoubtedly become influential.

[22] See *IP Guidelines*, Part 4, (2), (iv).

Case 9: Apple Japan Versus Samsung Electronics (Decision at the Intellectual Property High Court, May 16, 2014)[23]

Samsung Electronics alleged that the production, assignment, and import of Apple products (including iPhone 4) by Apple Japan constituted an infringement of the patent right of Samsung Electronics (patent right for the patent to the invention titled "method and apparatus for transmitting/receiving packet data using pre-defined length indicator in a mobile communication system") and filed a petition for a provisional disposition order for an injunction against the production, etc. of products by Apple Japan. In response to this petition, Apple Japan alleged that its production, etc. of the products did not constitute infringement of the patent right of Samsung Electronics and sought a declaratory judgment to confirm that Samsung Electronics was not entitled to seek damages.

The products conformed to the UMTS (Universal Mobile Telecommunications System) standard, which is the telecommunications standard developed by 3GPP (Third Generation Partnership Project). ETSI (European Telecommunications Standards Institute), one of the standard-setting organizations that established 3GPP, provides the "Intellectual Property Rights Policy" as the guidelines for the treatment of intellectual property rights (IPRs). On August 7, 2007, Samsung Electronics, in accordance with the ETSI IPR Policy, notified ETSI that its IPRs, including the above-mentioned patent right, were or were highly likely to be essential IPRs for the UMTS standard with an undertaking that it was prepared to grant an irrevocable license on FRAND terms and conditions.

The Intellectual Property High Court of Japan concluded in its decision that the exercise of the right by Samsung Electronics to seek an injunction constitutes the abuse of right (according to the Civil Code). The court said:

> A party intending to engage in the manufacturing, sale, etc. of a UMTS standard-compliant product would recognize that, among the patent rights essential for the manufacturing, sale, etc. of such product, at least those owned by ETSI members, require the timely disclosure in accordance with ETSI IPR Policy Clause 4.1 and the FRAND licensing declaration under ETSI IPR Policy Clause 6.1. Such party would rely on the availability of a FRAND license through an appropriate negotiation with the patent holders and such reliance is worth protecting. Accordingly, in connection with the Patent subject to the FRAND Declaration, allowing the unconditional exercise of the right to seek an injunction would be detrimental to the reliance of parties who manufacture or sell the UMTS standard-compliant product based on the availability of such license.

The court determined that the claim for damages filed by Samsung Electronics constituted the abuse of rights to the extent exceeding the amount of the FRAND royalty but not to the extent of the amount not exceeding the FRAND royalty. To calculate the amount of the FRAND royalty, the court looked at three figures: (1)

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[23]The English description of Case 9 is mostly taken from the JFTC's contribution at the OECD Competition Committee roundtable titled "Intellectual Property and Standard Setting: Note by Japan," OECD DAF/COMP/WD(2014)114, November 2014. (http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DAF/COMP/WD(2014)114&doclanguage=en).

the percentage of the contribution of the compliance with the UMTS standard to the sales turnover of the products, denoted by A (undisclosed); (2) the aggregate royalty rate cap which, in line with the industry norm, was set at 5%; and (3) the number of UMTS standard essential patents, which was 529, assuming that the contribution ratio of each patent was the same.

The court then determined the appropriate royalty rate (percentage) as $A \times 5 \div 529$. Multiplying this percentage by the total sales of the product, the court ordered Apple Japan to pay 9,955,854 yen (approximately 71,000 euros) as the FRAND royalty.

Since the decision was announced, the adequacy of the amount or of the calculation method has been the subject of heated discussions among many practitioners and academics in Japan. However, as the only court case that has calculated the FRAND rate, it is expected to remain influential in the coming years.

2.5 Patents in a Merger Case

For business combination regulation, the JFTC may investigate the likelihood that merging firms substantially restrain competition through their combined ownership of IP, such as patents.

Case 10: Acquisition of a Vending Machine Business by Fuji Electric of Sanyo (2002)
Fuji Electric proposed the acquisition of the entire share of Sanyo's vending machine subsidiary. Fuji and Sanyo were, respectively, the top and second largest makers of vending machines for drinks with a combined market share of approximately 55%. With two other firms, the four-firm concentration ratio was over 80%. However, the buyers of the machines were drink makers, some of which, like Japan Coca-Cola, were large firms with significant bargaining power over the vending machine makers. In the hearings by the JFTC, the drink makers stated that if Fuji/Sanyo raised the price of the machines, they would not hesitate to switch to competitor suppliers including entrants.

However, the JFTC realized that the combined patents of Fuji and Sanyo accounted for approximately 40% of all the patents related to vending machines, which might create a technological barrier insurmountable to new entrants, thereby restraining competition and resulting in the persistent dominance of Fuji-Sanyo. In response to this concern expressed by the JFTC, Fuji proposed that it would license its patents with reasonable conditions in case any competitor requested such licensing. The JFTC considered this proposed remedy satisfactory and agreed to the acquisition.

Several years later, the JFTC conducted a follow-up study and found that, by 2007, no firm had requested licensing. Why? In response to a JFTC inquiry, one competitor replied that they were unaware of this remedy. This fact suggests that the JFTC should have compelled the merging firms to announce more widely their intention to license the patents under a FRAND condition. Some of the other competitors stated that they did not seek the license because the patents did not prevent them from making machines required by the buyers. It is well known that, in many industries, patents are not always a strong mechanism for inventors to secure profits from their inventions.[24] The vending machine industry appears to be such an industry. In contrast, in some industries, most notably pharmaceuticals, patents are known to be powerful. Thus, in these industries, licensing may prove an effective remedy to mergers that could otherwise have an anticompetitive effect.[25]

2.6 Conclusion

This study, first, provided an introductory account of competition policy in Japan, both from a legal and economic perspective, with several real cases. Second, the study showed how competition policy can be implemented to promote innovation and dynamic competition.

I will close this chapter with three general remarks.

First, the relationship between competition policy and innovation is not straightforward. There is a trade-off between static efficiency achieved through a competitive market structure and dynamic efficiency achieved through innovation. Such a trade-off is discussed in two respects, one related to the R&D investment and the other related to patents (or, more generally, intellectual property rights).[26] For R&D, proponents of the Schumpeterian hypothesis argue that monopolistic firms have more incentive and greater financial and technical resources for R&D, and therefore, innovation is more likely under monopolistic conditions. This argument has been questioned, and as discussed in Sect. 2.1, it is accepted that a certain level of competition, if not perfect competition, is desirable for active R&D. This fact is considered in the implementation of competition policy in Japan and other countries, including merger reviews. Also, competition agencies now allow firms to collaborate in R&D unless there is an anticompetitive intention or effect.

For patents, a stronger patent is desirable to give firms more incentive to engage in R&D, but a weaker patent is desirable for wider dissemination and active entry. Although it is basically the issue of the design of the patent system, such as the

[24] See the following survey studies: in the USA, the Yale survey and the follow-up Carnegie-Mellon survey (Cohen et al. 2000) and, in Japan, the National Innovation Survey (Ijichi and Odagiri 2006).

[25] The vending machine case and the follow-up study suggest the importance of ex-post evaluation of the activities by competition agencies. The OECD, in April 2016, published a "Reference Guide on Ex-post Evaluation of Competition Agencies' Enforcement decisions," for which merger review is one of the major topics. The reference guide and related documents can be accessed at the following site. http://www.oecd.org/daf/competition/reference-guide-on-ex-post-evaluation-of-enforcement-decisions.htm.

[26] For a textbook discussion of the trade-off, see Cabral (2000).

breadth of patent scope and the length of patent protection, to achieve the best balance between the two opposing purposes, competition agencies have been also attempting to tackle cases in related issues such as standard essential patents, patent trolls, and pay-for-delay.[27] Through such cases, competition agencies can accumulate more expertise, and businesses can gain a fuller understanding of the right balance between the exercise of patent rights and the maintenance of fair competition.

Second, economic theories and empirical methodologies have progressed rapidly in the past decade or two, providing a richer stock of knowledge with which to pursue competition policy. In many cases, except for hard-core cartels, the boundary between the legitimate strategic moves of firms and their anticompetitive behavior is not always clear. However, we are now equipped with more analytical tools based on economic theories, often accompanied by quantitative analyses. The increasing collaboration between economists, legal experts, and authorities has been useful. The chapters in the remainder of this book are devoted to economic analyses; therefore, I hope that these analyses provide a broader understanding of competition policy.

Third and lastly, competition policy cannot be pursued independently. I have already discussed that competition policy is closely related to patent policy. Other policies to promote innovation, including those aimed at the promotion of scientific research and entrepreneurial activity, can also affect market competition. Regulation in such fields as transportation, telecommunications, electric power, and other public utilities is still prevalent, and the promotion of competition is needed. Laws on business establishment and laws on factory location must be designed to avoid barriers to entry and the hindering of competition. For these and other policy legislations, competition policy concerns must be expressed and incorporated, and it is essential that policymakers and the public recognize the role of competition policy. This book provides a step in this direction.

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[27]These issues are discussed in detail in my recent book in Japanese (Odagiri 2016).

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Chapter 3
An Empirical Analysis of the Determinants of Collusion

Masato Nishiwaki

Abstract The aim of this study is to provide empirical evidence useful for the detection and prevention of collusion. Specifically, this study identifies which factors are related to the probability of collusion using cartel cases detected and prosecuted by the Japan Fair Trade Commission. This study highlights vertical integration between upstream and downstream firms as a factor potentially influencing the incentive to collude in addition to well-known factors such as the number of firms and asymmetry among firms. The estimation result is that the extent of vertical integration is positively related with the probability of (upstream) collusion. This empirical finding supports the antitrust authority's concern that vertical integration facilitates collusion.

Keywords Antitrust policy • Collusion • Vertical integration

3.1 Introduction

Collusion is central to the research field of Industrial Organization (IO). Almost all standard textbooks on IO address collusion and related subjects. In representative textbooks, including Tirole (1988), Vives (1999), Odagiri (2001), Motta (2004), Whinston (2006), and Belleflamme and Peitz (2010), a considerable number of pages is devoted to the theory of collusion, its consequences, and the policy implications. Collusion is also a major subject of both theoretical and empirical articles in leading IO journals such as *the RAND Journal of Economics* and *the Journal of Industrial Economics* with almost one associated article published in every issue.

The interest of IO economists' in collusion reflects public policy concerns. Detecting and preventing collusion is a pressing policy issue for antitrust agencies in almost all developed countries including the EU, the UK, the US, and Japan. One prominent policy to detect collusion is a leniency program, which has been

M. Nishiwaki (✉)
Graduate School of Economics, Osaka University, 1-7 Machikaneyama, Toyonaka, Osaka 560-0043, Japan
e-mail: m.nishiwaki@econ.osaka-u.ac.jp

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introduced in these countries. A leniency program induces colluding firms to confess to ongoing collusion. Leniency programs will promote the detection of collusion and reduce the incentive for firms to collude. Efforts to prevent market environments where firms can easily collude have been made along with detection policies. Antitrust agencies regulate firm conduct leading to environments such as less competitors, too much concentration, and sensible information transparency. For example, through merger regulations, antitrust agencies try to avoid environments favorable for collusion in advance.

Against this background, what can IO economists contribute to help combat collusion? Although IO economists can potentially help antitrust authorities by providing both theoretical and empirical models, the role of empirical work is emphasized in this study. In recent years, interest in using empirical tools to detect collusion has been increasing. For example, the OECD Competition Committee discusses the use of screens to detect cartels.[1] Therefore, the above question is whether IO economists can detect ongoing collusion given data and/or can provide guidance to prevent future collusion given data. Recent developments in IO have provided empirical tools and enabled the identification of collusion in a statistical sense.

The approach employed in IO to detect and prevent collusion is classified into two categories. The first category is behavioral and the second is structural.[2] A behavioral approach observes market and/or individual firms' outcomes such as transaction results, submitted bids, and prices or quantities supplied. This approach presumes that market and/or individual firms' outcomes reflect underlying firms' decision-making. Very often guided by economic theories (rationales) that provide insight into the type of behavior that is unlikely to arise in competitive environments, a structural approach distinguishes between competition and collusion. More concretely, a behavioral approach identifies patterns in data that are not generated by competitive behavior and predicts the presence of collusion. Representative work that can, to the best of my knowledge, be categorized into this approach are Porter and Zona (1994, 1999), Bajari and Ye (2003), and Kawai and Nakabayashi (2015).

The second approach is structural. While a behavioral approach directly and literally looks at firms' behavior and the resulting outcomes, a structural approach is a more fundamental approach to collusion. A structural approach lists market or industry characteristics that are favorable for collusion and, using the list, determines which markets or industries are more susceptible to collusion than others. For instance, collusion is more likely to occur in an industry with many of the listed characteristics related to collusion. The focus of a structural approach is the structure of the targeted industries and markets, not the conduct and outcomes of the industries and markets.

[1]OECD Policy Roundtables 2013: "Ex officio cartel investigations and the use of screens to detect cartels."

[2]Terminologies are borrowed from Harrington (2008).

For the detection of ongoing collusion, a structural approach is less suitable than a behavioral approach, as noted by Harrington (2008). The reason is that if an industry has all the listed favorable traits for collusion, such as few firms, a homogeneous product, and stable demand, strong evidence is still required to conclude that collusion is occurring. However, if high and stable prices and stable market shares are occurring despite variations in demand and supply factors, firms could be suspected of colluding.

Although a structural approach may not directly discover collusion, it helps antitrust agencies take precautionary actions. That is, the virtue of a structural approach is to help agencies prevent market environments where firms can easily coordinate and collude. A typical example where a structural approach can guide is a situation where antitrust agencies must examine whether a change in market structure associated with a proposed merger causes a market structure facilitating firms to collude. If the resulting structure is favorable for collusion, the proposed merger should be blocked or only approved with remedies.

A structural approach assists antitrust agencies in flagging certain dangerous market structures. However, to assess markets based on their characteristics and flag a market as dangerous, antitrust agencies need to identify the factors that facilitate collusion. This study conducts the identification of factors favorable to collusive behavior using real-world data. Particularly, this study provides empirical evidence of factors related to collusion in Japan and assists Japan's antitrust agencies in listing which market structures should be avoided.

This study uses cartel cases in the Japanese cement industry as a case study. Firms formed illegal cartels in different markets of the cement industry at different times, and the Japan Fair Trade Commission (JFTC) detected and prosecuted (some or possibly all of) these cartels. Different cement markets have variations in the number and size of firms and variations in the demand and cost conditions. By taking advantage of the differences in market structure, I estimate the causal relationship between collusion and market structure.

The empirical analysis in this study is novel for two reasons. This current study explores how vertical integration affects the likelihood of cartels. In the context of the Japanese cement industry, whether vertical integration between a cement firm in the upstream market and concrete firms in the downstream market is related with upstream collusion is analyzed. The relationship between vertical integration and collusion in vertically related industries is a relatively new research topic in the IO literature. To date, only a few theoretical studies address the possibility that vertical integration facilitates collusion. These studies include Nocke and White (2007, 2011) and Normann (2009). To the best of my knowledge, the current study is the first empirical study of its kind.

Second, using the new developments in econometrics, this study rigorously addresses data error, which inevitably arises when cartel cases are analyzed. The problem facing IO researchers is that established cartels cannot be observed and any analysis is limited to antitrust agency cartel cases. In this chapter, I observe cartel cases in the cement industry, which were detected and prosecuted by the JFTC. However, I cannot observe cartels *not* detected by the antitrust agency. Additionally, the possibility exists that the JFTC mistakenly prosecuted firms for collusion. These errors in cartel investigation processes lead to data error. In the current study, I resolve this data problem with the misclassification approach of Abrevaya et al. (1998) and obtain consistent estimates of the effect of various factors on cartel probability.

3.2 A Brief Review of Collusion Theory and Factors Facilitating Collusion

Before proceeding to the analysis, this section provides a brief overview of collusion theory and explains how various market characteristics affect firms' incentive to collude by providing well-known examples including the number of firms, firm asymmetry, and demand fluctuation. In addition to the introduction of collusion theory and the representative market factors, I also introduce the focus of this chapter, that is, the effect of vertical integration on the possibility of collusion.

3.2.1 A Brief Review of Collusion Theory

In collusion theory, to analyze firms' incentive to collude in various market conditions, IO economists consider the three driving forces of collusion: the benefits of collusion, the benefits of cheating (deviating from the collusion), and the severity of punishment after cheating (deviating).

When firms attempt to coordinate their actions, mainly for pricing or supplying decisions, first, they must consider the (future) profit expected from colluding. For example, they may set a monopoly price in every period and gain the monopoly profit (and then share the monopoly profit among colluding members). In this case, the higher the collusive profit, the greater the incentive to collude because, holding other factors constant, there is a greater benefit of collusion. This is the first driving force motivating firms to engage in collusion.

On the other hand, a high price realized by coordinating behavior always tempts firms engaging in collusion to deviate from the collusive agreement, because, given that the other firms set the monopoly (or a high) price, the firm can gain more profit by cutting its own price just slightly; sometimes the firm may be able to supply the total market demand. This implies that a high price realized by collusion tempts firms to cheat and renders collusion difficult to sustain. If the benefits of cheating are greater, it is less likely that firms will coordinate their actions. This is the second force influencing firms' incentive to collude.

The benefits of cheating make collusion unsustainable. Therefore, collusion must have a scheme to deter cheating by punishing the cheaters. For instance, after a firm cheats, the other firms reduce their prices to a certain level so that the cheater can only realize a lower profit than the profit obtained if the cheater continued to collude. In this case, lowering prices and reducing the cheater's profit are effective punishments. Further, the severity of the punishment is determined by the difference between the (future) profit and the profit during the punishment phase. If firms set lower prices and induce lower profit in the punishment phase, the punishment becomes more severe and effective. The severity of punishment is the third relevant force driving collusion.

These three forces are central to understanding firms' incentive to collude and are summarized in the following expression. Let Π^m be the collusive profit, Π^d be the benefit of deviating from collusion, and $K = V^m - V^p$ be the punishment. V^m is the future profit if firms continue colluding, and V^p is the future profit in the punishment phase. How these three forces interact with each other is described in the following relationship:

$$\Pi^m \quad \text{v.s.} \quad \Pi^d - K. \tag{3.1}$$

Whether firms collude depends on which side is larger. If the left-hand side is larger, that is, $\Pi^m > \Pi^d - K$, firms will collude. Conversely, if $\Pi^m < \Pi^d - K$, firms will not engage in collusion because the benefit of collusion is less than the deviation profit and punishment.

The relationship between Π^m and $\Pi^d - K$ explains how each force affects firms' incentive to collude. When Π^m becomes larger (holding other factors Π^d and K constant), firms are more likely to collude. On the other hand, when the benefit of deviation increases, firms are less likely to collude. Additionally, the more severe the punishment implying that K becomes larger, the easier collusion is to establish, because a cheater is severely punished with a lower profit.

3.2.2 *Examples of Factors Influencing the Incentive for Collusion*

In this subsection, I introduce well-known factors facilitating collusion, including the number of firms, firm asymmetry, fluctuations in demand, and the focus of this study, that is, vertical integration.

First, I analyze the effect of the number of firms on firms' incentive to collude. As the number of firms colluding increases, the firms find less benefit from collusion because the collusive profit is shared among the cartel members. Therefore, Π^m is reduced. On the other hand, if a firm cheats by cutting its price, the firm receives the monopoly profit, because the firm set the lowest price.[3] The deviation profit does not depend on the number of firms: regardless of the number of firms, the

[3]In this argument, it is assumed that firms compete in price without capacity constraint in the punishment phase. However, the conclusion does not change in the case of firms competing in quantity.

deviation profit Π^d is constant. Finally, punishment after the deviation K is reduced because the future collusive profit V^m is shared by the members and decreases with the number of firms (remember that $K = V^m - V^p$). Therefore, the number of firms has a negative influence on collusion incentive.

Firms' asymmetries in size and unit costs affect the incentive for collusion.[4] If firms are heterogeneous, each firm faces a different incentive problem. This implies that a collusive agreement must satisfy each firm's incentive condition, which is described in (3.1). If firms are homogeneous, that is, they have the same costs, the cartel agreement only satisfies the need to solve one incentive problem because the firms are the same and must have the same incentive problem when considering colluding. In general, satisfying only one incentive problem is easier.

Fluctuation in demand also affects the incentive for collusion. A market is often affected by a demand shock, which shifts the market demand function up or down. The question is whether firms are more likely to collude during a high or low demand period.[5] High demand increases the deviation profit gained and the collusive profit at that time. However, the difference between the deviation profit and the collusive profit increases in the demand level.[6] On the other hand, when demand shocks in the current and future periods are not correlated, the future profits of collusion, profits from the punishment period from the high demand period, and profits from the low demand period are the same.[7] That is, regardless of the current realization of the level of demand, the future collusive profit V^m is constant and thus K is also constant. Therefore, demand fluctuation affects only the difference between the current collusive profit Π^m and the deviation profit Π^d. High demand increases and low demand decreases the difference between the current collusive profit and the deviation profit. This implies that when demand is high, firms are more tempted to deviate, and, thus, it is more difficult to collude with high demand.

In addition to these well-known factors, the focus of the current study is explained. As mentioned in the introduction, this study is first to highlight the possibility that vertical integration affects upstream collusion. This view on whether the vertical relationship is related to collusion is relatively new in the academic

[4]This argument is based on Motta (2004) and Vasconcelos (2005).

[5]This argument is based on the work of Rotemberg and Saloner (1986).

[6]Let $\Pi^d = N\Pi^m$(N is the number of firms). The difference between Π^d and Π^m is $(N-1)\Pi^m$. This difference is increasing with demand level.

[7]Kandori (1991) generalized this independence assumption on demand fluctuation by introducing more realistic assumption on demand fluctuation.

world.[8] Nocke and White (2007) is a seminal (theoretical) work, which was followed by Normann (2009) and again by Nocke and White (2011).

The basic insight of Nocke and White (2007) is that vertical integration has two opposing effects on collusion. The first effect is that vertical integration has a punishment effect on integrated firms. In a punishment phase, firms are less severely punished in cases where they integrate downstream firms than in cases where they do not integrate downstream firms, because integrated firms can gain some profits from their downstream affiliates even in the punishment phase. Because of additional profits from their downstream affiliates, vertical integration increases the integrated firms' incentive to deviate from a cartel agreement.

The second effect is an outlet effect for unintegrated firms. For unintegrated firms, vertical integration increases their incentive to collude because a gain from deviating from collusion is reduced by the presence of integrated (downstream) firms. When they deviate, unintegrated firms attempt to steal rival firms' customers. However, when some downstream firms are integrated into upstream firms, the unintegrated firms cannot sell their product to the integrated downstream firms (or it is difficult for them to attract integrated downstream firms). Therefore, unintegrated firms' incentive to deviate from collusion is reduced.

The above argument on the punishment and outlet effects is clarified by the relationship (3.1). First, the punishment effect reduces K in (3.1) because an integrated firm can sell its downstream affiliates even after it deviates and is not severely punished. Because of this effect, the right-hand-side variable tends to be higher, and the integrated firm's incentive for collusion lessens. Thus, collusion becomes more difficult under vertical integration.

On the other hand, the outlet effect reduces Π^d in (3.1) because unintegrated firms cannot sell downstream firms integrated by other firms and, thus, gain the entire market demand when they deviate from collusion. The reduction in Π^d means that the right-hand-side variable is reduced and unintegrated firms have more incentive to collude.

In summary, the punishment effect increases the right-hand-side variable, while the outlet effect reduces the right-hand-side variable. These two opposing effects mean that the effect of vertical integration on collusion is not decisive in general. With this theoretical ambiguity in mind, this study empirically examines whether

[8] Although the coordinated effect is new to IO economists, antitrust authorities have been concerned about the possibility that strengthening the vertical relationship between upstream firms and downstream firms facilitates collusive behavior. For instance, with respect to the extreme form of vertical relationships, that is, vertical mergers, antitrust agencies share concerns with the effects on upstream collusion. In the Non-horizontal Merger Guidelines, the US Department of Justice states the following: (1) "A high level of vertical integration by upstream firms into the associated retail market may facilitate collusion in the upstream market by making it easier to monitor price," and (2) "The elimination by a vertical merger of a particularly disruptive buyer in a downstream market may facilitate collusion in the upstream market." Similar statements are seen in the Non-horizontal Merger Guidelines of the European Commission (EC) in the EU, the Competition Commission (CC) in the UK, and the JFTC.

vertical integration facilitates collusion. To the best of my knowledge, this study is one of the first to empirically investigate collusion in the context of vertically related industries.[9] More precisely, this study tests whether the number of vertically integrated downstream firms affects the probability of collusion among upstream firms and tests whether the (total) size of these firms affects the upstream collusion probability.

3.3 Previous Studies and Features in This Paper

The purpose of this study is to identify factors facilitating collusion in the Japanese context. Identifying factors facilitating collusion has a long history in the literature of empirical IO. The empirical research on pro-collusive factors is categorized into two groups in terms of the data used. The first group of work uses antitrust illegal cartel cases or legal cartels as the explained variable. These studies identify the factors that influence the occurrence of cartels. A seminal work is Hay and Kelley (1974). They use price-fixing cases in the USA and examine the relationship between price-fixing cases and factors including the number of firms, product homogeneity, demand elasticity, and firm symmetry. Symeonidis (2003) exploits legal cartels in the UK manufacturing industries and examines factors promoting firms applications for cartels. Kudo and Odagiri (2014) conduct a cross-industry analysis of cartel frequencies in Japan using cartel cases detected in the Japanese manufacturing industries by the JFTC. More recently, Nishiwaki (2016b) takes advantage of illegal cartel cases detected in different regional markets in different periods in the Japanese cement industry and estimates bounds on the effects of factors influencing the cartel probability by developing a novel approach.

Another group of empirical studies use price and/or quantity data. The seminal work is Rotemberg and Saloner (1986), which examine the relationship between demand and pricing behaviors in the US cement industry. Ellison (1994) analyzes what causes price wars during the cartel periods in the US railroad industry and tests whether Green and Porter's (1984) theory can be applied to the railroad cartel. On the other hand, Evans and Kessides (1994) focus on the role of multi-market contacts on collusive behavior in the US airline industry. Nishiwaki (2016a) is a representative empirical study on a Japanese industry. He uses the Japanese and cement industries to explore whether the vertical relationship between the two industries causes collusive behavior in upstream.

The analysis conducted in this study belongs to the first group. The objective is to analyze factors facilitating collusion by using illegal cartel cases in Japan. In this sense, this study and Kudo and Odagiri (2014) share a common goal: both studies

[9]Nishiwaki (2016a) and Nishiwaki (2016b) also empirically test the causal relationship between vertical integration and upstream collusion in the Japanese cement and concrete industries.

explore the causes of illegal cartels in Japan. The main difference between the two studies is that Kudo and Odagiri (2014) examine all manufacturing industries in Japan, while this study focuses on cartels in a single industry.[10] One study is comprehensive while the other one is more restrictive.[11] The benefits of restricting attention to a single industry are threefold.

First, by doing so, it is easier to collect data for the study. It is typically more difficult to collect information across industries as the number of industries studied increases. Consequently, some important variables, which affect collusion possibility, may be dropped, or some industries may be excluded from the empirical models. The first problem leads to omitted variable biases in the estimation, while the second problem can potentially cause selectivity bias. A study focusing on a single industry suffers less from these problems. The second reason is related to the first reason, which is that (the problems of) unobserved factors can be addressed more easily. Focusing on a single industry allows better access to instrumental variables to control endogenous variables. Third, there is no need for a strong assumption on parameter homogeneity when examining a single industry. Different variables affect collusion in different ways depending on the industry. Despite these heterogeneities, cross-industry studies place the homogeneity assumption in parameter values. This homogeneity assumption in parameter values is often not realistic and is not acceptable in general. The assumption leads to a specification error in the empirical models. Studies focusing on a single industry without the homogeneity assumption do not suffer this type of error.

3.4 The Cement Industry and Cartel Cases

The section provides an introduction to the Japanese cement industry and cartel cases formed and detected by the JFTC in this industry.

3.4.1 The Cement Industry

Cement is the key ingredient of concrete, which is used as construction material for skyscrapers, roadways, railways, airports, seaports, and other infrastructures. During the 1970s and 1980s, which is the period studied on this study, there were around 25 cement firms in Japan. Cement is produced in cement plants, which tend

[10] Nishiwaki's (2016a) aim is to develop a new approach to identifying cartel probability from by applying the concept of partial identification although he applies his approach to identify the effects of factors facilitating collusion.

[11] Hay and Kelley (1974) and Symeonidis (2003) are also comprehensive studies. The reason that cross-industries study is popular is that cartels are in general rare events and not observed too much within a single industry.

to be located where there are abundant reserves of limestone.[12] Once cement is produced in a plant, it is typically delivered by ship to distribution centers, called "service stations," in regional markets. Cement service stations (SSs) are located mainly along the coast and have silos for cement storage. Service stations connect cement plants with local customers and play a key role in the cement supply chain in Japan.

Within an individual region, a cement firm carries its product from its service stations to local consumers, that is concrete plants, by truck. This stage of the transportation from service stations to consumers is called "secondary-stage delivery," whereas transportation from plants to service stations is "primary-stage delivery." The transportation costs of the secondary stage are sufficiently high to prevent firms from delivering their product to customers far from a service station. Due to this high transportation costs in the secondary delivery stage, competition in the cement industry is localized.

Cement firms conduct business in some or all of these regions and have local headquarters in the regions. The management at local headquarters is responsible for supplying and selling cement in the regions. A region consists of several prefectures (provinces) except the Hokkaido region where there is only one prefecture. On average, there are 9.8 firms in an individual prefecture.

Around 70% of the cement produced in Japan is delivered to the concrete industry. Concrete plants produce ready-mixed concrete. The second biggest customer of the cement industry is the cement- and concrete-related products industries including blocks, tiles, and other concrete products. The demand accounts for approximately 10% of total cement shipments. Overall, at least 80% of cement produced is consumed in the above two industries.[13]

Cement is shipped (from plants and SSs to customers' location) packed or bulk. Over 90% of cement produced at plants is shipped as bulk cement. Firms deliver bulk cement using trucks specifically made for cement delivery. The average price of bulk cement during the period studied is approximately 13,000 yen per ton. The remaining cement (less than 10% of cement produced) is delivered as packed cement. A unit of packed cement is 25kg and its average price is approximately 650 yen.

As noted above, the cement industry has a close connection with concrete industry. The concrete industry is a downstream industry of the cement industry. Concrete firms use cement as an input for their production. Concrete is a perishable good and can only be delivered over small distances. Competition in the concrete

[12]This means that in Japan, the Chugoku, Hokkaido, and Kyushu areas account for an overwhelming proportion of cement production.

[13]The remainder cement is consumed in various sectors. However, all the sectors are marginal. No single sector accounts for more than 1% of the total cement consumption except public works with a share of approximately 4%.

industry is, therefore, localized. This study defines a local concrete market as a prefecture (although a finer market definition may be more appropriate for the industry's competition considering that ideal delivery distances are between 30- and 45-min drives from the concrete plant).

Compared to cement firms, concrete firms are small and most are single-plant firms. Within an individual concrete market, the average number of concrete plants was around 100 during the period studied. The number of concrete plants, which has a vertical relationship with cement firms, is approximately 20 on average within a prefecture. In the following sections, the fraction of vertically integrated concrete firms within a prefecture is used as a measure for the extent of vertical integration.

Concrete plants are heterogeneous in size (capacity), although their products are homogeneous. Concrete plants that are vertically integrated by cement firms tend to be much larger than unintegrated plants. Therefore, to measure the extent of vertical integration in the downstream industry more accurately, the difference in plant size should be reflected. Therefore, I use the fraction of vertically integrated concrete plants in terms of the number of vertically integrated concrete plants, which is defined previously, and in terms of the capacity of the plants in the estimation as variables indicating the extent of vertical integration in the downstream.

3.4.2 Cartel Cases in the Cement Industry

Cement firms engaged in cartels in different markets and in different periods. The JFTC detected some (possibly all) of them.

In 1973, cement firms formed cartels in all markets. All local managers of all cement firms gathered at the Japan's cement association. Managers in each region discussed their prices in the region to fix prices.

In 1981, cartels were formed in three different regions: Hiroshima and Okayama prefectures in the Chugoku region; Shiga, Wakayama, Nara, Kyoto, Osaka, and Hyogo prefectures in the Kinki region; and Tokyo, Kanagawa, Chiba, and Saitama prefectures in the (southern) Kanto region. In the Kinki region (Shiga, Wakayama, Nara, Kyoto, Osaka, and Hyogo prefectures), the local sales managers of 13 cement firms that were conducting their business in this region held meetings at the Kansai Electric Power Company Building. In the meetings held on September and October in 1981, the sales managers decided to raise bulk and packed cement prices in the region. On September 16, the firms agreed to raise the packed cement price from the next month, and, on October 13, the firms also decided to raise bulk cement price.

To sustain the cartel prices, the firms reduced the total amount of monthly cement supply by 20% compared to the previous year. Additionally, to determine whether each cartel member followed the cartel agreement on price and quantity, the firms monitored each other's action. Cartel members checked the amounts of cement supplied by monitoring each other's SSs when firms dispatched cement. To check whether each firm set the agreed price, cement firms used their downstream affiliates. Firms cross-supplied cement to their downstream affiliates: a firm supplied its product not to its downstream affiliates but to the other members' downstream affiliates so that the other members could determine if any firm undercut the cartel price.

In Okayama and Hiroshima prefectures, nine cement firms formed a cartel. On October 16, at the Hiroshima Kokusai Hotel, local managers of the nine cement firms reached a cartel agreement on packed cement prices for the two prefectures. On November 15, they also decided to collude on bulk cement prices in these two prefectures. The means employed to sustain the cartel were effectively the same as those employed in the Kinki region. Firms reduced the amount of cement supplied monthly to 70% of that of the previous year. Firms monitored each member's supply by looking at their SSs. Additionally, firms cross-supplied their cement to downstream affiliates monitoring whether other firms set the cartel price.

In the southern Kanto region, local sales managers of nine cement firms operating in this region met at the Sankei building on August 1981. At the first meeting, they decided to raise cement prices. At the second meeting, the firms agreed on the method of price fixing, which were similar to those employed in the Kinki region and Okayama and Hiroshima prefectures. The firms reduced the amount of cement supply by 20% and monitored other firms' supply behavior using SSs and downstream affiliates.

In 1990, cartels over 5 years old in the Chugoku region and Hokkaido prefecture were detected by JFTC. In the Chugoku region, from June 1985, nine firms had formed a cartel until it was detected by the JFTC in December 1990. In Hokkaido, eight cement firms engaged in collusion that began in July 1985 and was detected in December 1990. Both cartels employed comparable means to sustain the cartel rules and agreements, which were also similar to the means employed by cartel members in the previous cartels. The cartel committees set the amount of supply monthly and allocated an amount to each cartel member based on the market shares realized before the cartel began.[14]

In the estimation section, the cartel cases explained in this subsection are used as the explanatory variable.

3.4.3 Market Definition

It is always difficult to clearly define market where firms compete. In this paper, the focus is collusive behavior in the upstream industry, the cement industry. Therefore, it should be followed by the tradition in the industry in defining market. In the cement industry, a market is usually defined as a region which consists of several prefectures.

[14] With respect to market share allocation, an interesting feature is that a kind of so-called odd-even allocation was employed.

However, judging from the illegal cartels described above, cement firms did not necessarily collude in a region basis. For example, in the Chugoku region, in 1981, firms did not collude in the entire region but colluded only in two prefectures in the region. Therefore, in this paper, instead of using region as a unit of cement market, each prefecture is regarded as an unit of local cement market where cement firms form a cartel.

3.4.4 Data

This paper analyzes what determines the incentive for cement firms to collusion. Data from the *Cement Yearbook*(*Cement Nenkan* in Japanese), which is published annually by Cement Shimbun Company Limited, provides useful firm-level and regional-level information on, for example, the number of firms' service stations in an individual regions and firms' quantity of supply in a region. The *Cement Yearbook* also includes concrete firms' (plants') information. The most important information for this study is the list of affiliate cement firms. This list illustrates the relationship between cement firms and concrete firms. Using this list, it is possible to identify which concrete firms (plants) belong to which cement firm. The data used in this paper covers the years of 1973, 1975, 1977, 1979, 1981, 1983, and 1985, because detailed information on concrete plants is published biannually.

3.5 Estimation

The goal of this study is to estimate the probability that firms collude and the determinants. More precisely, I explore which and how (market-level) factors are related to the probability of firms colluding. However, to infer the cartel probability under different market structures is not an easy task because I cannot observe all established cartels, but I only observe the cartel cases detected by the antitrust agency. Cartels and cartel cases are not necessarily the same due to the following two types of error in cartel investigation, and the discrepancy between cartels and JFTC cartel cases causes a significant problem in the estimation.

The first error in cartel investigation is that the JFTC could not detect and prosecute a cartel although firms colluded in fact. It is not plausible that the JFTC could detect and prosecute all established cartels. It is almost impossible to detect all established cartels and to collect evidence on cartel agreements, the date and place of meetings, and to prosecute firms for price-fixing for each cartel ever formed. Therefore, even if firms formed a cartel (and the JFTC might be aware of the cartel), the JFTC cannot prosecute. This is the first indication that cartel cases and cartels do not coincide.

Fig. 3.1 Type 1 and Type 2 errors in cartel investigation

		JFTC Investigation	
		YES	NO
Firms Collude	YES	Correct Investigation	Type 1 Error
	NO	Type 2 Error	Correct No Investigation

On the other hand, there is another possibility that the JFTC mistakenly prosecuted firms for collusion although the firms did not actually collude.[15] That is, there is the possibility of false prosecution by the JFTC. This is the second error in cartel investigation. The possibility of false prosecution occurring is very small because JFTC's rule for cartel investigation is stringent.[16] However, at least theoretically, it should not be ruled out a priori that false prosecution occurs.

Figure 3.1 describes concisely the potential errors in JFTC cartel investigations. The row "JFTC Investigation" represents JFTC's action ("YES" means the JFTC detects and prosecutes a cartel, while "NO" means the JFTC does not). The column "Firms Collude" represents whether firms collude, "YES" indicates they collude and "NO" indicates they do not. The first error is the error that occurs when firms collude but the JFTC cannot detect and prosecute. I call this a type 1 error. In the case of a type 1 error, I cannot observe the cartel although it is present. The second error is the error that occurs when firms do not collude, but the JFTC mistakenly prosecutes them of collusion. This error is called a type 2 error. In the case of a type 2 error, I observe firms falsely accused of collusion. Only when "JFTC Investigation" and "Firms Collude" coincide does "Correct Investigation" occur.[17]

A different perspective on this matrix might clarify the problem. What I should observe is "Firms Collude." However, I can observe only "JFTC Investigation." Figure 3.1 shows that "JFTC Investigation" suffers from type 1 and type 2 errors. If "JFTC Investigation" is "YES" (that is, I observe a JFTC cartel case), "YES" means a (true) cartel or a false prosecuted cartel. On the other hand, if "JFTC Investigation" is "NO" (that is, I do not observe a cartel case), "NO" means that there is a cartel but no cartel case, or there is no cartel case but a cartel. The JFTC cartel cases are the result of cartel investigation. Among JFTC cartel cases, false prosecutions

[15] Firms can appeal to a (higher) court when they do not accept the JFTC's decision. Therefore, the business conduct (practice) of firms that should not be prosecuted of engaging in a cartel is recorded as an illegal cartel only when firms did not appeal to a court for some reasons (typically costs for litigation) or when firms appealed to a court(s) but the court(s) made the wrong decision as well as the JFTC.

[16] During the period studied here, the rule was more stringent than it is today. Toshiba Chemical Case (Tokyo High Court, 1995) is a landmark case that loosened the rule. For further details, see Odagiri's study in this book.

[17] The terminologies for the type 1 and type 2 errors are borrowed from Froeb et al. (2015).

can be included. Among established cartels, the cartels that the JFTC could not prosecute can be included. Thus, JFTC cases are considered a proxy for the true variable "Firms Collude" with errors.

Considering JFTC cases as a proxy variable for underlying cartels with measurement error, which is caused by the types 1 and 2 errors, is a key step in the estimation. The reason is that, by using the concept of the type 1 and type 2 errors, I can relate a JFTC cartel case to the underlying collusion. Let y^*_{mt} represent whether collusion is present or not. It is a binary variable, and, thus, takes one if firms collude and zero otherwise:

$$y^*_{mt} = \begin{cases} 1 & \text{if firms collude} \\ 0 & \text{otherwise} \end{cases} \tag{3.2}$$

where m represents a market and t is time (year). y^*_{mt} is the true variable. Next, consider a JFTC cartel case as the proxy variable for the true variable. Let y_{mt} represent a JFTC cartel case. The proxy variable takes one if the JFTC detects and prosecutes a cartel and zero otherwise:

$$y_{mt} = \begin{cases} 1 & \text{if JFTC cartel case} \\ 0 & \text{otherwise} \end{cases} \tag{3.3}$$

where m represents a market and t is time (year).

The observable variable is y_{mt}, which indicates a JFTC cartel case or not. Therefore, I need to link y_{mt} and y^*_{mt} to define the relationship between these two variables: to express explicitly y_{mt} as a function of y^*_{mt} or conversely to express y^*_{mt} as a function of y_{mt}. To do so, I use the categories described in the matrix in Fig. 3.1.

For each row in the matrix, I use the following two indicators describing whether JFTC investigation fails (equivalently, whether the type 1 and 2 errors arise). Let g^1_{mt} be the indicator for the first row and g^0_{mt} for the second.

$$g^1_{mt} = \begin{cases} 1 & \text{if Correct Investigation} \\ 0 & \text{if Type 1 Error} \end{cases} \tag{3.4}$$

$$g^0_{mt} = \begin{cases} 1 & \text{if Correct No Investigation} \\ 0 & \text{if Type 2 Error} \end{cases} \tag{3.5}$$

$g^1_{mt} = 1$ corresponds to "Correct Investigation" in Fig. 3.1 and $g^1_{mt} = 0$ corresponds to "Type 2 error," while $g^0_{mt} = 1$ corresponds to "Correct No Investigation" and $g^0_{mt} = 0$ corresponds to "Type 1 error." With g^1_{mt} and g^0_{mt}, I can express the link between y^*_{mt} and y_{mt}.

As a consequence of the type 1 and 2 errors, $g^1_{mt} = 0$ and $g^0_{mt} = 0$, when I observe a cartel case, that is, $y_{mt} = 1$, there are possibilities of firms colluding and that of firms not colluding. On the other hand, when I do not observe a cartel case, that is, $y_{mt} = 0$, there are two possibilities concerning the presence of a cartel, that is $y^*_{mt} = 1$ and $y^*_{mt} = 0$. By using g^1_{mt} and g^0_{mt}, the relationship between y_{mt} and y^*_{mt} is expressed by the following way:

$$(y_{mt} = 1) = (g^1_{mt} = 1) \cap (y^*_{mt} = 1) + (g^1_{mt} = 0) \cap (y^*_{mt} = 0) \tag{3.6}$$

$$(y_{mt} = 0) = (g^0_{mt} = 0) \cap (y^*_{mt} = 1) + (g^0_{mt} = 1) \cap (y^*_{mt} = 0), \tag{3.7}$$

where $(g^1_{mt} = 1) \cap (y^*_{mt} = 1)$ means that when firms collude, the JFTC detects the collusion, while $(g^1_{mt} = 0) \cap (y^*_{mt} = 0)$ means that when firms do not collude, the JFTC mistakenly detects collusion. $(g^0_{mt} = 0) \cap (y^*_{mt} = 1)$ means that firms collude but the JFTC cannot detect it, while $(g^0_{mt} = 1) \cap (y^*_{mt} = 0)$ means that when firms do not collude, the JFTC does not investigate. Equations (3.6) and (3.7) relate the observable variable y_{mt} and the unobservable variable y^*_{mt}. Thus, this implies that by looking at when and where y_{mt} becomes one, I can determine when and where y^*_{mt} becomes one.

As mentioned in the beginning of this section, I estimate how market structure and market conditions influence the probability of firms colluding. In the estimation, I consider the probabilistic form of the relationship in (3.6) and (3.7).

$$G_1(x_{mt}) = \Pi_{11}(x_{mt})P_1(x_{mt}) + \Pi_{10}(x_{mt})(1 - P_1(x_{mt})) \tag{3.8}$$

$$G_0(x_{mt}) = \Pi_{01}(x_{mt})P_1(x_{mt}) + \Pi_{00}(x_{mt})(1 - P_1(x_{mt})) \tag{3.9}$$

where x_{mt} is the vector of variables including market structure which is potentially related to the probability of collusion. $G_1(x_{mt})$ is the probability of $y_{mt} = 1$ and $P_1(x_{mt})$ is the probability of $y^*_{mt} = 1$. $\Pi_{11}(x_{mt})$ is the probability of $g^1_{mt} = 1$, which is the probability that the JFTC can detect a cartel when it is present. I call this the correct classification probability. $\Pi_{10}(x_{mt})$ is the probability of $g^1_{mt} = 0$, which is the probability that the JFTC detects a cartel mistakenly when it is not present. I call this the misclassification probability. $G_0(x_{mt})$, $\Pi_{01}(x_{mt})$, and $\Pi_{00}(x_{mt})$ are the probabilities of $y_{mt} = 0$, $g^0_{mt} = 0$, and $g^0_{mt} = 1$, respectively. The empirical objects in the estimation are $P_1(x_{mt})$, which is influenced by the market variables x_{mt} and $\Pi_{ij}(x_{mt})$ $i = 1, 2, j = 1, 2$.

To estimate these objects, I employ an approach developed in the literature of (binary) discrete choice models with data error. As described, the type 1 and 2 errors misclassify a cartel into different categories. An estimation technique dealing with such misclassification is developed by Abrevaya et al. (1998). They consider the identification problem arising from misclassification of the dependent variable in a discrete choice model and estimate the true probability and the correct and misclassified probabilities jointly.

The estimation procedure is briefly introduced here because the details of the estimation procedure are provided in the Appendix. For a feasible estimation procedure, (3.8) is modified into the following form:

$$\begin{aligned} G_1(x_{mt}, \beta) &= \Pi_{11} F(x_{mt}\beta) + \Pi_{10}(1 - F(x_{mt}\beta)) \\ &= \Pi_{10} + (\Pi_{11} - \Pi_{10}) F(x_{mt}\beta) \end{aligned} \quad (3.10)$$

where $P_1(x_{mt}) = F(x_{mt}\beta)$ and $\Pi_{11}(x_{mt})$ and $\Pi_{10}(x_{mt})$ become Π_{11} and Π_{11}, respectively.[18] Roughly speaking, in this estimation, the left-hand-side variable is JFTC cartel cases, and the right-hand-side variable is K-dimensional vector $x_{mt} = (x_{1,mt}, \ldots, x_{K,mt})$, and the target parameters estimated are K-dimensional vector of $\beta = (\beta_1, \ldots, \beta_K)$ and Π_{11} and Π_{10}. The vector of parameters β means the relationship between variables x_{mt} and the cartel probability. If β_i is positive, this means that the corresponding variable $x_{i,mt}$ increases the probability of collusion. On the other hand, if β_i is negative, this means that $x_{i,mt}$ decreases the probability of collusion. The other parameters Π_{11} and Π_{10} mean the correct investigation probability and the misclassification probability, that is, the probability that the type 1 error occurs.

3.6 Estimation Results

In this section, the estimation results are presented. The estimation strategy used in this study allows me to estimate the cartel probability (and the parameters) and the correct and misclassification probabilities. The estimation results are presented in Table 3.1.

First, estimates of the effects of explanatory variables on the probability of firms colluding are discussed. The number of cement firms in a market is negatively related to the cartel probability in both specifications. The estimates of the coefficient on "Cement Firms" are −0.019 and −0.006 as presented in the second and fifth column in Table 3.1. These negative values mean that an increase in the number of cement firms decreases the probability of collusion. However, the estimates do not indicate that the effect of the number of firms on the probability of collusion is −0.019 and −0.006, because estimates are normalized up to its scale in the process of estimation. Therefore, to understand the significance of the effect of the number of firms on the probability of collusion, the marginal effects of the number of firms are calculated and presented in the fourth and seventh columns in the table. These marginal effects indicate approximately how much change one increase in the number of firms lead to in the probability of collusion. For example, the marginal effect of −0.0039 means that a one-unit increase in the number of firms leads to −0.0039 decreases in the probability.

The role of the number of firms is intuitive as explained in Sect. 3.2.2. The greater the number of firms, the more difficult the coordination because the benefit of colluding is smaller, but the benefit of deviating is greater as the number of firms increases as explained in standard IO textbooks and antitrust economics, including

[18] For the derivation of (3.10), see the Appendix.

Table 3.1 Estimation result

Variables	(1) Coeff.	Std. Err.	Marginal effect	(2) Coeff.	Std. Err.	Marginal effect
Cement Firms ($\times 10^{-1}$)	−0.119	(0.002)	−0.039	−0.006	(0.003)	−0.001
Cement Firms Asymmetry	−0.014	(0.003)	−0.004	−0.010	(0.004)	−0.003
Concrete Plants	−0.007	(0.004)	−0.002			
VI Concrete Plants	0.014	(0.004)	0.005			
Concrete Capacity ($\times 10^{-1}$)				−0.100	(0.377)	−0.003
VI Concrete Capacity				0.019	(0.008)	0.005
Construction Inv.	−0.001	(0.025)	−0.000	−0.005	(0.011)	−0.001
$\Pi_{11} - \Pi_{10}$	0.669	(0.003)		0.680	(0.005)	
Π_{10}	0.001	(0.000)		0.001	(0.000)	
Region Effects?	Yes					
Obs.	322					

Notes: "Cement Firms" indicates the number of cement firms. "Cement Firms Asymmetry" is the standard deviation of the number of service stations, which is a proxy variable for cement firms' cost efficiencies. "Concrete Plants" is the number of concrete plants, while "Concrete Capacity" is the sum of concrete capacities. "VI Concrete Plants" is the number of vertically integrated concrete plants, while "VI Concrete Capacity" is the sum of vertically integrated concrete capacities. "Construction Inv." is the total amount of private and public construction investment in a prefecture. All specifications include time-invariant region-specific effects. "Marginal Effect" is evaluated at the mean

Tirole (1988), Odagiri (2001), Motta (2004), and Belleflamme and Peitz (2010). The antitrust policy implication from this result is clear; it is important to maintain a high number of firms holding other factors constant.

Next, the effect of asymmetry between firms on the cartel probability is explained. The asymmetry among firms is measured by the standard deviation of the number of a firm's SSs. The number of SSs that a firm has within a prefecture is a proxy variable for the firm's cost efficiency. The more SSs a firm has, the stronger its logistics network within the region. The estimates of the coefficient are negatively estimated, and, thus, the extent of firms' asymmetry reduces the probability of collusion. As firms become more asymmetric, the more difficult it is for them to collude.

The relation between asymmetry across firms and cartel probability is also easily understood. A simple theory shows that the discount factor required to sustain collusion in a market configuration with heterogeneous firms is greater than that in a market with homogeneous firms. In the case of homogeneous firms, in order to sustain a cartel, there is a single incentive compatible constraint firms must satisfy because they are symmetric. Suppose there are two symmetric firms. If firms maximize joint profits when they collude and compete a la Bertrand after someone deviates, the minimum discount factor needed to sustain collusion is one-half. On the other hand, suppose firms are heterogeneous in their size and, if firms collude, they use a sharing rule that allocates total production to each firm according to firm size. To collude, unlike the previous situation, the cartel must satisfy two firms' incentive compatibility constraints. In that case, if the same punishment is imposed, the smaller firm requires a higher discount factor to satisfy its incentive compatibility constraint for collusion, because deviating is more profitable for the smaller firm. The smallest discount factor is higher than one-half. Therefore, it is more difficult to sustain collusion in a market with heterogeneous firms than in that with homogeneous firms.

Then, move on to the variables regarding vertical integration, the number of vertically integrated concrete plants, and the capacity of these plants. These variables relating to vertical integration make this paper novel in the literature of collusion. This study provides the first empirical results on the effect of vertical integration on the probability of collusion. To examine the relationship between collusion and vertical integration, I use two different variables indicating the degree of vertical integration: the first one is the number of vertically integrated plants within a prefecture, and the second one is the total capacity of vertically integrated plants. Using these variables, I test whether vertical integration affects the possibility of collusion in upstream markets.

Both variables indicate that the degree of vertical integration is positively related to the probability of collusion. These estimates are statistically significant at the 5% level and economically substantial. The marginal effect of the number of vertically integrated concrete plants, 0.0140, means that one standard deviation increase in the variable increases the collusion probability by around 0.09. On the other hand, the marginal effect of the sum of vertically integrated concrete plants' capacities means that one standard deviation increase leads to 0.12 increases in the probability of collusion.

These results confirm the common concern for the coordinated effect of vertical integration held by antitrust authorities in developed countries. For instance, the JFTC states in its merger guidelines that vertical integration leads to a situation where firms share their sensitive transaction information, such as prices, more easily through their downstream affiliates (if one firm's downstream affiliates are supplied by other upstream firms). This empirical finding provides support to the JFTC's view on the possibility that vertical integration facilitates upstream collusion.

Lastly, the correct and misclassification probabilities are estimated as well as the cartel probability. The estimates indicate that the misclassification probability is almost zero. This is not surprising for the following. During the periods studied, the JFTC's rule for prosecuting cartels was too stringent. To prove the presence of a cartel, it required investigators to provide evidence of communication and details on cartel, for example, the date and place of meeting, the details of the cartel agreement, and the date of the agreement established. Therefore, it is unlikely that the JFTC would make a mistake in detection and prosecution. It is reasonable to assume that the upper bound of the misclassification probability be close to zero.[19]

[19]In addition to providing evidence on a cartel, the JFTC needed to prove the cartel agreement, which the JFTC found, and the actual conduct of the cartel members to coincide. This is often

On the other hand, the correct classification probability is estimated to be surprisingly high. The estimate indicates that more than 60% of cartels in the cement industry were detected by the JFTC.[20] Considering that there was a stringent process for detecting cartels, this estimate seems high.[21] One possible reason is that the cement industry was caught several times in different markets. Consequently, the JFTC might have given their special attention to the industry.

3.7 Conclusions

Detecting and preventing collusion is a pressing issue in competition policy all over the world. IO economists assist antitrust authorities in the fight to identify what types of conduct are regarded as a sign of the presence of collusion and which market structures are favorable for collusion by providing theoretical and empirical evidence.

This study added new evidence to a list of factors facilitating collusion. Although some of the factors identified in this study are already known, there is a new finding: vertical integration between the cement and concrete industry increases the upstream cartel probability. This is a novel finding that contributes to the literature on collusion and competition policy.

No one has provided a result on whether vertical integration facilitates upstream collusion, although some theories predict in limited circumstances where an upstream firm integrates with only one downstream firm that vertical integration leads to collusion in upstream. The result obtained in this study is the first empirical evidence and is expected to be followed by future empirical and theoretical work. The evidence on vertical integration is also important to competition policy authorities all over the world because the current study provides empirical support to guidelines that state the possibility that vertical integration leads to coordinated effects in upstream and downstream markets.

In addition to presenting the new finding, the detection probability is estimated. The estimate indicates that more than half of cartels were discovered by the

difficult because the agreement that the JFTC could find was not necessarily the final agreement that the cartel members reached. If this is the case, even though there was a cartel (or at least communications about prices), JFTC could not prosecute.

[20]The way of counting cartels is the following. The variable indicating the presence of a cartel takes one if, within a particular year, firms colluded regardless of how many months (or days) they colluded. Therefore, the detection probability of 0.6 means that firms colluded ten times in terms of market year. Among ten cartels, the JFTC detected six cartels.

[21]As a reference to the probability of cartel detection, there is Bryant and Eckard's (1991) estimate. They estimate the probability that a price-fixing conspiracy is detected is at most between 0.13 and 0.17.

JFTC. This estimate is one of the first estimates on detection probability in Japan. Identifying the number of cartels is important to measure the severity and damage of collusion.

Although this study focuses on a structural approach, a behavioral approach is also important. The combination of the two approaches is necessary to detect and prevent collusion. However, research applying a behavioral approach is scarce in Japan, while some studies, which can be regarded as structural approaches, have been conducted. More research in this direction could help fight collusion more effectively.

Appendix: Details of Estimation

In implementing the estimation, the difficulty is that cartel cases detected by the JFTC do not necessarily coincide with cartels that firms formed. The difference between cartel cases and cartels means measurement error, specifically, a misclassification in the binary variable. A misclassification in a binary discrete variable, which introduces a discrepancy between the true and observable variables, causes an identification problem. The probability of taking one is reduced by the measurement error because of the negative correlation between the true variable and that observable. In the context of this study, the true probability corresponds to the probability that firms collude and the observable probability that the JFTC detects a cartel. The negative correlation between these two probabilities means that the estimates are biased toward zero and, consequently, the effects of explanatory variables on the probability of a cartel are underestimated. This implies that even though a variable has a substantial impact on the cartel probability, it might be estimated not to be substantial. Therefore, it is necessarily to deal with this problem arising form data error.[22]

In order to eliminate the bias inevitably arising from misclassification, I apply the estimation approach of Abrevaya et al. (1998) to the current problem. They consider an identification problem arising from misclassification of the dependent variable in a discrete choice model. When the (binary) dependent variable in a discrete choice model is misclassified, traditional estimation techniques, such as logit or probit models, suffer from substantial bias, as explained above. The point of the problem is that I do not have any knowledge on the misclassification probability (and the correct classification probability). The misclassification probability is the gap between the true probability, which is the probability that firms actually colluded in the current case, and the observable probability, which is the probability that a JFTC cartel case is observed. If the misclassification and correct classification probabilities can be known, the problem will be resolved because the true probability can

[22]This is a common problem when researchers study collusion using cartel cases by antitrust authorities.

be inferred from the observable probability. Abrevaya et al. (1998) develop the estimation technique which simultaneously estimates the true probability and the misclassification probability (and the correct classification probability). By applying their estimation technique to the current problem, I identify the factors affecting the cartel probability.

The misclassification is summarized as follows:

$$y_{mt} = 1 \text{ when } y^*_{mt} = 0 \tag{3.11}$$

$$y_{mt} = 0 \text{ when } y^*_{mt} = 1 \tag{3.12}$$

where y^*_{mt} represents the presence of collusion and y_{mt} indicates a JFTC cartel case or not. The potential problem caused by this misclassification is that the mean of the true variable indicating collusion is reduced because the negative correlation between the observable variable y_{mt} and the true variable y^*_{mt} arises.

The main point is how to relate the observable variable y_{mt} with the true variable y^*_{mt}. The key is the misclassification probability (and the correct classification probability). To explain the role of the misclassification probability, first, introduce the observable and true probabilities of collusion. let $G_1(x_{mt}) = \Pr[y_{mt} = 1|x_{mt}]$ be the probability of a cartel detected at the state of x_{mt} and $P_1(x_{mt}) = \Pr[y^*_{mt} = 1|x_{mt}]$ be the probability of cartel formed. (Because this is a problem of binary choice, $G_0(m_{mt})$ represents the probability that cartel is not detected by the JFTC and $P_0(x_{mt})$ in the probability that firms colluded.)

To bridge these two probabilities, I introduce another two probabilities for misclassification. The first one is the probability that the JFTC detects a cartel when a cartel is formed actually. This is called the correct classification probability. $\Pi_{11}(x_{mt}) = \Pr[y_{mt} = 1, y^*_{mt} = 1|x_{mt}]$ indicates the correct classification probability ($\Pi_{00}(x_{mt}) = \Pr[y_{mt} = 0, y^*_{mt} = 0|x_{mt}]$ is also the correct classification probability). The second one is the probability that the JFTC mistakenly prosecuted firm for forming a cartel. This is called the misclassification probability. Let $\Pi_{10}(x_{mt}) = \Pr[y_{mt} = 1, y^*_{mt} = 0|x_{mt}]$ indicate the misclassification probability ($\Pi_{01}(x_{mt}) = \Pr[y_{mt} = 0, y^*_{mt} = 1|x_{mt}]$ is another misclassification probability).

The probability that a cartel is detected by the JFTC is composed of two composite terms.[23] The probability of firms colluding times the probability that the JFTC detects the cartel, and the second is the probability that firms do not collude times the probability that the JFTC mistakenly prosecutes the firms. That is, the cartel probability is decomposed as follows:

$$G_1(x_{mt}) = \Pi_{11}(x_{mt})P_1(x_{mt}) + \Pi_{10}(x_{mt})(1 - P_1(x_{mt})) \tag{3.13}$$

The first term in the first equation represents the probability that the JFTC correctly detects the cartel when firms collude. The second term in the first equation

[23]This is a binary choice model so that $G_1(x_{mt})$ and $G_0(x_{mt})$ are linearly dependent each other. In the followings, the decomposition of the probability $G_1(x_{mt})$ is focused.

represents the probability that the JFTC wrongly decides that firms collude when they did not. The probability $G_1(x_{mt})$ is expressed as the sum of these two terms.

The goal is to estimate the probability of firms colluding $P_1(x_{mt})$ and the correct and misclassification probabilities. To make the estimation feasible, I put some restrictions on these probabilities. First, I assume that the probability of firms actually colluding, $P_1(x_{mt})$, is expressed as a function of a single index: $F(x_{mt}\beta)$ where β is the vector of the parameter. In addition to restricting the relationship between the state variables x_{mt} and the probability of firms forming a cartel $P_1(x_{mt})$ to the single index model, I assume $F(\cdot)$ is the standard normal distribution function. With these assumptions, the probability decomposition is rewritten as follows:

$$G_1(x_{mt}, \beta) = \Pi_{10}(x_{mt}) + (\Pi_{11}(x_{mt}) - \Pi_{10}(x_{mt}))F(x_{mt}\beta) \tag{3.14}$$

The parameter vector β and the probability distribution function $F(\cdot)$ and the probabilities relating to misclassification, $\Pi_{11}(x_{mt})$ and $\Pi_{10}(x_{mt})$, are to be estimated.

For these empirical objects to be identified separately, assumptions on the correct and misclassification probabilities are needed. First, the restriction on $\Pi_{11}(x_{mt}) - \Pi_{10}(x_{mt})$ is necessary. More precisely, the condition

$$\Pi_{11}(x_{mt}) - \Pi_{10}(x_{mt}) > 0 \tag{3.15}$$

is required. If the assumption is not satisfied, the relationship between $G_1(x_{mt})$ and $P_1(x_{mt})$ is nothing or completely opposite even if they are both related. This means that the true cartel probability $P_1(x_{mt})$ cannot be inferred from the observable probability $G_1(x_{mt})$.

Equation (3.14) illustrates why this additional assumption is needed to identify the collusion probability and the correct and misclassification probabilities. Suppose $\Pi_{11}(x_{mt}) - \Pi_{10}(x_{mt}) = 0$. In this case, even if $G_1(x_{mt})$ is related to $F(x_{mt}\beta)$, the relationship cannot be identified because any variation in $F(x_{mt}\beta)$ is not reflected in $G_1(x_{mt})$. On the other hand, suppose $\Pi_{11}(x_{mt}) - \Pi_{10}(x_{mt}) < 0$. In this case, the probabilities $G_1(x_{mt})$ and $F(x_{mt}\beta)$ are related in the completely opposite direction, and estimates with the opposite signs of the parameters are obtained.

Second, exclusion restrictions are needed to estimate the probability $F(x_{mt}\beta)$ and the probabilities of correct and misclassification separately. As indicated in Eq. (3.14), both the probability of cartel and the correct and misclassification probabilities are affected by the same set of variables x_{mt}. This means that a movement in a variable in x_{mt} moves all of these probabilities up or down simultaneously. Because of this collinearity, these probabilities cannot be identified separately.[24] I assume that the correct and misclassification probabilities are constant across markets and time. Although this is the most strict exclusion restriction, there is a trade-off between the first identification condition and the second identification

[24]It should be noted that these could be estimated separately based on the functional forms of these probability distributions.

condition. In the case that the correct and misclassified probabilities are allowed to vary with some of x_{mt}, the first condition must be satisfied at every point of x_{mt}, which influences the correct and misclassification probabilities, as shown in (3.15). Therefore, the weaker the second condition becomes, the stricter the first condition becomes. Coupled with this exclusion restriction, Eq. (3.14) is written as

$$G_1(x_{mt}, \beta) = \Pi_{10} + (\Pi_{11} - \Pi_{10})F(x_{mt}\beta) \tag{3.16}$$

where Π_{11} and Π_{10} are the parameters to be estimated.

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Chapter 4
Is Domestic Competition Beneficial for International Competitiveness? An Empirical Analysis of Japanese Manufacturing Industries

Masatoshi Kato

Abstract This study examines whether domestic competition enhances competitiveness in international markets for Japanese manufacturing industries. The study analyzes the effects of competition in Japanese industries, measured as the price–cost margin compared to that in US industries, on export and output market shares in OECD countries. The results show that relative price–cost margins negatively affect both export and output market shares, suggesting that competition contributes to international competitiveness. In addition, high-tech industries in Japan are more likely to have strong competitiveness in international markets in terms of both export and output market shares. The implications of the findings are discussed.

Keywords Competition • Export market share • International competitiveness • Output market share • Price–cost margin

4.1 Introduction

Economists generally recognize that competition fosters innovation and enhances efficiency in markets (e.g., Nickell 1996; Symeonidis 2008; Vives 2008). Economists consider competition to be a positive dynamic. Competition exerts downward pressure on costs, reduces slack, provides incentives for the efficient organization of production, and even drives innovation (Nickell 1996). Aghion et al. (2009) suggest that the market entry of firms close to the productivity frontier can provide an incentive for productive incumbents to "raise their game" and innovate

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M. Kato (✉)
School of Economics, Kwansei Gakuin University, 1-155 Uegahara Ichiban-cho, Nishinomiya, Hyogo 662-8501, Japan
e-mail: mkato@kwansei.ac.jp

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to survive. Other studies, including Siegfried and Evans (1994), Geroski (1995), and Ito and Kato (2016), suggest that competitive pressure through new entry helps improve market efficiency because inefficient incumbents are more likely to be driven out of the market by efficient entrants. Therefore, competition policy makers seek to promote competition to achieve innovation and enhance efficiency in markets.

From the perspective of industrial policy, a government may want to develop internationally competitive domestic firms by protecting them from overt competition. Mowery (2009) argues that the US government has had a considerable influence on industrial innovation by, for example, restricting or promoting collaboration in research among firms. The Japanese government also plays a significant role in economic development. For instance, certain types of cartels, such as recession and export cartels, have been exempted from the application of the Antimonopoly Act under industrial policies since the 1950s, although most are no longer exempt. The Japanese government has also promoted the formation of cooperative research and development (R&D) consortia as an industrial policy since the 1950s in order to make Japanese firms catch up to Western technology. Government-sponsored R&D consortia were formed to lower R&D costs and foster Japanese firms' international competitiveness (e.g., Branstetter and Sakakibara 1998; Sakakibara 2001). In this respect, while economists generally consider that cooperative arrangements are closely associated with anticompetitive behaviors that lead to less competitiveness, it is not clear whether promoting cooperative arrangements among domestic firms is harmful to international competitiveness.

Although previous studies have addressed the effects of competition on market performance in a home country, little is known about whether enhanced competition in a home country improves competitiveness in international markets. This study reexamines this question using a dataset of Japanese manufacturing industries covering 2000–2006. I use a measure of competition different from those used in previous studies. Absolute measures of competition, such as the market share instability of leading firms in a home country, have been used in the literature, but these cannot capture the intensity of competition in the country relative to that in other countries. When international competitiveness is relatively measured as world market share (i.e., the relative position in the world), it is natural to use a relative measure for the intensity of domestic competition. In this analysis, therefore, competition is measured as price–cost margins (PCMs) in Japanese manufacturing industries relative to those in the US. On the other hand, Japan's competitiveness in international markets is measured as its export and output market shares for each industry among 34 Organisation for Economic Co-operation and Development (OECD) countries. The estimation results of the regression reveal that export and output market shares tend to be high in industries where the relative price–cost margins of Japanese industries are low, suggesting that competition in a home country enhances international competitiveness.

The remainder of this chapter is organized as follows. The next section reviews the background and related literature for this study. Section 4.3 explains the data used in the analysis and discusses descriptive statistics. The estimation model and results are presented in Sect. 4.4, and the final section includes some concluding remarks.

4.2 Research Background

4.2.1 Theoretical Background and Related Literature

According to microeconomics textbooks, the allocation of resources is efficient in competitive markets, while deadweight loss is generated in imperfectly competitive markets. It is believed that competition exerts downward pressure on costs, reduces slack, provides incentives for the efficient organization of production, and even drives innovation (Nickell 1996). By contrast, a lack of competition leads to inertia, low worker effort, and managerial slack, thus reducing firm productivity (Symeonidis 2008). Many studies have examined the effects of competition on performance. For example, Nickell (1996) examined the effects of competition measured as the number of competitors and level of rents on the growth of total factor productivity in a panel of UK industries, finding that competition improved productivity. Symeonidis (2008) investigated the effects of competition on wages and productivity in UK industries following the introduction of cartel law. The findings support the view that competition improves performance and therefore competitiveness. By contrast, the Schumpeterian hypothesis posits that market power favors rather than impedes innovation (Schumpeter 1943). According to Symeonidis (1996), firms with greater market power are better able to finance research and development (R&D) from their own profits. Additionally, firms with greater market power can more easily appropriate the returns from innovation and therefore have more incentive to innovate. These arguments imply that promoting competition negatively affects innovation and thus competitiveness. Aghion et al. (2005) found an inverted-U-shaped relationship between competition and innovation, suggesting that excess competition may impede innovation in industries. Overall, these arguments suggest that overt competition may be harmful to innovation and productivity in markets.

Several studies in the field of international trade have examined the role of domestic competition in international markets. For example, Brander and Krugman (1983, p. 313) argued that profit-maximizing firms that believe they face a higher elasticity of demand abroad than at home and that can discriminate between foreign and domestic markets will charge a lower price abroad than at home. The authors found that oligopolistic firm rivalry leads to dumping in international markets, suggesting that collusion in domestic markets is associated with the expansion of domestic firms in international markets. Sakakibara and Porter (2001) also argued that there are impediments to trade, such as tariffs, transport costs, and transaction costs, and that firms face a more elastic demand for exports than for domestic sales; therefore, domestic prices become higher than export prices, and domestic collusion is associated with high exports.[1] These arguments lead to the question of whether promoting competition in a home country is beneficial to the international competitiveness of domestic firms.

Several studies have addressed whether and how competition in a home country affects competitiveness in international markets. Porter et al. (2000) emphasized the importance of local rivalry in gaining global competitiveness because it drives innovation and continual improvement in productivity. The authors argued that firms lacking competition at home will never be competitive abroad. Sakakibara and Porter (2001) examined how competition at home measured as market share instability affected export market shares representing international competitiveness, finding that competition at home had a positive influence on competitiveness. Following Sakakibara and Porter (2001), Doi et al. (2014) also investigated how competition in a home country measured as market mobility affected international competitiveness, finding no significant effect. While their studies provide interesting evidence, they feature several limitations.

First, the authors used the world export shares of Japanese industries, which captures the "relative" position of Japanese industries to other countries, as a measure of international competitiveness and linked this to the "absolute" level of domestic competition measured as the market share instability of leading firms. The relative level of domestic competition should be used to explain the relative position of domestic markets in the world. Even if a Japanese market is competitive in an absolute sense and stimulates innovation, fierce competition may occur and spur innovations in the corresponding markets of other countries. In this case, Japanese industries might lose their market shares globally, and the corresponding markets in other countries may increase their market shares.

Second, market share instability might not be an appropriate measure of the intensity of domestic competition, although it has been used as a measure of market mobility. For example, as pointed out by Kato and Honjo (2006), anticompetitive activities such as unilateral predation lead to increases in concentration and greater instability in market shares and thus are not associated with overt competition. Further, Bradburd and Over (1982, p. 57) argue that, once industry concentration has been allowed to increase above a critical level and an industry cooperative equilibrium is allowed to form, this will tend to persist, even if the concentration subsequently declines. Thus, alternative measures other than market share instability should be used to reflect the intensity of domestic competition. The price–cost margin (PCM) has been used as a measure of competition in a rich stream of literature (e.g., Nickell 1996; Aghion et al. 2005; Okada 2005). As pointed out by Boone (2008), PCM has been widely used as a measure of competition, since

[1] Doi et al. (2014) argued that market concentration promotes overseas operations, since higher concentration may induce strategic interactions among firms, particularly among leading firms.

theoretical papers predict that more intense competition leads to higher PCM (e.g., Stiglitz 1989; Bulow and Klemperer 2002).

Considering these limitations, a relative price–cost margin is used as a measure of competition in this study, defined as average price–cost margins in Japanese industries divided by those in the US (as a representative country), since the relative level of competition in international markets should explain the relative position of Japanese industries in those markets.

Aside from competition measures, the literature's consideration of international competitiveness may also have limitations. Studies have used only one measure, such as world export share, and their results lack robustness. For example, the measure of world market share does not include domestic and overseas sales; therefore, the measure might not reflect global competitiveness, particularly for countries where the scale of domestic markets is large, on average. In this study, I use world output share as well as world export share as a measure of international competitiveness.

4.2.2 The Japanese Context

Post-World War II reform, including the dissolution of *zaibatsu*, has contributed to industrial development in Japan by promoting investment and innovation by fringe firms, while the Antimonopoly Act has prevented the emergence of strong market leaders (Odagiri and Goto 1996). Japanese industry experienced tremendous growth until the 1970s (e.g., Johnson 1983). In this era, the government tended to protect domestic firms from overt competition in international markets (e.g., Komiya et al. 1988). For example, the automobile industry had been protected from international competition by the government in the postwar era, especially in the 1950s and 1960s. In this industry, the government set high tariffs, promoted the growth of domestic producers, and encouraged foreign technology acquisition in order to catch up with Western technology. As a result, domestic automobile makers such as Toyota and Honda became global market leaders, although it is not clear whether the industrial policy of protecting domestic firms led to this strong international competitiveness.

The government has played an important role in the development of Japanese industries. As mentioned in Sect. 4.1, certain types of cartels, such as recession cartels, small and medium-sized enterprise (SME) cartels, and export cartels have been exempted from the application of the Antimonopoly Act since the 1950s. Among these legally sanctioned cartels, SME cartels accounted for more than half of all exemptions in the 1960s and were the largest category of legally sanctioned cartels in the postwar period (e.g., Schaede 2000). Although such legal cartels are no longer exempt from the Antimonopoly Act, industries legally sanctioned in the past may have an historical legacy in terms of the propensity to cooperate. In addition to legally sanctioned cartels, government-sponsored R&D consortia, which may promote cooperative behaviors among firms, were formed to lower R&D

costs and help foster Japanese firms' international competitiveness (e.g., Branstetter and Sakakibara 1998; Sakakibara 2001). Therefore, the propensity among Japanese firms to cooperate may remain.

Meanwhile, it is often argued that Japanese industries may have special characteristics in terms of firm behaviors. Schaede (2000) pointed out the presence of a cooperative system based on self-regulation through trade associations, weak antimonopoly enforcement, and strong government intervention in Japan. Odagiri (1992) noted that Japanese firms tend to pursue long-term growth under a system of lifetime employment and internal promotion. Kaplan (1994) argued that Japanese firms tend to maximize growth or market share rather than (short-term) profits or share prices. Lieberman and Asaba (2006) demonstrated that Japanese firms tend to behave similarly by analyzing the patterns of new product introductions in the soft drink industry.

In such contexts, many Japanese firms, such as Honda and Toyota, became global market leaders. Japan's industries had been fairly competitive until the 1990s, but they have been losing their competitiveness in international markets. The number of Japanese firms ranked in the *Fortune Global 500* peaked at 149 in 1994; the latest number is 52 (in 2016). However, while many firms have been losing their competitiveness, some automobile firms, including Toyota, Honda, and Nissan, have maintained their leadership positions over long periods. This suggests that industry-specific characteristics play a critical role in international competitiveness.

The Japanese industry with such characteristics may be an interesting setting for research on the relationship between domestic competition and international competitiveness.

4.3 Data

4.3.1 Data Sources

This study is based mainly on the *Industrial Demand-Supply Balance (IDSB) Database* 2014 Edition (Revision 3), compiled by the United Nations Industrial Development Organization (UNIDO). This database provides data on output and imports and exports by industry at the four-digit Standard Industrial Classification (SIC) level across many countries. The availability of variables differs among countries and changes over time. Using this database, the export and output market shares of Japanese industries in OECD countries can be measured as a reflection of international competitiveness. Japan's ratios of export and output to total export and output for 34 OECD countries in period t are calculated for each industry.[2] Our sample is restricted to the period from 2000 to 2006 since data on export and output are available for these OECD countries only for this period. Data on domestic and global output growth are obtained from the *IDSB*.

[2] Appendix Table 4.9 presents the list of OECD countries used for the data.

To measure the relative level of competition in Japanese industries via their relative level of average price–cost margins to those of the US, data on Japanese and US industries are taken from the *Report by Industry, the Census of Manufactures* of the Ministry of Economy, Trade and Industry (METI) and *Annual Survey of Manufactures* of the Bureau of the Census, US Department of Commerce, respectively.

However, a problem arose when I tried to match data between the sources. First, the industrial classifications in the data sources for price–cost margins differ between Japan and the US; I therefore dropped the industries for which data are not obtainable in both Japan and the US. The industrial classifications also differ between the two sources for price–cost margins and the *IDSB*. I tried to match the data between them again. As a result, I obtained a final sample of 37 industries at the four-digit SIC level.

For data on the technological regime, the full sample is grouped into high- and low-tech subsamples using the OECD classification (OECD 2011). Although the OECD (2011) classifies manufacturing industries into four groups—high-tech, medium-high-tech, medium-low-tech, and low-tech—we defined the first two and last two groups as high- and low-tech sectors, respectively.

4.3.2 Sample and Descriptive Statistics

Before showing the regression results, I will discuss the descriptive statistics for the dependent and independent variables. Tables 4.1 and 4.2 show data on world export and output shares from 2000 to 2006 for the 37 industries in the sample. As shown in Table 4.1, there are large differences in the values between industries. For example, the export market shares are high for some industries, such as engines and turbines (2911), building and repairing of ships (3511), and musical instruments (3692), while values are low in other industries, such as dairy products (1520) and sugar (1542). More than half of the sample industries, including musical instruments, have reduced export market share during the observation period, while some industries, such as machinery for mining and construction (2924), have increased shares.

Table 4.2 shows that there are large differences in the world output share values among industries. In some industries, such as processing/preserving of fish (1512) and watches and clocks (3330), the output market shares are high, while the market shares are low in other industries, such as dressing and dyeing of fur, fur processing (1820), and aircraft and spacecraft (3530). Table 4.2 shows that the market shares tend to decrease over time in most industries, with a few exceptions. This suggests that Japanese industries lost their competitiveness in international markets during the observation period. Among industries with high market shares in 2000, for example, the watches and clocks industry maintained its position, as shown in Table 4.1. In contrast, the musical instruments industry lost 20% of its market share between 2000 and 2006.

Table 4.1 Export market share during the observation period

ISIC	ISIC description	2000 (%)	2001 (%)	2002 (%)	2003 (%)	2004 (%)	2005 (%)	2006 (%)
1511	Processing/preserving of meat	0.12	0.16	0.16	0.16	0.14	0.16	0.14
1512	Processing/preserving of fish	3.94	3.59	3.46	3.54	3.54	4.24	4.58
1513	Processing/preserving of fruits and vegetables	0.30	0.25	0.20	0.19	0.21	0.22	0.22
1514	Vegetable and animal oils and fats	0.65	0.55	0.51	0.50	0.46	0.41	0.38
1520	Dairy products	0.05	0.04	0.04	0.03	0.04	0.04	0.04
1531	Grain mill products	1.81	15.26	1.51	1.27	1.19	0.97	0.91
1532	Starches and starch products	1.13	0.96	1.00	0.98	0.96	1.01	1.01
1541	Bakery products	1.30	1.09	0.91	0.80	0.76	0.84	0.80
1542	Sugar	0.06	0.05	0.05	0.06	0.06	0.04	0.04
1551	Distilling, rectifying, and blending of spirits	0.88	0.50	0.46	0.42	0.36	0.44	0.26
1552	Wines	0.42	0.39	0.37	0.38	0.38	0.27	0.41
1553	Malt liquors and malt	0.86	0.74	0.65	0.34	0.23	0.20	0.26
1554	Soft drinks and mineral waters	0.69	0.69	0.79	0.66	0.73	0.75	0.69
1600	Tobacco products	1.37	2.19	1.98	1.83	1.93	1.88	1.62
1722	Carpets and rugs	0.35	0.24	0.25	0.26	0.38	0.43	0.36
1723	Cordage, rope, twine, and netting	7.37	7.25	6.24	6.28	6.79	7.63	6.65
2023	Wooden containers	0.29	0.24	0.18	0.20	0.23	0.25	0.22
2101	Pulp, paper, and paperboard	2.49	2.14	2.46	2.35	2.46	2.21	2.25
2221	Printing	2.48	1.95	1.80	1.96	2.15	2.84	3.07
2320	Refined petroleum products	1.82	0.27	2.02	1.53	1.78	2.70	2.57
2412	Fertilizers and nitrogen compounds	3.08	2.73	2.36	2.37	2.43	2.22	2.14
2423	Pharmaceuticals, medicinal chemicals, etc.	3.69	3.26	2.59	3.24	3.17	2.84	2.93
2511	Rubber tires and tubes	17.43	15.90	16.88	17.30	16.30	16.83	16.97
2520	Plastic products	6.57	5.50	5.75	6.02	6.68	7.00	7.18
2610	Glass and glass products	10.83	9.36	9.42	9.57	10.32	11.31	10.91
2911	Engines and turbines (not for transport equipment)	22.75	20.22	18.87	20.7	18.21	18.56	17.91
2921	Agricultural and forestry machinery	6.32	5.21	5.16	5.52	6.29	6.18	6.17
2924	Machinery for mining and construction	13.45	13.03	13.36	18.59	21.13	19.61	20.13
3150	Lighting equipment and electric lamps	7.40	7.20	7.05	8.93	9.40	9.44	10.57
3311	Medical, surgical, and orthopedic equipment	9.01	7.14	6.40	7.17	7.94	7.51	6.73
3330	Watches and clocks	16.53	12.69	11.32	10.86	9.43	8.00	7.56

(continued)

Table 4.1 (continued)

ISIC	ISIC description	2000 (%)	2001 (%)	2002 (%)	2003 (%)	2004 (%)	2005 (%)	2006 (%)
3420	Automobile bodies, trailers, and semitrailers	1.16	1.17	0.92	1.28	1.54	2.07	1.92
3511	Building and repairing of ships	34.95	28.02	29.12	28.38	30.64	29.58	27.14
3530	Aircraft and spacecraft	2.25	2.41	1.88	2.17	1.87	2.02	2.77
3610	Furniture	1.13	1.04	1.12	1.16	1.31	1.40	1.40
3692	Musical instruments	36.80	28.87	28.59	28.43	25.78	24.53	23.46
3693	Sports goods	7.46	7.58	8.37	8.62	8.30	8.24	8.90

Concerning the intensity of domestic competition, Table 4.3 shows the relative price–cost margins in the 37 industries. A value of 1 reflects that the level of competition is the same between Japan and the US. The value is negative (positive) when Japanese industries are more competitive (uncompetitive) than the corresponding industries in the US. Table 4.3 shows large differences in the relative price–cost margins between industries. On the one hand, the value is greater for some industries such as refined petroleum products (2320), where competition is limited in Japan compared to the US. On the other hand, the value is lower than in other industries, such as watches and clocks (3330), where competition is fiercer in Japan than in the US.

Table 4.4 provides the definitions of the variables used in the analysis. Table 4.5 shows the summary statistics for the variables used in the regressions. For the dependent variables, the mean value of export market shares (*E_SHARE*) is 0.056, indicating that the export market shares for Japanese industries are on average 5.6% for the sample industries. The minimum and maximum values are 0.000 (0.0%) and 0.368 (36.8%), respectively. For output share, the mean value of *O_SHARE* is 0.171, indicating that Japanese industries have, on average, 17.1% of the market share in the international markets. The minimum and maximum values are 0.033 (3.3%) and 0.608 (60.8%), respectively. For independent variables, the mean value of the relative level of price–cost margins (*R_PCM*) is 0.959, indicating that, on average, Japanese industries are more competitive than US industries. For domestic and global market growth (*D_GROW* and *G_GROW*), the mean values are −0.007 and 0.095, respectively, indicating that there are some differences in the growth rates between Japanese and world markets. The mean value of *H_TECH* is 0.270, implying that 27% of the sample industries are in the high-tech sector.

Table 4.6 shows the correlation matrix of the variables. The correlation between *R_PCM* and *E_SHARE* is −0.221, indicating that Japan's world export shares tend to be higher in industries where relative price–cost margins are low and competition is relatively fierce. Similarly, the correlation between *R_PCM* and *O_SHARE* is −0.179. These findings suggest that a higher level of competition in a home country favors international competitiveness.

Table 4.2 Output market share during the observation period

ISIC	ISIC description	2000 (%)	2001 (%)	2002 (%)	2003 (%)	2004 (%)	2005 (%)	2006 (%)
1511	Processing/preserving of meat	6.23	5.13	5.03	4.60	4.34	4.16	3.94
1512	Processing/preserving of fish	54.00	50.52	46.36	45.60	44.73	42.16	37.97
1513	Processing/preserving of fruits and vegetables	9.55	7.65	6.96	6.47	6.52	6.56	5.76
1514	Vegetable and animal oils and fats	11.87	9.97	8.67	8.74	8.32	8.47	7.60
1520	Dairy products	10.87	9.02	9.06	7.95	8.00	7.66	7.10
1531	Grain mill products	19.84	16.60	18.27	17.10	18.67	16.09	14.65
1532	Starches and starch products	13.89	11.46	10.46	10.67	10.76	10.57	9.29
1541	Bakery products	19.17	17.23	16.26	14.91	14.34	13.78	12.95
1542	Sugar	11.50	10.86	9.73	8.74	8.31	7.82	7.63
1551	Distilling, rectifying, and blending of spirits	35.36	32.42	32.05	31.52	32.61	32.55	30.89
1552	Wines	25.79	20.27	16.77	19.59	17.88	15.80	11.34
1553	Malt liquors and malt	28.13	25.76	24.88	20.98	20.19	18.45	14.68
1554	Soft drinks and mineral waters	21.53	19.54	18.20	17.39	17.59	14.33	13.17
1600	Tobacco products	24.44	19.16	19.36	18.41	22.03	20.88	17.53
1722	Carpets and rugs	7.99	7.07	7.07	6.13	5.90	5.25	5.39
1723	Cordage, rope, twine, and netting	25.34	21.39	19.30	18.34	18.41	17.69	15.86
2023	Wooden containers	9.52	8.09	6.03	5.53	4.96	4.26	3.99
2101	Pulp, paper, and paperboard	14.88	13.82	13.31	13.81	12.30	13.67	12.56
2221	Printing	27.36	23.48	22.28	21.75	21.27	20.24	19.00
2320	Refined petroleum products	14.76	14.47	15.23	14.67	12.74	12.54	10.53
2412	Fertilizers and nitrogen compounds	9.36	8.88	7.22	7.27	6.89	5.96	4.82
2423	Pharmaceuticals, medicinal chemicals, etc.	18.46	16.48	15.00	14.49	14.77	13.58	11.85
2511	Rubber tires and tubes	17.94	16.59	16.20	17.24	15.57	14.37	14.57
2520	Plastic products	22.62	20.15	18.76	18.30	18.82	17.52	16.49
2610	Glass and glass products	19.47	16.93	16.41	15.50	16.93	15.66	16.13
2911	Engines and turbines (not for transport equipment)	20.85	20.54	18.86	16.30	16.65	20.34	16.91
2921	Agricultural and forestry machinery	10.48	15.69	13.24	12.10	12.27	11.33	10.72
2924	Machinery for mining and construction	24.21	16.61	17.51	18.24	19.37	17.91	16.85
3150	Lighting equipment and electric lamps	27.53	26.18	21.38	22.24	18.79	18.35	16.83
3311	Medical, surgical, and orthopedic equipment	11.77	10.30	10.00	9.13	9.26	9.84	9.48
3330	Watches and clocks	55.01	51.26	51.01	53.50	60.82	54.06	53.84
3420	Automobile bodies, trailers, and semitrailers	32.74	32.73	34.12	33.38	26.08	27.43	26.63
3511	Building and repairing of ships	22.62	21.31	20.30	17.43	18.88	16.18	14.66
3530	Aircraft and spacecraft	3.94	3.86	3.83	4.42	3.60	3.30	4.17
3610	Furniture	8.73	7.59	6.34	6.20	5.78	5.43	4.94
3692	Musical instruments	46.28	43.65	30.98	22.04	21.59	21.58	26.51
3693	Sports goods	16.46	13.85	12.19	11.16	11.17	10.64	9.08

Table 4.3 Relative price–cost margins during the observation period

ISIC	ISIC description	2000	2001	2002	2003	2004	2005	2006
1511	Processing/preserving of meat	0.99	0.88	0.75	0.75	0.75	0.71	0.59
1512	Processing/preserving of fish	1.01	0.97	0.84	0.92	0.93	0.86	0.84
1513	Processing/preserving of fruits and vegetables	0.67	0.66	0.63	0.61	0.63	0.66	0.72
1514	Vegetable and animal oils and fats	1.64	1.27	1.33	1.42	1.40	1.45	1.55
1520	Dairy products	1.20	1.09	1.12	1.09	1.03	1.05	1.04
1531	Grain mill products	0.47	0.44	0.48	0.49	0.43	0.45	0.41
1532	Starches and starch products	1.03	1.01	0.78	0.79	0.80	0.67	0.62
1541	Bakery products	0.86	0.84	0.86	0.86	0.91	0.83	0.84
1542	Sugar	1.29	1.33	1.47	0.96	0.93	1.00	0.85
1551	Distilling, rectifying, and blending of spirits	1.57	1.51	1.55	1.22	1.16	1.31	1.32
1552	Wines	1.17	1.19	1.12	0.96	1.01	0.89	0.82
1553	Malt liquors and malt	1.38	1.58	1.56	1.55	1.40	1.41	1.43
1554	Soft drinks and mineral waters	1.32	1.37	1.38	1.31	1.20	1.09	1.03
1600	Tobacco products	1.00	0.96	0.95	0.99	0.97	0.99	0.97
1722	Carpets and rugs	0.77	1.18	1.02	0.75	0.65	0.63	0.78
1723	Cordage, rope, twine, and netting	0.94	1.07	1.01	1.32	1.26	0.87	0.83
2023	Wooden containers	0.91	0.92	1.00	1.00	0.95	0.96	0.97
2101	Pulp, paper, and paperboard	0.80	0.76	0.80	0.74	0.77	0.78	0.75
2221	Printing	0.86	0.85	0.87	0.85	0.88	0.88	0.88
2320	Refined petroleum products	2.39	2.48	1.88	3.24	2.28	2.04	1.22
2412	Fertilizers and nitrogen compounds	1.16	1.31	1.42	1.00	1.08	1.12	0.97
2423	Pharmaceuticals, medicinal chemicals, etc.	1.10	1.08	1.05	0.97	0.96	0.97	0.93
2511	Rubber tires and tubes	1.44	1.45	1.44	1.49	1.37	1.48	1.51
2520	Plastic products	0.88	0.94	0.91	0.86	0.90	0.93	0.95
2610	Glass and glass products	0.97	1.03	0.98	1.10	1.18	1.20	1.24
2911	Engines and turbines (not for transport equipment)	0.70	1.19	0.96	0.99	1.07	1.54	1.15
2921	Agricultural and forestry machinery	0.93	0.98	0.84	0.84	0.68	0.59	0.52
2924	Machinery for mining and construction	0.92	0.86	0.86	0.79	1.01	0.76	0.81
3150	Lighting equipment and electric lamps	0.76	0.76	0.76	0.79	0.81	0.82	0.81
3311	Medical, surgical, and orthopedic equipment	0.85	0.90	0.89	0.89	0.87	0.91	0.86
3330	Watches and clocks	0.38	0.52	0.49	0.21	0.23	0.13	0.24
3420	Automobile bodies, trailers, and semitrailers	0.67	0.69	0.56	0.63	0.56	0.46	0.42
3511	Building and repairing of ships	0.93	1.12	0.97	0.67	0.62	0.72	0.52
3530	Aircraft and spacecraft	0.56	0.56	0.98	0.93	1.00	1.05	0.69
3610	Furniture	0.86	0.93	0.92	0.82	0.87	0.89	0.80
3692	Musical instruments	0.50	0.71	0.25	0.22	0.07	0.07	0.09
3693	Sports goods	1.01	0.97	1.01	0.87	0.93	0.90	0.86

Table 4.4 Definitions of variables

Variable	Definition	Data source
(Dependent variable)		
E_SHARE	Export market share: Japanese industry's exports divided by total exports of OECD countries	*Industrial Demand-Supply Balance* (*IDSB*) *Database 2014 edition* (Revision 3), UNIDO
O_SHARE	Output market share: Japanese industry's output divided by total output of OECD countries	*Industrial Demand-Supply Balance* (*IDSB*) *Database 2014 edition* (Revision 3), UNIDO
(Independent variable)		
R_PCM	Japanese industry's value of shipments minus labor and material costs, divided by the value of shipments in period $t-1$, divided by that of the US industry	*Report by industry*, *Census of Manufacture*, METI, and Annual Survey of Manufactures, US Department of Commerce
D_GROW	Domestic growth rate: Differences in the logarithm of Japanese industry's output between periods $t-1$ and t	*Report by industry*, *Census of Manufacture*, METI
W_GROW	World growth rate: Differences in the logarithm of OECD countries' output between periods $t-1$ and t	*Industrial Demand-Supply Balance* (*IDSB*) *Database 2014 edition* (Revision 3), UNIDO
H_TECH	Dummy for high-tech manufacturing: 1 if the industry is high-tech or mid-high-tech sector, 0 if mid-low-tech or low-tech sectors	Organisation for Economic Co-operation and Development (2011)

Table 4.5 Summary statistics of variables

Variable	Mean	Std. Dev.	Min	Max
(Dependent variable)				
E_SHARE	0.056	0.076	0.000	0.368
O_SHARE	0.171	0.109	0.033	0.608
(Independent variable)				
R_PCM	0.959	0.376	0.068	3.240
D_GROW	−0.007	0.122	−0.494	0.438
W_GROW	0.095	0.155	−0.132	0.959
H_TECH	0.270	0.445	0	1

Note: Number of observations is 259

Table 4.6 Correlation matrix of variables

Variable	*E_SHARE*	*O_SHARE*	*R_PCM*	*D_GROW*	*W_GROW*	*H_TECH*
E_SHARE	1					
O_SHARE	0.289	1				
R_PCM	−0.221	−0.179	1			
D_GROW	0.075	0.025	0.055	1		
W_GROW	−0.013	−0.136	0.285	0.101	1	
H_TECH	0.181	0.119	−0.217	0.122	0.182	1

Note: Number of observations is 259

4.4 Empirical Analysis

4.4.1 Model

In this section, I consider an empirical model. This study examines whether competition in a home country has a significant effect on competitiveness in international markets. Therefore, our dependent variable is competitiveness in international markets, measured as the export and output market shares of Japanese industries in OECD countries. Intensity of domestic competition, measured as the relative level of the average price–cost margins of Japanese industries compared to those of the US, is a key independent variable.

The empirical model can be presented as follows:

$$SHARE = \beta_0 + \beta_1 RPCM + \beta_2 DGROW + \beta_3 GGROW + \beta_4 HTECH + \varepsilon, \quad (4.1)$$

where *SHARE* is composed of export market share (*E_SHARE*) and output market shares (*O_SHARE*), representing the dependent variables; *R_PCM* is the relative price–cost margins, representing the relative level of competition in the home country; *D_GROW* is the domestic market growth; *G_GROW* is the global market growth; and *H_TECH* is a dummy for high-tech industries.

For the dependent variables, export market share (*E_SHARE*) is defined as the Japanese industry's value of exports divided by the value of total exports in 34 OECD countries. While this measure reflects competitiveness in export markets, it ignores domestic and overseas sales. Therefore, the measure might not reflect global competitiveness, particularly for countries where the scale of domestic markets is large. Similarly, another measure of competitiveness, output market share (*O_SHARE*), is defined as the Japanese industry's value of output divided by the value of total output in 34 OECD countries. This measure includes domestic and overseas sales, as it is not clear whether the products are consumed in Japan or in other countries.

As mentioned, domestic competition should be measured in a relative sense, since I consider domestic competition as a key factor determining the relative position of domestic markets in the world. In practice, even if a Japanese market is competitive in an absolute sense and stimulates innovation, fierce competition may occur and spur innovation in the corresponding markets of other countries. In this case, Japanese industries might lose their market shares globally, and the corresponding markets in other countries may increase their market shares. In this study, therefore, the level of domestic competition explaining international competitiveness is measured as the relative level of price–cost margins (*R_PCM*) of Japanese industries compared to those of the US. Price–cost margins are defined as the value of shipments minus labor and material costs divided by the value of shipments in period t-1. Then, *R_PCM* is measured as price–cost margins in Japan divided by the price–cost margins in the US.

Domestic and global market growth (*D_GROW* and *G_GROW*) are included in the model to control for differences in life cycles between industries for domestic and global markets. As suggested by some studies, including Klepper (1996), the market shares of firms tend to be more unstable in growing phases in the life cycle of an industry than in mature phases. Therefore, growing industries may be more likely to gain or lose market shares. These variables are measured as the differences in the value of output between periods $t - 1$ and t divided by the value of output in period t.

A dummy for high-tech manufacturing industries is also included in the model to examine which industries obtain strong international competitiveness in terms of technological regime. To control for time-specific effects, year dummies (with a 2000 reference year) are included in the model.

4.4.2 Results

In this section, I show the results on how competition in Japanese industries affects their competitiveness in international markets. Before showing the regression results, Table 4.7 shows summary statistics for export and output market shares according to *R_PCM* level. The values of export and output market shares are higher in the 23 industries in the sample for which the value of *R_PCM* in 2000 is lower than 1 ("low *R_PCM* industries" hereafter) compared to the 14 industries where the value of *R_PCM* is higher than 1 ("high *R_PCM* industries" hereafter). The means difference of *R_PCM* is significant for export shares but not for output shares. Another important finding is that the correlations between *R_PCM* and competitiveness measures (*E_SHARE* and *O_SHARE*) are significantly negative in low *R_PCM* industries but are not significant in high *R_PCM* industries.

Table 4.8 shows the estimation results of ordinary least squares (OLS) regressions. For the effects of competition in the home country on the aggregated market shares of the firms in international markets, the relative level of price–cost margins (*R_PCM*) has a negative and statistically significant effect on export market share

Table 4.7 Summary statistics for export and output market shares according to the level of *R_PCM*

	Low *R_PCM* (23 industries)				High *R_PCM* (14 industries)					
	Mean	S.D.	Correl	*N*	Mean	S.D.	Correl		*N*	Mean difference
Export share	0.073	0.087	−0.143*	161	0.028	0.044	0.022		98	0.044***
Output share	0.171	0.112	−0.401***	161	0.170	0.106	−0.026		98	0.001

Note: *S.D.* represents standard deviation, *Correl* means the simple correlation coefficients between *R_PCM* and export (*E_SHARE*) or output market shares (*O_SHARE*), *N* indicates the number of observations. ***, **, and * are significance at 1%, 5%, and 10% levels

Table 4.8 OLS regression results

Variable	(i) *E_SHARE*	(ii) *O_SHARE*
R_PCM	−0.042**	−0.039**
	(0.017)	(0.018)
D_GROW	0.069	0.075
	(0.066)	(0.054)
W_GROW	−0.002	−0.140***
	(0.043)	(0.049)
H_TECH	0.021*	0.028*
	(0.012)	(0.017)
*Year*2001	0.008	−0.014
	(0.023)	(0.029)
*Year*2002	−0.001	−0.036
	(0.021)	(0.028)
*Year*2003	−0.009	−0.057**
	(0.020)	(0.027)
*Year*2004	−0.011	−0.063**
	(0.019)	(0.027)
*Year*2005	−0.007	−0.067**
	(0.020)	(0.027)
*Year*2006	−0.010	−0.082***
	(0.020)	(0.027)
Constant term	0.096***	0.260***
	(0.025)	(0.029)
Number of observations	259	259
Adjusted R-squared	0.077	0.105

Note: Robust standard errors are in parentheses. ***, **, and * are significance at 1%, 5%, and 10% levels

(*E_SHARE*), as seen in column (i) of Table 4.8, indicating that the industries where competition is severer in Japanese markets than in corresponding US markets are more likely to have strong export competitiveness in international markets. This is consistent with the result of Sakakibara and Porter (2001).

For output market share (*O_SHARE*), the relative level of price–cost margins (*R_PCM*) has a negative and statistically significant effect, as seen in column (ii) of Table 4.8, indicating that the industries where competition is more intense in Japanese markets than in US markets are more likely to have strong output competitiveness in international markets, including in domestic and overseas sales. This result is generally consistent with the result for export market shares. Therefore, these results suggest that domestic competition is beneficial to international competitiveness regardless of whether export or market shares are used as a measure of competitiveness.

For the control variables, domestic market growth (*D_GROW*) is not significant, as seen in columns (i) and (ii) of Table 4.8. Global market growth (*G_GROW*) has a negative and significant effect on output market share (*O_SHARE*), as seen in column (ii) of Table 4.8, but has no effect on export market share (*E_SHARE*).

The dummy for high-tech manufacturing industries (*H_TECH*) has a positive and significant effect on export and output market shares (*E_SHARE and O_SHARE*), as seen in columns (i) and (ii) of Table 4.8, indicating that the high-tech sector tends to be internationally competitive among Japanese manufacturing industries in terms of both exports and output. For example, Japanese firms are highly internationally competitive in high-tech industries such as watches and clocks and automobiles. Therefore, this result may suggest that, while many Japanese industries have been losing their leadership positions, some of them, especially high-tech industries, can compete with those in other countries.

4.5 Conclusions

In this study, I examined whether domestic competition enhances competitiveness in international markets using data from Japanese manufacturing industries. The study examined the effects of competition in Japanese industries, measured as the relative level of price–cost margins compared to US industries, on export and output market shares in OECD countries. The results show that the relative levels of price–cost margins negatively affect both export and output market shares, suggesting that competition contributes to international competitiveness. In addition, high-tech industries in Japan are more likely to have strong competitiveness in international markets in terms of both export and output market shares.

This study makes two main contributions to the literature. First, it examined the effects of domestic competition on competitiveness in international markets using a new measure for the intensity of domestic competition. While previous studies tend to use absolute measures of competition in domestic markets, I used a relative measure to describe the relative position of domestic industries in international markets. Using this relative measure, I showed that the relative level of domestic competition plays a significant role in explaining international competitiveness. Second, multiple measures of international competitiveness and of export and output market shares in OECD countries were used to compare the results. The results were shown to be generally robust among the measures.

The results of this study may also be of interest to policy makers. The results suggest that promoting domestic competition is beneficial to international competitiveness. Although the effects of domestic competition on international competitiveness should be interpreted with caution, these findings challenge the view that domestic markets should be protected from overt competition for the sake of international competitiveness. The findings suggest that governments should promote fierce competition among firms in domestic markets to strengthen international competitiveness rather than protect domestic firms from overt competition. As Porter et al. (2000) argued, many government-protected Japanese firms tend to be less competitive in international markets. This study provides a clue as to whether competition should be promoted in domestic markets for international competitiveness.

However, this study has several limitations. First, I used the aggregated export and output market shares of Japanese firms relative to 34 OECD countries as measures of international competitiveness, but some major countries, including China, were ignored as rivals. Although it is difficult to obtain global data on market shares, a dataset of world market shares should be developed. Second, the measure for international competitiveness does not include foreign direct investment (FDI), although FDI is an important element of firms' overseas operations and is therefore closely associated with international competitiveness. Further analyses using alternative competition measures should be conducted. Third, I used data on the relative level of price–cost margins of Japanese industries compared to those of the US to measure the intensity of competition in domestic markets, but I did not consider countries other than the US in this measure. More sophisticated measures should be employed in future analyses. Fourth, the size of this study's newly constructed panel dataset for Japanese manufacturing industries may not be adequate for the analysis. The cross-sectional (37) and time-series variations (7) in the dataset are not sufficient. Fifth (and related to the fourth point), the study's empirical method might be problematic. I used OLS regressions in the analysis, but fixed and random-effects regressions would be preferable in order to consider unobservable heterogeneity between industries.

This study, while still in the preliminary stage, offers some important findings. Nevertheless, the results should be interpreted with caution. Further analyses are needed to attain a better understanding of the relationship between competition and international competiveness.

Appendix

Table 4.9 OECD countries used in the data

No.	Country
1	Australia
2	Austria
3	Belgium
4	Canada
5	Chile
6	Czech Republic
7	Denmark
8	Estonia
9	Finland
10	France
11	Germany
12	Greece
13	Hungary
14	Iceland
15	Ireland
16	Israel
17	Italy
18	Japan
19	Luxembourg
20	Mexico
21	The Netherlands
22	New Zealand
23	Norway
24	Poland
25	Portugal
26	Republic of Korea
27	Slovakia
28	Slovenia
29	Spain
30	Sweden
31	Switzerland
32	Turkey
33	The United Kingdom
34	The United States

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Chapter 5
Measuring Innovation in Firms

Kenta Ikeuchi

Abstract This chapter examines the interdependence between various measurements of firms' innovation outputs. Linking firm-level microdata from the Japanese National Innovation Survey to the literature-based microdata on firm innovation from press releases and data on intellectual property rights such as patents, trademarks, and design registrations, I construct a panel data set that captures the diversity of innovation activities. Additionally, I examine the effects of firms' innovation outputs on the market value and productivity of firms. The empirical results suggest that observed firm's press releases represent the multidimensional innovation activities of firms, particularly the radical product (new-to-market) innovations, organizational innovation, and research and development (R&D) activities for technological developments. For intellectual property rights, the empirical results show that firms with product innovation registered more trademarks, and firms with more radical new products registered trademarks. Patent data reflects the R&D activity of firms, while design registrations reflect the self-reported design innovations and design activity measured in the innovation survey. In addition to patent applications and trademark registrations, press releases on new products, technological developments, and organizational changes increase the market value of a firm.

Keywords Design registration • Innovation • Literature-based innovation output indicator • Patent • Press release • R&D • Trademark

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K. Ikeuchi (✉)
Research Institute of Economy, Trade and Industry (RIETI), IAA, 1-3-1 Kasumigaseki, Chiyoda-ku, Tokyo 100-8901, Japan

National Institute of Science and Technology Policy (NISTEP), 3-2-2 Kasumigaseki, Chiyoda-ku, Tokyo 100-0013, Japan
e-mail: ikeuchi-kenta@rieti.go.jp

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5.1 Introduction

Innovation is one of the most important concepts for economic development, growth, and the wealth of nations. To capture innovation is to understand the determinants or process of productivity improvements. Japan has faced long-term economic stagnation that began in the early 1990s and labor shortages from an aging population; therefore, policy makers need ways to enhance productivity and encourage innovation. This subject has received attention from economic and science and technology policy makers, because it is widely believed that the knowledge creation and diffusion process is closely related to innovation.

The definition of innovation is provided by the Organisation for Economic Co-operation and Development (OECD)/Eurostat's Oslo Manual (2005). According to the Oslo Manual, "an innovation is the implementation of a new or significantly improved product (goods or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization, or external relations." Edison et al. (2013) examined 41 definitions by conducting a questionnaire survey and interviews with academics and practitioners, and the authors recommended a definition by Crossan and Apaydin (2010): "Innovation is: production or adoption, assimilation, and exploitation of a value-added novelty in economic and social spheres; renewal and enlargement of products, services, and markets; development of new methods of production, and the establishment of new management systems. It is both a process and an outcome." Both definitions indicate that innovation has a broad meaning. Innovation includes the discovery of new ideas or knowledge but also the commercialization or implementation of these discoveries into production processes, business practices, or marketing activities. Additionally, Edison et al. (2013) argued that "the perception of innovation differs across the departments of the same organization."

An innovation activity in a firm is a function that changes innovation inputs to innovation outputs and generates some positive economic value. Because innovation inputs are multidimensional, innovation outputs also have several dimensions. Four types of innovation outputs are recognized (OECD 2005):

1. Product innovations, which is the introduction of new or significantly improved goods or services to markets
2. Process innovations, which is the implementation of new or significantly improved production or delivery methods including a significant change in techniques, equipment, and/or software
3. Organizational innovations, which is the implementation of a new organizational method in a firm's business practices, workplace organization, or external relations
4. Marketing innovation, which is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion, or pricing

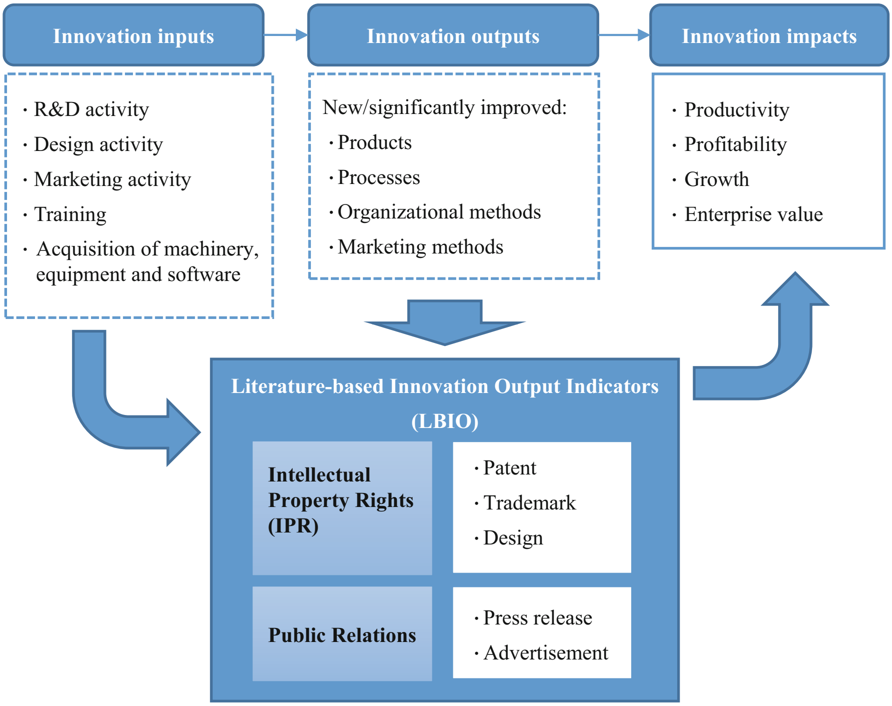

Fig. 5.1 Framework for measuring innovation outputs in firms (Source: Modification of Edison et al. (2013) by the author)

This chapter examines the interdependence between various measurements of innovation outputs of firms. Figure 5.1 illustrates a framework to measure innovation outputs in this chapter. Linking firm-level microdata from the Japanese National Innovation Survey (J-NIS) to other microdata sources related to innovation in firms such as patents, trademarks, design rights, and press releases on new products and services, which are called as literature-based innovation output (LBIO) indicators, I summarize the innovation indicators and explore the best treatment of the indicators to explain observed diversity in firms' innovation.

This chapter is organized as follows. In the next section, several approaches to measuring innovation outputs are introduced. Then, in Sect. 5.3, data sources and the methodology for data set construction are explained. In Sect. 5.4, several variables to measure innovation outputs are defined. Section 5.5 shows the empirical results and examines the relationship between innovation output indicators. Finally, Sect. 5.6 concludes this chapter.

5.2 How to Measure Innovation

A reliable measure of innovation is particularly important for policy makers who must assess policy intervention and evaluate the impacts of their policies on innovation. Understanding the current state of innovation and innovation processes correctly is a necessary condition for policy makers to enforce appropriate policies. Relevant measurement of innovation outputs is also important for researchers who are constructing models or empirically examining innovation processes. Measuring innovation, however, is one of the most challenging and difficult tasks not only for policy makers and researchers but also for industry although innovation itself has diverse aspects and consists of several processes. According to Andrew et al. (2008), most executives believe that their companies should track innovation, but only 43% of companies measure innovation.

A major development in innovation output measurements has been the direct innovation survey. This survey involves surveying firms to ascertain product, process, organizational, and marketing innovations introduced or implemented during a period. The community innovation survey (CIS) organized by Eurostat (the statistical office of the European Union) is the most standard questionnaire worldwide. According to the Oslo Manual guideline, all four types of innovation outputs are surveyed in the CIS: product innovation, process innovation, organizational innovation, and marketing innovation. According to Coombs et al. (1996), however, "the CIS-type surveys suffer from their own unique problems, the main problem being the burden they place on responding firms to provide data." Additionally, even for firm respondents, it may be difficult to determine whether their firms innovate.

The measure of firm innovation outputs obtained from literature such as trade journals, rather than firm surveys or interviews, is known as the literature-based innovation output (LBIO) indicator (Coombs et al. 1996). In the 1980s, LBIO data were used to analyze innovation activity in the USA (Acs and Audretsch 1987). However, measuring the quantity and quality of outputs of a firm's innovation activity is also important. The number of new products introduced and the number of new processes or methods implemented should be different across firms, and the impact of innovations should differ. While the quantity of innovation is not supported in the standard CIS questionnaire, the quality or novelty of (product) innovation is partly included. A count measure is available in the case of the LBIO; patents applied or granted, registered trademarks and designs, and published press releases are countable. In a large body of literature, patent data are used as a proxy for innovation (Griliches 1984, 1990; Nagaoka et al. 2010). Empirical research using trademarks and design registrations has been scarce. Recently, several studies, however, examine the relationship between trademarks and design activity (Livesey and Moultrie 2008). Mendonça et al. (2004) showed that trademark data capture the nontechnological innovation of firms. For example, Walsh (1996) and Verganti (2003) emphasized the importance of design activity in firms' innovation processes, and Rubera and Droge (2013) empirically examined the effects of design activity on sales and the market value of firms. D'Ippolito (2014) provided a literature review of research on firms' design activity. These LBIO data contain rich text information on the description of the features that deserve to be published, at least for the firm itself. The rich information may contain data on the quality or novelty of the innovation outputs.

Inputs in innovation activities are also important to measure. Research and development (R&D) investment is the main inputs measure. Recently, the importance of capturing comprehensive inputs other than R&D, such as design, marketing training, and copyright, has been emphasized by intangible assets scholars (Corrado et al. 2009). The absorption of external knowledge and collaborations is also considered an important source of innovation. In the following chapters, the determinants of innovations are discussed in detail.

5.3 Data

This chapter uses five data sources to measure innovation output at the firm level: the Japanese National Innovation Survey (J-NIS), patents, trademarks, design registration, and press releases.

The J-NIS is an official government survey conducted by the National Institute of Science and Technology Policy (NISTEP). The questionnaire used in the J-NIS is harmonized with the CIS, which is developed by Eurostat and is the most standard innovation survey worldwide. The J-NIS has been conducted four times in Japan. Data from the third wave (J-NIS 2012) are used in this chapter, because they are the latest available data. The survey represents a sample derived from all enterprises with ten or more employees active in Japan in 2009 in all manufacturing industries and some selected nonmanufacturing industries from the core and noncore coverage of the CIS 2010. The sample size of J-NIS 2012 is 20,405 firms, and the number of valid responses is 7034 firms. The J-NIS 2012 surveys innovation outputs as well as innovation inputs or innovation activities of firms. According to the Oslo Manual guideline, four types of innovation output are surveyed in the J-NIS: product innovation, process innovation, organizational innovation, and marketing innovation (Fig. 5.2). Innovation outputs introduced or implemented during the period 2009–2011 are surveyed in the J-NIS 2012. Innovation outputs are defined as new-to-firm innovations. For product innovation, new-to-firm innovation and new-to-market innovation are differentiated (Fig. 5.3).

Although the definitions of each type of innovation are included in the questionnaire, the answers to the questionnaire are based on the self-judgment of the respondents. For innovation activities, R&D activity and expenditures and design, marketing, and training activities are captured. Most questions required a yes or no answer. Therefore, I could only capture whether a firm has innovation output. The amount or count of innovation outputs could not be captured in this survey. This is a common limitation of the CIS-type questionnaire.

Figure 5.4 shows the results of J-NIS 2012 for each type of innovation output for three firm sizes.

Patent data are obtained from the Institute of Intellectual Property (IIP) patent database, which is a normalized relational database compiled from more complex data in the SGML (Standard Generalized Markup Language) format from the Japan Patent Office (JPO) by IIP. The latest version of the IIP patent database (version 2015) contains the data for all patent applications to the JPO from 1964 to 2011. Applicant information (names) is used to match data with the other databases. The number of patent applications is used as an indicator of innovation outputs. Additionally, to consider the difference in quality among patents, the number of claims (Okada et al. 2016) and citations from other patents is also calculated.

Databases for trademarks and design registrations are also relational and are compiled from SGML format data from the JPO by NISTEP. These databases contain only registered trademarks and designs applied in the period 1999–2012.

2. Product (good or service) innovation

A product innovation is the market introduction of a **new** or **significantly** improved **good or service** with respect to its capabilities, user friendliness, components or sub-systems.

- Product innovations (new or improved) must be new to your enterprise, but they do not need to be new to your market.
- Product innovations could have been originally developed by your enterprise or by other enterprises.

A **good** is usually a tangible object such as a smart phone, furniture, or packaged software, but downloadable software, music and film are also goods. A **service** is usually intangible, such as retailing, insurance, educational courses, air travel, consulting, etc.

2.1 During the three years 2008 to 2010, did your enterprise introduce:

	Yes *1*	No *0*	
New or significantly improved goods (*exclude the simple resale of new goods and changes of a solely aesthetic nature*)	☐	☐	*INPDGD*
New or significantly improved services	☐	☐	*INPDSV*

3. Process innovation

A process innovation is the implementation of a **new** or **significantly** improved production process, distribution method, or supporting activity.

- Process innovations must be new to your enterprise, but they do not need to be new to your market.
- The innovation could have been originally developed by your enterprise or by other enterprises.
- Exclude purely organisational innovations – these are covered in section 9.

3.1 During the three years 2008 to 2010, did your enterprise introduce:

	Yes *1*	No *0*	
New or significantly improved methods of manufacturing or producing goods or services	☐	☐	*INPSPD*
New or significantly improved logistics, delivery or distribution methods for your inputs, goods or services	☐	☐	*INPSLG*
New or significantly improved supporting activities for your processes, such as maintenance systems or operations for purchasing, accounting, or computing	☐	☐	*INPSSU*

Fig. 5.2 J-NIS (CIS 2010) questions on innovation outputs

9. Organisational innovation

An organisational innovation is a new organisational method in your enterprise's business practices (including knowledge management), workplace organisation or external relations that has not been previously used by your enterprise.

- It must be the result of strategic decisions taken by management.
- Exclude mergers or acquisitions, even if for the first time.

9.1 During the three years 2008 to 2010, did your enterprise introduce:

	Yes *1*	No *0*	
New **business practices** for organising procedures (i.e. supply chain management, business re-engineering, knowledge management, lean production, quality management, etc)	☐	☐	*ORGBUP*
New methods of **organising work responsibilities and decision making** (i.e. first use of a new system of employee responsibilities, team work, decentralisation, integration or de-integration of departments, education/training systems, etc)	☐	☐	*ORGWKP*
New methods of **organising external relations** with other firms or public institutions (i.e. first use of alliances, partnerships, outsourcing or sub-contracting, etc)	☐	☐	*ORGEXR*

10. Marketing innovation

A marketing innovation is the implementation of a new marketing concept or strategy that differs significantly from your enterprise's existing marketing methods and which has not been used before.

- It requires significant changes in product design or packaging, product placement, product promotion or pricing.
- Exclude seasonal, regular and other routine changes in marketing methods.

10.1 During the three years 2008 to 2010, did your enterprise introduce:

	Yes *1*	No *0*	
Significant changes to the aesthetic **design** or **packaging** of a good or service (*exclude changes that alter the product's functional or user characteristics – these are product innovations*)	☐	☐	*MKTDGP*
New media or techniques for **product promotion** (*i.e. the first time use of a new advertising media, a new brand image, introduction of loyalty cards, etc*)	☐	☐	*MKTPDP*
New methods for **product placement** or sales channels (*i.e. first time use of franchising or distribution licenses, direct selling, exclusive retailing, new concepts for product presentation, etc*)	☐	☐	*MKTPDL*
New methods of **pricing** goods or services (*i.e. first time use of variable pricing by demand, discount systems, etc*)	☐	☐	*MKTPRI*

Fig. 5.2 (continued)

The number of registered trademarks and designs by firm by application year is calculated and used as a proxy for firms' innovation outputs. The names of applicants are used for database matching.

Figure 5.5 shows that although the number of patent applications is greater than the trends for trademarks and design registrations, patent applications exhibit a downward trend from 2005. From 1998 to 2011, there were 5.66 million patent applications in total and 404,000 applications for each year, on average. The number of trademarks and design registrations has been stable compared to that of patent applications. From 1999 to 2012, there were 1.24 million trademark applications and 405,000 design registration applications in total and 88,700 trademark applications and 28,900 design registration applications for each year, on average.


2.3 Were any of your product innovations (goods or services) during the three years 2008 to 2010:

		Yes 1	No 0	
New to your market?	Your enterprise introduced a new or significantly improved product onto your market before your competitors (it may have already been available in other markets)	☐	☐	*NEWMKT*
Only new to your firm?	Your enterprise introduced a new or significantly improved product that was already available from your competitors in your market	☐	☐	*NEWFRM*

Fig. 5.3 Questions in the J-NIS (CIS 2010) on the novelty of product innovations

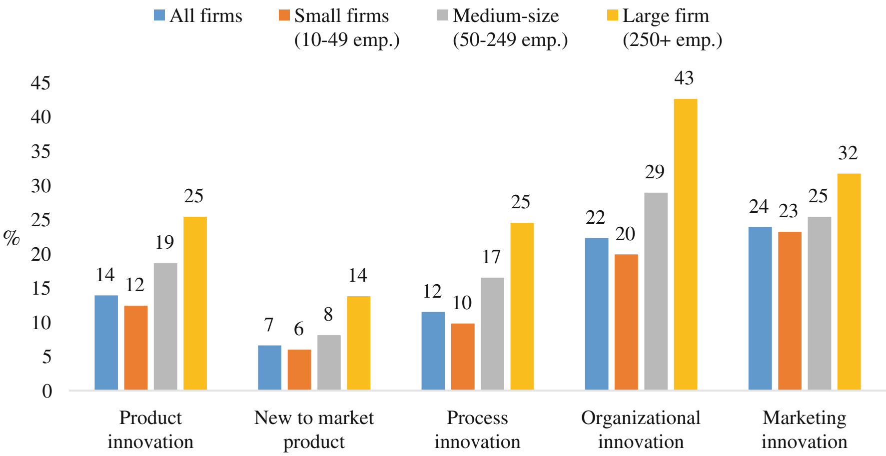

Fig. 5.4 Percentages of firms with innovations (J-NIS 2012)

Press release data are derived from Nikkei Telecom, which contains all articles published on the Nikkei Press Release website[1] from 2003 to 2014. The number of articles is calculated for each subject. The types of articles are also differentiated. Figure 5.6 shows the number of articles by type for each year. There are 355,000 articles in total. Table 5.1 indicates that 61% of articles are classified as new product announcements and 8% and 6% are classified as organizational changes and technological progress announcements, respectively. The subject and type of each article are extracted from the header of each article. The header of release documents contains information on who did what. The beginning of the release header indicates the subject of the release, and the latter part of the header indicates the object of the release. Because there are abbreviations for subjects, the subject names are manually checked and changed to the correct format for the NISTEP Dictionary of Corporate Names (DCN).

[1] http://release.nikkei.co.jp/.

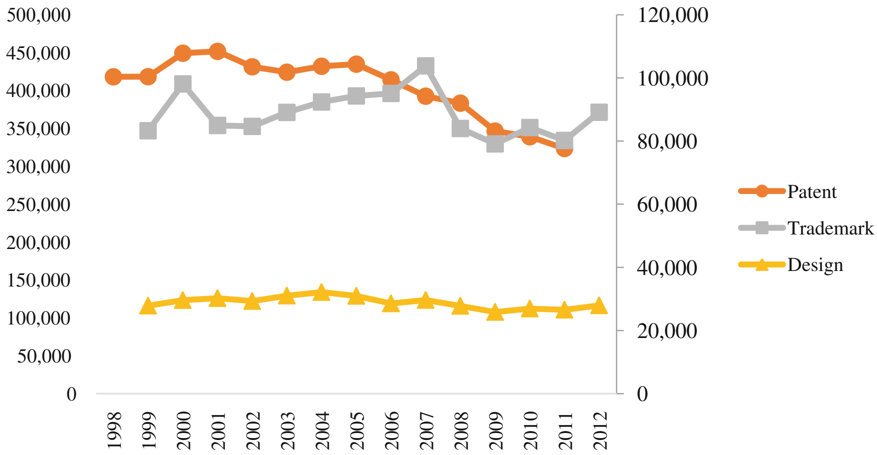

Fig. 5.5 The number of patent application, trademarks, and design registrations

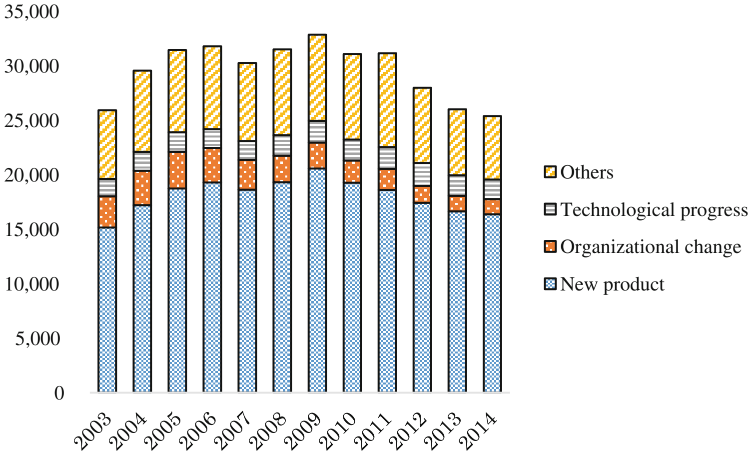

Fig. 5.6 Number of press releases

Table 5.1 Types of press releases

	Total	%
Total	354,689	100
New product	217,059	61
Organizational change	28,363	8
Technological progress	22,190	6
Others	87,077	25

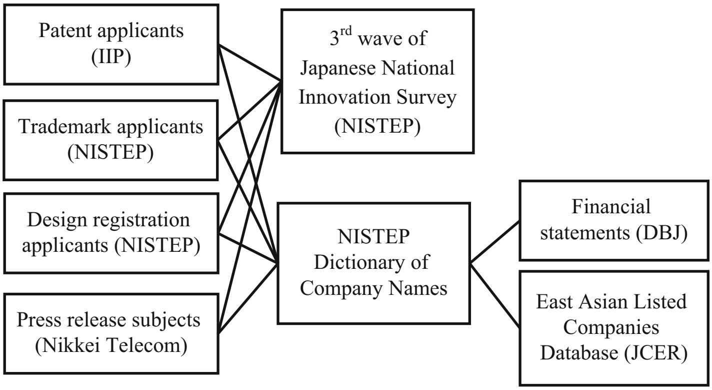

Fig. 5.7 Matching between databases

Table 5.2 Matching results of the first data set

	# of firms	%	# of articles	Avg.
Press release	287	4.1	8633	30.1
New product	217	3.1	4926	22.7
Technological progress	82	1.2	590	7.2
Organizational change	124	1.8	513	4.1
Patent application	843	12.0	86,536	102.7
Trademark application	1222	17.4	11,341	9.3
Design registration	437	6.2	7169	16.4
Total	7034	100.0		

Using these data, two firm-level data sets are constructed to examine the interdependencies among innovative outputs. Figure 5.7 shows the structure of the matched data sets.

The first data set is a cross section, and the respondent firms of the third wave of the J-NIS (J-NIS 2012) are matched with the applicants of patents, trademarks, design registrations, and the subjects of press releases. The J-NIS 2012 contains 7036 respondents. Matching across databases is based on firm name using the NISTEP Dictionary of Corporate Names. Table 5.2 shows the matching results of the data set. Out of 7034 J-NIS 2012 respondent firms, 4.1% of firms issued a press release, 12% of firms applied a patent, 17.4% of firms had a trademark application, and 6.2% of firms applied a design registration. The average number of articles was 30.1 for press releases and 102.7 for patent applications from 2009 to 2011.

The second data set is panel data for which the applicants of patents, trademarks, design registrations, and the subjects of press releases are matched with each other by name and year. As a base for matching, the NISTEP DCN and the concordance table for patent applicant tables developed by NISTEP are used. For each applicant and application year, the number of applications for patents, trademarks, and design registrations is calculated. For listed companies, the financial statements of the firms

Table 5.3 Matching results for the second data set

# of documents	Period	Total	%	Matched	%	Listed firms	%
Press release	2003–2014	354,691	100	209,235	59	168,698	48
Patent	1998–2011	5,658,505	100	3,960,887	70	3,174,171	56
Trademark	1999–2012	1,242,272	100	447,456	36	346,302	28
Design	1999–2012	404,645	100	282,231	70	203,938	50
# of firms				Matched	%	Listed firms	%
Total (DCN)				6292	100	3783	100
Press release				3080	49	2402	63
Patent				5091	81	2758	73
Trademark				5405	86	3502	93
Design				3076	49	1720	45

derived from a company database provided by the Development Bank of Japan and the East Asian Listed Companies (EALC) database are also merged. Table 5.3 shows the matching results of the data set. The matching rates are higher than the first data set. Among 355 press releases, 59% of articles could be matched with the NISTEP DCN. Seventy percent of patents and design registrations are also matched, but the matching rate for trademarks is slightly lower (36%). Among the 6292 firms filed in NISTEP DCN, 49% of firms with a press release and design registration matched, and 81% and 86% of firms with patents and trademarks, respectively, matched. Matching rates are higher for listed firms: 63% for firms with press releases, 73% for firms with patent applications, and 93% for firms with trademarks but only 45% for firms with design registrations.

5.4 Variables

5.4.1 J-NIS 2012

For innovation outputs, the following dummy variables are utilized from J-NIS 2012: (i) a dummy variable taking the value of one if the firm introduced a new or significantly improved good or service to the firm (New-to-Firm Product) from 2009 to 2011, (ii) a dummy variable taking the value of one if the firm introduced a new-to-market product innovation during the period (New-to-Market Product), (iii) a dummy variable taking the value of one if the firm implemented a process innovation (new or significantly improved production process, distribution method, or supporting activity: Process Innovation), (iv) a dummy variable for an implementation of a new organizational method (Organizational Innovation), and (v) a dummy variable indicating a significant change to the aesthetic design or packaging of a good or service (Design Innovation). For innovation inputs, the natural logarithm of R&D expenditure (Ln. of R&D Expenditure) in fiscal year

2011 is calculated, and a dummy variable for Design Activity, which takes the value of one if the firm conducted activities to design new products, improve or change the shape or appearance of existing goods, or improve services, and zero otherwise, is also used.

5.4.2 Press Release Data

From the press release data, the following variables are defined: (i) the number of new product announcements (N. of PRs on New Products), (ii) the number of press releases related to technological progress (N. of PRs on Technological Development), and (iii) the number of press releases announcing an organizational change, for example, establishments of new departments, mergers, and acquisitions of other enterprises, or a company split (N. of PRs on Organizational Changes).

5.4.3 Intellectual Property Rights

For invention or innovation output variables, the number of (i) patent applications (N. of Patent Applications), (ii) applications of trademarks (N. of Trademark Registration), and (iii) the applications of design registrations (N. of Design Registration) are used as output variables.

5.4.4 Innovation Outcomes

Using firm financial information, variables for innovation outcomes are also defined. First, innovation can affect market evaluation from investors (Hall 2000). In this chapter, the market value of the firm is measured by the simple approximation of Tobin's q (Chung and Pruitt 1994):

$$\text{Simple q} = (\text{stock price times the number of stocks issued} + \text{total debt}) / (\text{total assets})$$

Second, innovations can enhance firm productivity (OECD 2009). Using the EALC database, the effects of innovation indicators on total factor productivity (TFP) of the firm are examined.

5.5 Empirical Results

This section first examines the interrelationship among the LBIO indicators and innovation outputs measured in the J-NIS 2012. Then, the section examines the effects of these innovation output indicators on the innovation outcome indicators.

5.5.1 The Interrelationship Among Innovation Output Indicators

Table 5.4 shows the results of the regression analyses.[2] For all models, I control for firm size (the logarithm of the number of employees) and industry-year dummies. In columns (i) to (iii) in Table 5.4, the number of each type of press release is regressed on the related innovation indicators measured by the J-NIS and the intellectual property rights. Column (i) shows the estimation result of the Poisson model in which the dependent variable is measured by the number of new product-related press releases. For explanatory variables, the dummy variables for new-to-firm product innovation and new-to-market product innovation are included in the model. The results show that new-to-market product innovation had significantly positive effects on the number of new product-related press releases.

The dependent variables of columns (ii) and (iii) are the number of press releases related to technological progress and organizational changes, respectively. For the press releases related to the technological progress model, R&D expenditures and the number of patent applications are included as explanatory variables. For press releases related to the organizational changes model, I test the effect of organizational innovation. The estimation results shown in column (ii) indicate that the effects of R&D expenditure and the number of patent applications on the number of technological progress-related press releases were significantly positive. The estimation results shown in column (iii) indicate that the effects of organizational innovation on the number of organizational change-related press releases were significantly positive.

Next, I examine the relationships between the number of applications for intellectual property rights and the innovation survey. Columns (iv) to (vi) in Table 5.4 show the estimation results for the Poisson model for the number of applications for (iv) patents, (v) trademarks, and (vi) design registration. The results show that R&D expenditure has significant positive effects on the number of patent applications. The effects of new-to-firm product innovation and new-to-market product innovation on the number of trademark applications were both positive and

[2]To control for simultaneous bias, standard errors are adjusted with an unrelated estimation method using the Stata command; *suest*.

Table 5.4 Relationship between LBIO indicators and indicators of the innovation survey

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
	N. of PRs on New Products	N. of PRs on Tech. Develop.	N. of PRs on Org. Changes	N. of Patent Applic.	N. of Trademark Registr.	N. of Design Registr.	New-to-Market Product
	Poisson	Poisson	Poisson	Poisson	Poisson	Poisson	Probit
Ln. N. of Employees	0.806***	0.419***	1.122***	0.987***	0.636***	0.641***	−0.017
	(0.081)	(0.136)	(0.064)	(0.104)	(0.049)	(0.098)	(0.021)
New-to-Firm Product (0/1)	0.614				0.428**		
	(0.571)				(0.203)		
New-to-Market Product (0/1)	1.390***				1.135***		
	(0.333)				(0.219)		
Process Innovation (0/1)							0.494***
							(0.063)
Organizational Innovation (0/1)			0.738***				0.160***
			(0.248)				(0.060)
Marketing Innovation (0/1)							0.415***
							(0.063)

Ln. of R&D Expenditure		0.119**		0.213***			0.166***
		(0.050)		(0.053)			(0.018)
Ln. N. of Patent Applications		0.558***					0.090***
		(0.110)					(0.032)
Design Activity (0/1)						1.100***	0.812***
						(0.285)	(0.072)
Design Innovation (0/1)						0.582*	
						(0.314)	
Constant	−4.747***	−6.231***	−9.315***	−4.175***	−2.321***	−3.576***	−1.872***
	(0.687)	(0.672)	(0.577)	(0.540)	(0.320)	(0.658)	(0.101)
Industry-year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	6565	6565	6565	6565	6565	6565	6565
Pseudo R squared	0.458	0.769	0.601	0.861	0.384	0.383	0.323

Notes: $*p < 0.10$, $**p < 0.05$, $***p < 0.01$

significant, and the effects of design innovation and design activity on the number of design registrations were significant and positive.

Finally, to examine the complementarity between the various innovation output indicators including process innovation, I regress the dummy variable for new-to-market product innovation on process, organizational, and marketing innovation, R&D expenditure, the number of patent applications, and design activity. Column (vii) indicates that these innovation output indicators were significantly and positively related to new-to-market product innovation. Particularly, the result indicates that to enhance the novelty of product innovation, other types of innovation, such as process innovation, organizational innovation, and marketing innovation, are required in addition to technological activity such as R&D and patent invention.

In summary, the results in Table 5.4 indicate that the LBIO indicators are reliable indicators for innovation outputs, at least related to products, and particularly for novel products, innovations, organizational innovations, and design innovations measured in the CIS-type questionnaire survey.

5.5.2 Relationship Between LBIO Indicators and Innovation Outcomes

Table 5.5 shows the relationship between LBIO indicators and the market value of the firm using the data of listed firms in the second data set. The simple q index is regressed on the LBIO indicators. Table 5.5 shows the effects of the number of press releases on firm market value. Columns (i) to (iii) show the statistically significant and positive effects of the number of new product-related press releases, technological development, and organizational changes on the market value of the firm. Column (iv) shows that the coefficient on the number of technological development-related press releases is no longer significant if these three variables are simultaneously included in the model. Column (v) shows the effects of patent applications, trademarks, and design registrations on firm market value. The numbers of patent applications and trademark applications have significant and positive effects on market value. Column (vi) shows that if all the LBIO indicators are included in the model, new product and organizational change-related press releases, patent applications, and trademark registrations have significant positive effects on the simple q index. These results indicate that the stock market positively evaluated the firms' innovation outputs examined in the chapter.

Finally, Table 5.6 shows the relationship between the LBIO indicators and the TFP of firms using the data for listed firms from the second data set. Columns (i) to (iii) in Table 5.6 show the effects of the number of firm market value-related press releases. I found statistically significant and positive effects of the number of new product-related announcements, organizational changes, and technological developments on firm TFP. Column (v) shows the effects of patents, trademarks, and design registrations on firm market value. The numbers of patent applications and

Table 5.5 Relationship between LBIO indicators and market value of the firm

Dependent variable: Ln. simple Q index	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Ln. N. of Employees	0.043***	0.108***	0.079***	0.096***	0.010*	0.064***
	(0.007)	(0.013)	(0.014)	(0.017)	(0.006)	(0.017)
Ln. N. of PRs on New Product per Emp.	0.078***			0.064***		0.048***
	(0.007)			(0.008)		(0.008)
Ln. N. of PRs on Org. Change per Emp.		0.138***		0.065***		0.060***
		(0.014)		(0.015)		(0.015)
Ln. N. of PRs on Tech. Develop. per Emp.			0.106***	0.003		−0.028*
			(0.015)	(0.017)		(0.017)
Ln. N. of Patent Applications per Emp.					0.036***	0.034***
					(0.005)	(0.005)
Ln. N. of Trademark Registrations per Emp.					0.037***	0.022***
					(0.005)	(0.005)
Ln. N. of Design Registrations per Emp.					−0.009	−0.014**
					(0.006)	(0.006)
Constant	0.278***	0.272***	0.244***	0.298***	0.355***	0.385***
	(0.094)	(0.084)	(0.092)	(0.093)	(0.096)	(0.098)
Industry-year dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	20,468	20,468	20,468	20,468	20,468	20,468
R squared	0.242	0.233	0.227	0.244	0.247	0.257

Notes: $^{**}p < 0.05$, $^{***}p < 0.01$

Table 5.6 Relationship between LBIO indicators and TFP

Dependent variable: Ln. TFP	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Ln. N. of Employees	0.003	0.021***	0.018***	0.024***	0.002	0.015**
	(0.002)	(0.006)	(0.004)	(0.006)	(0.002)	(0.006)
Ln. N. of PRs on New Product per Emp.	0.011***			0.005**		−0.002
	(0.002)			(0.002)		(0.003)
Ln. N. of PRs on Org. Change per Emp.		0.028***		0.019***		0.018***
		(0.006)		(0.007)		(0.007)
Ln. N. of PRs on Tech. Develop. per Emp.			0.025***	0.008		−0.001
			(0.005)	(0.006)		(0.005)
Ln. N. of Patent Applications per Emp.					0.011***	0.010***
					(0.002)	(0.002)
Ln. N. of Trademark Registrations per Emp.					0.011***	0.011***
					(0.002)	(0.002)
Ln. N. of Design Registrations per Emp.					−0.004**	−0.003**
					(0.002)	(0.002)
Constant	0.060***	0.060***	0.059***	0.066***	0.091***	0.094***
	(0.012)	(0.012)	(0.012)	(0.013)	(0.012)	(0.012)
Industry-year dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	14,072	14,072	14,072	14,072	14,072	14,072
R squared	0.223	0.224	0.222	0.225	0.238	0.240

Notes: **$p < 0.05$, ***$p < 0.01$

trademark applications have significant and positive effects on TFP. If all the LBIO indicators are included in the model (Column (vi)), while the coefficients on design registration, new product announcements, and press releases concerning technological development become insignificant, the coefficients on the press releases related to organizational changes, patent applications, and trademark registrations remain significant and positive.

5.5.3 Relationship Between LBIO Indicators

Some LBIO indicators are not independent and are conceptually dependent on each other. First, trademark registrations and new product-related press releases should be related, because both indicators measure product innovation. Figure 5.8 shows the form of the relationship between the number of trademark registrations and the number of new product-related press releases. The relationship between the two indicators is positive and almost linear. On the other hand, patent applications and press releases on technological development are also conceptually related. Figure 5.9 shows a positive but nonlinear relationship between the number of patent applications and the number of technological development-related press releases. A positive relationship between the two indicators is stronger at low and high levels and weaker at the middle level.

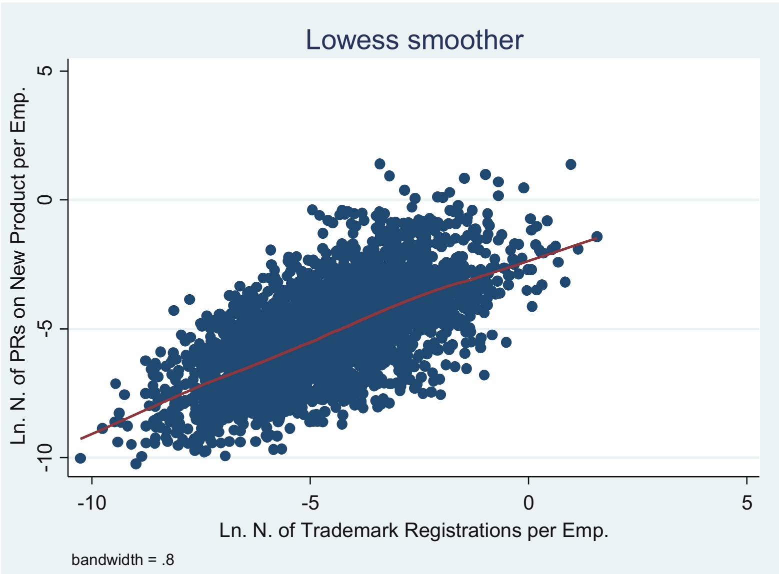

Fig. 5.8 Trademark registration versus new product press releases

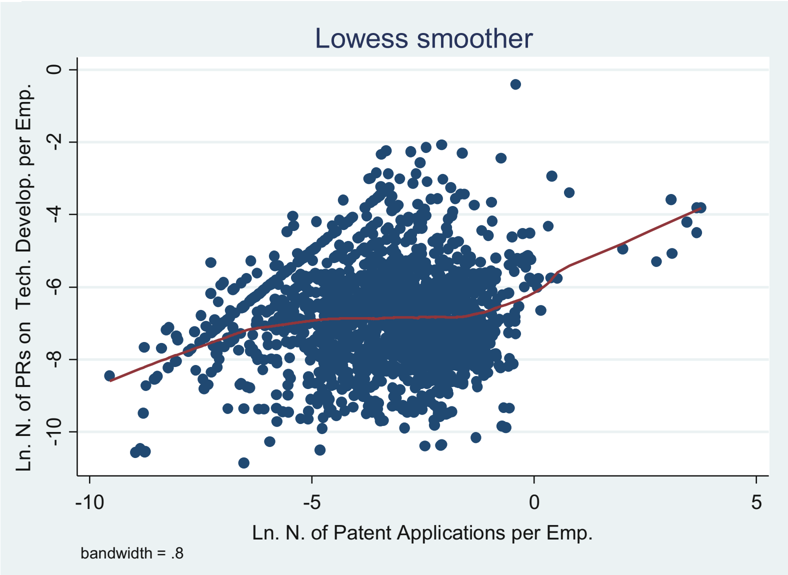

Fig. 5.9 Patent applications versus technological development press releases

5.6 Conclusions

This chapter examined the relationship between various innovation output indicators. Linking several micro data sets on firm-level innovations, such as the J-NIS databases of intellectual property rights and press releases, I examined the relationship between questionnaire-based innovation output indicators and LBIO indicators. The empirical results indicate that there are consistent and statistically significant relationships between innovation output measurements based on the innovation survey and the LBIO indicators. I confirmed that the patent data, trademark data, and press release data contain the information that contributes to the measurement of firms' product innovation. The empirical results show that these LBIO indicators represent technological innovation such as product innovation and nontechnological innovations such as marketing and organizational innovation. On the one hand, I confirmed that design registration data represent the firms' design activity and design innovation. On the other hand, organizational change-related press releases have a significant relationship with organizational innovation. Moreover, this chapter confirms significant relationships between LBIO indicators and firm performance. I found a significant positive effect of LBIO indicators on firm market value and firm TFP. These results indicate that, in addition to direct firm questionnaires, using the LBIO data including trademarks, design registrations, and press releases as well as patent data is important to measure the multidimensional characteristics of innovation outputs at the firm level.

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Chapter 6
Organizational Design and Human Resource Management of R&D Activities

Shoko Haneda

Abstract This chapter elucidates the relationship between innovation outcome and organizational design of research and development (R&D) activities including human resource management (HRM) within a firm. This chapter first reviews the related literature on the interaction between organizational and human resource management (OHRM) and innovation. The chapter then focuses on three types of management practices: cooperation and coordination across firm business units or divisions overall, HRM of R&D personnel, and restructuring the organization of R&D. The chapter provides a detailed overview of the characteristics of Japanese firms' patenting activities by combining two datasets, the Japanese National Innovation Survey (J-NIS) 2009 and the Institute of Intellectual Property (IIP) Database. The chapter then focuses on OHRM practices and patent applications as a proxy for innovation outcome.

Keywords Human resource management • Innovation • Organization • Patent • R&D

6.1 Introduction

What affects and what determines successful innovation? This question has been a focus for business managers, entrepreneurs, and policy makers. Many firms have implemented organizational and human resource management (OHRM) in research and development (R&D) centers or divisions to innovate new products. As a recent example in Japan, Shiseido, a global cosmetic company, announced a plan to

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S. Haneda (✉)
Faculty of Commerce, Chuo University, 742-1 Higashinakano, Hachioji, Tokyo 192-0393, Japan
e-mail: shaneda@tamacc.chuo-u.ac.jp

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reform R&D organization and establish one of the world's largest cosmetic research facilities in the city of Yokohama.[1] Shiseido uses an open lab environment where innovation is conducted in a vibrant space, buzzing with activity, which enables customers, marketers, and researchers to mingle daily, strengthening basic and generic research in new fields.

In academic articles, Teece (1996), for instance, argued that an important determinant of innovation is firm organization. Researchers should understand the importance of market structure, the business environment, and the formal and informal structures of firm organization, where formal structures include factors such as scale, scope, integration, and hierarchy while informal structures are composed of a firm's organizational culture, including its norms, values, and the shared identity within the firm. Quantitative evidence indicates that organizational factors are determinants central to innovation inputs and outputs. For example, estimating patent production functions, Pakes and Griliches (1984) found that the magnitude of the coefficient on R&D investment fell drastically when firm-specific effects were controlled. Meanwhile, Scott (1984) found that firm fixed effects explained approximately 50% of the variance in R&D intensity. These results imply that there are unobserved firm-specific factors that greatly affect innovation activities. While neither of these two studies nor any subsequent research explores the key determinants of such firm-specific effects, one possible explanation of the results is that firm-specific organizational practices play a role in determining firms' innovation outputs and inputs.

The literature has increasingly focused on various features of organizations, including (1) the design of incentive systems, (2) the firms' ability to manage spillovers of knowledge, and (3) the firms' choice of organizational structure. OHRM is the most important form of nontechnological innovation and the most difficult to grasp both on a conceptual and on an empirical level. Azoulay and Lerner (2013) noted that most knowledge does not stem from the mining of traditional datasets such as large-sample survey census-type datasets. There are data constraints and methodological problems related to the availability of appropriate indicators to measure OHRM on firm-level innovation. In addition, empirical examinations on organizational R&D management are relatively scarce. Instead, the literature investigates, for example, the relationship between firm productivity and firm-wide management practices such as the role of teams, payment schemes, and training for workers overall, without specifically focusing on management practices for researchers and/or research units.

This chapter examines in detail the characteristics of organizational management and innovation activities of Japanese firms. For the analysis, this chapter uses the firm-level data underlying the Japanese National Innovation Survey (J-NIS) conducted by the Ministry of Education, Culture, Sports, Science and Technology in 2009. The survey is the Japanese equivalent of the Community Innovation Survey

[1]For more details, see the Nikkei website, March 27, 2015: http://www.nikkei.com/ (accessed on September 20, 2016).

(CIS) conducted in the European Union. The J-NIS contains rich information on innovation inputs such as financial support from public sectors, cooperation for innovation, or information sources for innovations. The survey similarly includes information on innovation outputs such as realizing product/process innovations, effects of innovation, or sales of new-to-the-firm innovations except for the information on patenting activities.

This chapter is novel because I also use firm-level patent application data from the Institute of Intellectual Property (IIP) Database for the reference years from the J-NIS 2009. This chapter reviews the characteristics of Japanese innovating firms with patent applications using the number of co-applicants or the types of co-applicants and their innovation inputs and outputs. The chapter then investigates the relationship between firm-level information on OHRM and patent application. It has been frequently suggested that OHRM should be reformed in response to changes in the functions of the central research institute, incentives to innovate, and the attribution of invention to researchers. The results of this chapter could be useful to show the effectiveness of OHRM on innovation by focusing on eight management practices.

The remainder of this chapter is organized as follows. The following section provides a survey of the related literature and highlights the importance of organizational factors as determinants of innovation outcome. Section 6.3 describes the dataset used in this chapter and discusses various characteristics of innovation activities of Japanese firms. Section 6.4 concludes with some remarks.

6.2 Related Literature

This section briefly explains the importance of organization factors as determinants of successful innovation based on the literature by Teece (1996). The section then reviews the findings of previous empirical studies and summarizes the issues on the role of OHRM for innovation activities.

Teece (1996) focused on the importance of strength of innovation activities to the formal and informal structures of a firm. Specifically, innovation tends to be characterized by uncertainty, path dependency, and technological interrelatedness. Innovation tends to be cumulative in nature and to exhibit irreversibility; knowledge is often tacit, and innovations can be difficult to appropriate. Given these underlying properties of technological innovation, Teece (1996) identified the organizational requirements for innovation success: (1) joint research projects or alliances with other firms to obtain better access to capital, (2) cooperation and coordination across business units or divisions to mitigate various types of uncertainties, (3) horizontal and/or vertical integration of organizational subunits such as R&D, manufacturing, and marketing to attain economies of scope and successfully commercialize innovations, and (4) human resource management (HRM) practices to develop corporate norms and instill them in employees. Based on Teece's (1996) discussion, this chapter – reflecting data availability – focuses on the following three broad types of management practices: (1) cooperation and coordination across business units or divisions of the firm, (2) HRM of R&D personnel, and (3) restructuring of organizational R&D. The remainder of this section reviews the findings of previous empirical studies on these types of management practices.

First, cooperation and coordination across business units or divisions are expected to increase knowledge spillovers within a firm and to improve firm performance. A substantial number of studies have correlated various aspects of firms' performance with various management practices. Bloom and Van Reenen (2007), for example, constructed original data with a sample of 732 medium-sized manufacturing firms in the USA, the UK, France, and Germany by collecting accurate responses and obtaining interviews with managers. Bloom and Van Reenen (2007, 2011) mainly focused on the effects of HRM on productivity as the key outcome and, thus, elaborately surveyed the related literature. The authors expected any changes in HRM to produce a positive outcome, on average, because firms improve their productivity through optimization, and the authors also expected the introduction of incentive pay to affect the type of workers who wanted to join and leave firms. Their results indicated that the management scores calculated in their research were strongly associated with measures of firm performance such as productivity, Tobin's q, and sales growth.

Bloom and Van Reenen (2007) calculated management scores as the simple average of scores across 18 questions related to both OHRM issues. The authors' measures of management practices thus include both OHRM practices and do not separate the effects of each type of management practice. Although this approach makes sense in certain respects – because some management practices are mutually complimentary, and it is not straightforward to attach weights to individual practices – an average score makes identifying the management practices most important for the determinants of firm performance difficult. Focusing on organizational management practices, Evangelista and Vezzani (2010), using a large micro dataset of European CIS from 2002 to 2004, showed that organizational innovations have a positive and significant impact on sales growth for firms in many of the European manufacturing industries. Evangelista and Vezzani (2010) attempted to capture nontechnological content of innovations and to distinguish organizational innovations from marketing innovation based on the questions.[2] However, the authors did not separate the effects of each type of management practice.

Second, a subject that has received considerably more attention is the role of incentive systems such as pay for performance. Incentives include remuneration

[2]CIS asked whether firms had (1) implemented new or significantly improved management systems, (2) made a major change to the organization of work within the enterprise, such as changes in the management structure or integrating different departments or activities, (3) introduced new or significant changes in relations with other firms such as alliances, partnerships, outsourcing, and subcontracting, (4) made significant changes to the design or packaging of a good or service, and (5) introduced new or significantly changed sales methods or distributions channels such as Internet sales, franchising, direct sales, or distribution licenses.

systems such as individuals/group incentive/contingent pay, appraisal, promotion, and career advancement programs. Managers design various reward programs mixed with extrinsic reward programs, such as incentive pay, and intrinsic reward programs, such as performance-based evaluation systems, to stimulate employee motivation. Theoretical and empirical research presents conflicting findings on the relationship between extrinsic rewards and innovation outcomes represented by new products and services, productivity, or profitability. Many studies indicate that extrinsic rewards are ineffective when employees are charged with tasks that require innovation and creativity.

Studies on pay for performance have thus produced mixed results. While some literature showed that compensation based on the pay-for-performance principle induces higher levels of effort and productivity (e.g., Lazear 2000; Shearer 2004), other studies highlighted the distortions associated with incentive pay schemes (e.g., Bloom and Van Reenen 2011). Meanwhile, using a large micro dataset on inventors, Nagaoka et al. (2014) examined the relationship between revenue-based payments for inventions and research outcomes proxied by the number of patent citations. The authors found that although incentive pay schemes tend to increase the number of patent citations (i.e., they result in higher quality inventions), the effects depend on the degree of inventors' intrinsic motivation for science. Intrinsic motivation is based on researchers' enthusiasm for exploration and implies that researchers work on a project because they find it personally rewarding. On the other hand, monetary incentives provide only extrinsic incentives, and Nagaoka et al. (2014) found that for inventors with greater intrinsic motivation, incentive pay schemes have smaller positive effects. Onishi (2013) found that although monetary compensation from incentive pay schemes leads to an increase in the number of patent citations, it does not contribute to an increase in the number of patents. The results are consistent with the findings of Stern (2004), who, using a dataset on job offers for postdoctoral biologists, observed a negative relationship between intrinsic and extrinsic incentives. These studies suggest that firms need to design incentive schemes that do not crowd out researchers' intrinsic motivation to innovate.

Studies that statistically examined the relationship between remuneration schemes and innovation include those by Lerner and Wulf (2007), Yanadori and Cui (2013), and Kanama and Nishikawa (2015). Lerner and Wulf (2007) analyzed the relationship between the compensation of senior executives and R&D outcomes and found that long-term incentives, such as stock options, are associated with heavily cited patents. In contrast, Yanadori and Cui (2013) focused on the compensation of R&D employees and found that pay dispersion among R&D employees in US high-tech firms is negatively associated with firm innovation proxied by the number of successful patent applications. The results suggest that large pay differentials among employees decrease employees' collaboration as well as preclude innovation. Kanama and Nishikawa (2015) examined the effects of extrinsic rewards for R&D employees on innovation outcomes using a sample of 942 manufacturing firms from J-NIS 2009. The authors found that performance-based monetary compensation systems do not have a positive impact on innovation while the introduction of an assessment system based on R&D performance does.

Also of interest in this context is the study by Ederer and Manso (2013), who, using a laboratory experiment, provided evidence that the combination of tolerance for early failure and reward for long-term success is effective in motivating innovation, suggesting that incentive schemes should be designed from a long-term perspective. The results are consistent with the findings by Lerner and Wulf (2007) and Kanama and Nishikawa (2015) that long-term incentives are positively associated with innovation.

Finally, turning to R&D organization structures, several studies investigated whether the choice of a centralized or decentralized R&D structure affects R&D outcomes. Argyres and Silverman (2004), using a sample of 71 large research-intensive corporations, showed that firms with centralized R&D labs generate more highly cited patents than firms with decentralized structures. Lerner and Wulf (2007), focusing on the relationship between innovation and compensation of corporate R&D heads with a sample of 500 firms listed by Fortune, found that more long-term incentives are associated with innovation in firms with centralized R&D organizations while no association in firms with decentralized R&D organizations was found. These studies suggest that firms with a centralized R&D organization tend to generate more frequently cited patents.

Most of the studies mentioned employed patent citation data to measure innovation outcomes. Azoulay and Lerner (2013) noted that patents are direct outcomes of firms' innovation activities. However, patent citations represent neither the relevance of the research to the firm's product market nor the role of management practices in the successful commercialization of innovation. A better proxy for the relevance of research outcomes is the sales from innovative products. Moreover, some management practices may be complementary, and the choice of management practices is potentially endogenous. Previous studies provide suggestive conditional correlations, not estimates of causal effects. In addition, HRM and organization management practices have complimentary effects; however, such complementarities are not sufficiently explored in previous studies. The internal organization of innovating firms still represents a black box, and knowledge on the management of the impact of each management practice is still limited. Many questions related to the effects of OHRM practices on innovation remain.

6.3 Japanese Firms' Patent Application and Human Resource Management Practices

6.3.1 Data

In the following sections, by focusing on OHRM issues, I examine the factors affecting the likelihood that firms innovate using a large-scale firm-level dataset on innovation. Specifically, this chapter investigates complementarities among various management practices and identifies which management practices are strongly associated with innovation outcomes.

The data used in this study are firm-level data from the J-NIS.[3] The survey is based on the Oslo Manual and provides a wide range of information on firms' innovation activities and their outcomes, such as the sale of products that embody innovations new to the firm or the market.

The J-NIS was conducted in 2003, 2009, 2012, and 2015, and the data collected in the 2003, 2009, and 2012 surveys were available for academic research at the time this study was conducted. However, each survey is considerably different in sample size and size distribution of responding firms.[4] Moreover, the questions and choices provided for answers were also different, although all the surveys are based on the Oslo Manual. This means that only the J-NIS 2009 extensively surveys HRM of researchers and organizational management of research units/divisions, while the 2003 and the 2012 J-NIS focus more on organizational management of the entire firm. Therefore, this study uses the J-NIS 2009 data. In addition, for the empirical analyses, I eliminated observations on firms that did not provide information on their total sales amount. Consequently, 3,837 observations remained for the year 2009. Table 6.1 shows the number of firms by industry. Although more detailed (3-digit level) industry information is available, this study classifies firms into 11 manufacturing industries and 7 nonmanufacturing industries. A sample for this study includes 1,589 manufacturing firms (41.4%) and 2,248 firms that fall into the nonmanufacturing industry category (58.6%).

6.3.2 Overview of Patent Applicants and Innovation Activities

J-NIS contains rich information on firms' innovation activities. One of the greatest advantages of using J-NIS is the ability to define firm-level innovation output as the successful introduction of new products or sales from innovation products, such as

[3]The statistical analysis of the firm-level data was conducted by the First Theory-Oriented Research Group, National Institute of Science and Technology Policy (NISTEP), Ministry of Education, Culture, Sports, Science and Technology (MEXT) under arrangements that maintain legal confidentiality requirements. The firm-level data from this national survey are available to researchers for academic research purposes. There is no restriction on who can apply to use the data if it is for academic purposes, but researchers must provide the necessary documents, and the data cannot be taken out of Japan.

[4]Although for all of the surveys the questionnaire was sent out to a sample of firms with ten or more employees, the size distribution of the sample firms differs across surveys. In the 2003 survey, 19% of the firms that answered were large firms (250 or more employees) while in the 2009 survey, 48% were large firms. It is possible to construct a panel consisting of firms that responded to all three surveys but, unfortunately, there are few such firms, and the number of observations is insufficient. For more details on the 2003, 2009, and 2012 J-NISs, see the National Institute of Science and Technology Policy (2004, 2010, 2014).

Table 6.1 Number of firms by industry

Industry	ISIC Rev. 3.1	Number of firms
Manufacturing		1589
Food products and beverages, tobacco products	15–16	121
Textiles; wearing apparel; dressing and dyeing of fur; tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harnesses, and footwear	17–19	104
Wood and products of wood and cork, except furniture; articles of straw and planting materials; paper and paper products; publishing, printing, and reproduction of recorded media	20–22	141
Coke, refined petroleum products, and nuclear fuel; Chemicals and chemical products	23–24	134
Rubber and plastics products	25	102
Other nonmetallic mineral products	26	62
Basic metals and recycling; fabricated metal products, except machinery and equipment	27–28, 37	201
Machinery and equipment n.e.c	29	156
Office, accounting, and computing machinery; electrical machinery and apparatus n.e.c; radio, television, and communication equipment and apparatus; medical, precision, and optical instrument, watches and clocks	30–33	335
Motor vehicles, trailers, and semi-trailers. Other transport equipment	34–35	167
Furniture, n.e.c	36	66
Nonmanufacturing		2248
Agriculture, hunting and forestry, fishing, mining and quarrying	1–2, 5, 10–11, 13–14	104
Electricity, gas, heat supply, and water	40–41	275
Wholesale and retail trade; repair of motor vehicles	50–52	825
Transport, storage, and postal services	60–64	327
Telecommunications	64	246
Financial intermediation	65–67	163
Real estate; rental, and leasing activities; business services	70–74	308
Total		3837

realizing product/process innovations, effects of innovations, or sales of new-to-the-firm innovations.

Patents are a common proxy for direct outcomes of firms' innovation activities, and they have been used in previous research as detailed in Sect. 6.2. For HRM, firms might use patents as an evaluation for personnel assessment or incentive payment schemes for researchers. Because the information on patents is excluded from the J-NIS, how many patents were applied by innovating firms or how many applicants were applied by innovating firms is unknown. This chapter combined the data from J-NIS 2009 and the IIP Database to examine the relationship between firms' management on effective R&D and patenting activities.

This chapter uses the information of patents applications submitted to the Japan Patent Office during the period from 2006 to 2008, responding to the J-NIS 2009. The database is called the IIP Database constructed by the Institute of Intellectual Property, a research institute based in Tokyo, and the methodology for the construction is based on Goto and Motohashi (2007). Tracing the innovation activities and patenting of firms, this chapter first matched the patent application number in the IIP Database with innovation activities of the corresponding firm number in the J-NIS 2009. A total of 94,469 patents were submitted from 700 of 3,837 sample firms. This subsection summarizes the information on the patents submitted by the firms of the J-NIS 2009 and then examines the characteristics of the firms' innovation activities based on the results of the J-NIS 2009.

Table 6.2 shows the number of firms that applied for patents by industry. The first category in Table 6.2 indicates that 68.5% of total firms were classified as manufacturing industry firms. The second and third categories in the table indicate the number of firms that applied for patents independently and jointly and independently only, respectively. Seven hundred firms from J-NIS 2009 applied for patents from 2006 to 2008. Five hundred and sixty firms applied independently for patents, whereas 515 firms co-applied for patents; 185 firms (26.4%) only applied independently for patents, and 140 firms (20.0%) only co-applied for patents, and 375 firms out of 700 firms (53.6%) applied for patents both independently and jointly. The share of firms applying for patents by themselves as well as jointly with research partners is 40–63.5% in manufacturing industries, which is much larger than for firms with other activities.

Iwasa and Odagiri (2004) investigated the contribution of R&D at home and abroad to firms' inventing activity using a sample of 137 Japanese multinationals and noting the extent that the firm can gain from external technological knowledge, which is determined by the interaction of several factors. One important factor is absorptive capacity, that is, the capacity to scan, evaluate, and assimilate the technological knowledge to be integrated. Thus, for successful innovation, firms have a sufficient absorptive capacity with a certain level of prior related knowledge accumulated through their own R&D. Considering the number of patent applications per firm, firms may conduct research collaboration to use external knowledge for challenging themes in conducting their own research projects. I expect that 53.6% of the targeted 700 firms apply for patents independently and jointly with research partners as innovation outputs according to their R&D strategies.

Though the share of those firms is over 50% of targeted firms (Table 6.2), the total amount of the co-applied patents is small. Table 6.3 shows the number of patent applicants from 2006 to 2009. Table 6.3 indicates that 94,469 patents were submitted during the period, and the share of patents applied for with more than one partner was 15.7% (=100 − 84.3). The number was small compared to independently applied patents. Tables 6.2 and 6.3 imply that a large number of Japanese innovating firms filed singly and jointly; however, the greatest number of patent applications were independent submissions.

Table 6.2 Number of firms applying for patents by industry

Industry	Number of firms	Number of firms applying patents independently and jointly	Number of firms applying patents independently only
Manufacturing	480	279 (58.1%)	120 (25.0%)
Food products and beverages, tobacco products	19	11 (57.9%)	2 (10.5%)
Textiles. Wearing apparel; dressing and dyeing of fur. Tanning and dressing of leather manufacture of luggage, handbags, saddlery, harness, and footwear	22	12 (54.5%)	6 (27.3%)
Wood and products of wood and cork, except furniture; articles of straw and planting materials. Paper and paper products. Publishing, printing, and reproduction of recorded media	21	9 (42.9%)	9 (42.9%)
Coke, refined petroleum products, and unclear fuel. Chemicals and chemical products	54	34 (63.0%)	11 (20.4%)
Rubber and plastics products	40	26 (65.0%)	7 (17.5%)
Other nonmetallic mineral products	22	14 (63.6%)	5 (22.7%)
Basic metals + Recycling. Fabricated metal products, except machinery and equipment	81	50 (61.7%)	18 (22.2%)
Machinery and equipment n.e.c	63	40 (63.5%)	16 (25.4%)
Office, accounting, and computing machinery. Electrical machinery and apparatus n.e.c. Radio, television, and communication equipment and apparatus. Medical, precision, and optical instrument, watches and clocks	100	54 (54.0%)	26 (26.0%)
Motor vehicles, trailers, and semi-trailers. Other transport equipment	35	14 (40.0%)	14 (40.0%)
Furniture, n.e.c	23	15 (65.2%)	6 (26.1%)
Nonmanufacturing	220	96 (43.6%)	65 (29.5%)
Agriculture, hunting and forestry, fishing, mining and quarrying	2	0 (0.0%)	0 (0/0%)
Electricity, gas, heat supply, and water	58	28 (48.3%)	11 (19.0%)
Wholesale and retail trade; repair of motor	67	35 (52.2%)	24 (35.8%)
Transport, storage, and post	10	4 (40.0%)	1 (10.0%)
Telecommunications	8	2 (25.0%)	2 (25.0%)
Financial intermediation	9	2 (22.2%)	6 (66.7%)
Real estate, renting, and business activities	66	25 (37.9%)	21 (31.8%)
Total	700	375 (53.6%)	185 (26.4%)

Table 6.3 Patent counts by the number of applicants from 2006 to 2008

Number of patent applicants	Number of patents
1	79640 (84.30%)
2	11625 (12.31%)
3	2736 (2.90%)
4	290 (0.31%)
5	53 (0.06%)
6	51 (0.05%)
7	10 (0.01%)
8	3 (0.00%)
9	37 (0.04%)
10	7 (0.01%)
11	2 (0.00%)
12	11 (0.01%)
13	2 (0.00%)
14	2 (0.00%)
Total	94469

This raises the question: What type of research partners, as sources of external knowledge, do firms look to partner with for co-patent application? The number of patents jointly submitted by 700 targeted firms was 14,829. I examined co-applicant information for each patent and classified the patents into eight categories shown in Table 6.4, identified by firm name and their business description.[5] Table 6.4 provides information on targeted firms and their engagement with the various types of innovation partners. Although many of the patents were submitted with other enterprises, the share of applied patents with at least one other applicant in the following seven categories was approximately 16%. Particularly, the patents submitted with nonprofit research institutes such as universities, higher education institutions, or/and governmental institutions or research organizations were approximately 9.5% (=6.55 + 2.94) of co-applied patents.

For R&D for science-based innovation, for example, in medical devices and clinical applications, collaboration with healthcare professionals working at medical institutions and universities is necessary for the development of future technologies corresponding to the latest global healthcare trends and clinical needs. Clinical evaluation studies and investigations in cooperation with medical facilities, academic publications, and scientific presentations are necessary to accept the validity

[5]The first category includes subsidiaries and enterprise group membership. The second category consisted of patents submitted with university or higher education institutions. Because applicants who engaged in university laboratories applied for patents as an individual and not as a university laboratory, the number of patents submitted by universities must be underestimated. I thus modified the number using the information on partners for innovation from the J-NIS 2009 and using the mailing address of individual patent applicants. The sixth category includes overseas enterprises and universities. The seventh category excludes individuals who belonged to university laboratories.

Table 6.4 Number of patents by categories of co-applicants from 2006 to 2008

Co-applicants	Number of patents
Other enterprises	12476 (84.13%)
Universities, higher education institutions	971 (6.55%)
Governmental institutions and research organizations	436 (2.94%)
Consultants, commercial laboratories/R&D enterprise/research institutes	1223 (8.24%)
Prefectural/municipal/provincial governments	96 (0.65%)
Overseas enterprises	182 (1.23%)
Individual person/association	222 (1.50%)
Foundations/incorporated associations	302 (2.04%)
Total number of patents which jointly applied	14829

Notes: Some co-applicants (e.g., a university abroad) are in more than one category. Some patents include various types of co-applicants. Therefore, the total number is much larger than the total number of patents with more than two applicants shown in Table 6.5

of new technologies. Toshiba Medical System Corporation (TMSC), which is one of the affiliated companies of Japanese major industrial/consumer electronics manufacturer Toshiba Corporation, conducts collaborative research with Kobe University for new clinical application software, image analysis technologies, and imaging methods to integrate the technologies owned by TMSC, Toshiba Corporation, and other overseas affiliated companies with Kobe University's image analysis technologies and clinical experience. Their joint research in 2004, for instance, was three-dimensional, computer-aided diagnosis (CAD), followed by clinical application software for organs/lesions using Aquilion ONE and an optical imaging method for trunk regions using Toshiba's 3-tesla magnetic resonance imaging (MRI) systems Vantage Titan 3T. Because of the joint research, TMSC has successfully introduced a variety of products based on these outcomes and produced many joint inventions (Tachizaki 2015).

As the example of TMSC's joint research indicates, I suspect that innovating firms tend to access more advanced or different types of external knowledge, although the number of patents submitted with outside partners is smaller than in Table 6.3.

J-NIS 2009 provide a more in-depth look at the differences between the firms applying for patents and the firms that are not applying for patents. Table 6.5 provides summary statistics on the innovation activities of Japanese firms based on the 2009 survey. Most of the variables in Table 6.5 are dummy variables that take one if an observation applies. The first category, consisting of firms that applied for patents during the period 2006–2008, indicates innovation activity by the firms. The table shows that 80% of firms that applied for patents were large firms and more likely to innovate than firms without patenting activities. For innovation output,

Table 6.5 Characteristics of innovation by patent application: means of variables

	Patent application in 2006–2008 = Yes	Patent application in 2006–2008 = No	Overall average
Knowledge/Innovation			
R&D intensity (internal R&D expenditure/sales in 2006) (%)	1.43	0.51	0.67
Innovator (product and/or process innovation) [0/1]	0.78	0.42	0.49
Product innovation [0/1]	0.65	0.24	0.32
Process innovation [0/1]	0.61	0.34	0.39
Amount of sales with new products (million yen; only firms with product innovation)	5579.15	506.08	1431.58
Cooperation for innovation with other firms and institutions [0/1]	0.64	0.22	0.29
Cooperation for innovation with foreign firms and institutions (only for firms with cooperation for innovation) [0/1]	0.20	0.04	0.07
Public support			
Local funding [0/1]	0.10	0.04	0.05
National funding [0/1]	0.17	0.03	0.06
Effects regarding product innovation (only for firms with product innovation)			
Increased the range of goods and services: medium or light importance [0/1]	0.44	0.15	0.20
Expanded the market or increased market share: medium or high importance [0/1]	0.29	0.11	0.15
Improved quality in goods or services: medium or high [0/1]	0.42	0.15	0.20
Effects regarding process innovation (only for firms with process innovation)			
Improved production flexibility: medium or high importance [0/1]	0.29	0.13	0.16
Reduced labor cost: medium or high importance [0/1]	0.12	0.07	0.08
Reduced materials and energy usage: medium or high importance [0/1]	0.09	0.06	0.07
Other effects (only firms with product and/or process innovation)			
Improved environment and impact or health and safety aspects: medium or high importance [0/1]	0.29	0.12	0.15
Satisfied regulations or standards: medium or high importance [0/1]	0.38	0.19	0.22

(continued)

Table 6.5 (continued)

	Patent application in 2006–2008 = Yes	Patent application in 2006–2008 = No	Overall average
Sources of information			
Internal sources within the group [0/1]	0.60	0.22	0.29
Suppliers as source of information [0/1]	0.47	0.20	0.25
Customers as source of information [0/1]	0.54	0.18	0.25
Competitors as source of information [0/1]	0.27	0.10	0.14
Universities or government as source of information [0/1]	0.40	0.08	0.14
Appropriability conditions			
Formal protection [0/1]	0.50	0.08	0.15
Strategic protection [0/1]	0.54	0.18	0.25
Firm size			
10–49 employees [0/1]	0.05	0.31	0.26
50–249 employees [0/1]	0.14	0.29	0.26
250 or more employees [0/1]	0.81	0.40	0.48
Observations	700	3137	3837

Notes: Items with [0/1] are based on dummy variables that take one for firms that apply and zero otherwise. Therefore, the mean values shown in the table for such items indicate the share of firms that apply

for example, the propensity to be an innovator measured by the amount of sales of new products, the share of firms that realized product or process innovation, was larger for firms with patent applications. For innovation inputs, the average R&D intensity was greater for this category of firms, for example. Another notable observation is that firms with patent applications were considerably more likely to have a cooperation agreement on innovation with other firms and industries and with foreign firms and institutions. These firms, moreover, were more likely to receive central government-funded public financial support for innovation activities and to use variable sources of information such as customers, universities, or government.

For the effects of innovation, firms with patent applications were more likely to increase the range of goods and service and place emphasis on improving the quality of goods and service than firms without patent applications. For the appropriability condition, firms with patent applications were more likely to use formal protections including intellectual property rights and strategic protections such as trade secrets, complexity of design, or advantages over competitors in lead time. The results imply that firms with patent applications tend to use other complementary ways and means to obtain greater profit from innovation.

6.3.3 Overview of Firms' Patent Applications and R&D Organizational Design

For internal factors affecting firms' innovation activities, patent applications are a direct outcome of innovation activities in this study, and I focus on OHRM within a firm. This section overviews the effect of HRM on the innovation of firms with patent applications.

J-NIS 2009 asked 11 questions regarding OHRM to promote efficient R&D activities during the preceding 3 years. For simplicity, I aggregate the 11 questions into eight items and group them into three broad categories. Categories O1 and O3 are related to narrowly defined organizational management while category O2 is related to HRM:

O1) *Cooperation and coordination across business units or divisions at the firm overall*

- Interdivisional cooperation/teams: The firm implemented employee rotations across divisions or created project teams across divisions.
- Interdivisional meetings/systems: The firm held meetings across divisions or introduced systems that accumulate, exchange, or share information across divisions.

O2) *R&D personnel human resource management*

- Board members with an R&D background: The firm assigned a person from the R&D division as a board member.
- Personnel assessment reflecting R&D outcomes: The firm reflected R&D outcomes in the assessment of researchers or engineers.
- Incentive payments: The firm employed an incentive payment scheme to reward inventions by employees.
- Employment or reemployment of retired researchers or engineers: The firm employed or reemployed researchers or engineers who had reached retirement age.

O3) *Restructuring of R&D organization*

- Creation/relocation/integration/reorganization of R&D centers or divisions: The firm created, relocated, integrated, or reorganized centers or divisions of the firm's R&D activities.
- Increased authority for researchers/engineers: The firm increased or extended the authority of researchers or engineers.

Table 6.6 shows the number of firms that answered affirmatively to questions related to the above management practices. The firms are further divided into two groups: firms that applied for patents in the preceding 3 years and firms that did not. First, to broadly capture the characteristics of management practices for Japanese

Table 6.6 Number of firms conducting a combination of three broad categories of organization management (total = 3837)

Combination (O1, O2, O3)	Patent application in 2006–2008 = Yes	Patent application in 2006–2008 = No
	700 (100.0%)	3137 (100.0%)
None (0, 0, 0)	124 (17.7%)	1544 (49.2%)
One	109 (15.6%)	824 (26.3%)
(1, 0, 0)	87 (12.4%)	721(23.0%)
(0, 1, 0)	19 (2.7%)	91 (2.9%)
(0, 0, 1)	3 (0.4%)	12 (0.4%)
Two	229 (32.7%)	558 (17.8%)
(1, 1, 0)	197 (28.1%)	469 (15.0%)
(1, 0, 1)	26 (3.7%)	81 (2.6%)
(0, 1, 1)	6 (0.9%)	8 (0.3%)
All (1, 1, 1)	238 (34%)	211 (6.8%)

firms, I identify the number of firms that implemented at least one practice for each of the three categories, O1, O2, and O3.

Table 6.6 lists various combinations of management practices and summarizes the number of firms by each combination. The combination (1, 0, 0), for example, represents a pattern where a firm implements at least one of the two practices from category O1 but does not implement any practices from categories O2 and O3. Similarly, the combination (0, 1, 1), for example, represents a pattern where a firm does not implement any practices from category O1 while it implements at least one practice from category O2 and at least one practice from category O3. Table 6.6 shows that the majority of the firms that did not apply for patents (49.2%, 1,544 firms out of the 3,137 firms without patent applications) did not implement any of the management practices listed in any of the three categories, that is, the combination (0, 0, 0), while most of the firms with patent applications (82.3%, i.e., 100 − 17.7%) implemented at least one of the management practices. Table 6.6 shows that firms with patent applications were much more engaged in OHRM.

However, practices from the category O1 (cooperation across business units at the firm level) were popular even among firms without patent applications; 1,959 (=721 + 558 + 469 + 211) firms out of the 3,137 firms without patent applications (62.4%) implemented at least one practice from category O1 while 868 (=91 + 558 + 8 + 211) and 312 (=12 + 81 + 8 + 211) firms implemented at least one of the practices from categories O2 and O3, respectively. Thus, the number of firms that implemented practices in the O3 category, "Restructuring R&D organization," was much smaller than the number of firms that implemented practices in the O2 category, "Human resource management," particularly in the case of firms without patent applications. Restructuring R&D organization might be a less important practice or a more difficult practice than HRM.

More importantly, a significant number of firms implemented practices from more than one category, particularly in the case of firms with patent applications;

Table 6.7 Characteristics of innovation by patent application

Number of firms (total = 3837)		
	Patent application in 2006–2008 = Yes	Patent application in 2006–2008 = No
Total number of firms	700 (100.0%)	3137 (100.0%)
Ways of organization management		
O1) Cooperation across business units		
Interdivisional cooperation/teams	431 (61.6%)	1016 (32.4%)
Interdivisional meetings/systems	524 (74.9%)	1380 (44.0%)
O2) Human resource management		
Board members with R&D background	165 (23.6%)	127 (4.0%)
Personnel assessment reflecting R&D outcome	294 (42.0%)	276 (8.8%)
Incentive payment	314 (44.9%)	294 (9.4%)
Employment or reemployment of retired researchers or engineers	268 (38.3%)	493 (15.7%)
O3) Restructuring R&D organization		
Creative/relocation/integration of R&D centers	260 (37.1%)	257 (8.2%)
Increased authority for researchers/engineers	60 (8.6%)	111 (3.5%)

229 firms (32.7%) out of the 700 firms with patent applications implemented practices from two out of the three categories, and 238 firms (34%) implemented practices from all three categories while 109 firms (15.6%) implemented practices from only one of the three categories. However, for firms without patent applications, the number and share of firms that implemented practices from all three categories is 211 firms (6.8%), which is small. The fact that a substantial share of firms with patent applications implemented all three types of management practices simultaneously suggests that all three categories are potentially important for greater efficiency of R&D activities, and there may be some complementarities among the different management practices.

Table 6.6 focused on the three broad categories of OHRM, O1, O2, and O3, and presumed that such management practices are positively associated with patent applications. Table 6.6 also indicated that implementing different types of management practices simultaneously is important for innovation outputs, for example, patent applications. I thus examine each management practice in more detail. As described in this subsection, there are two to four detailed management practices included in each of the three management categories, O1, O2, and O3. Table 6.7 shows the number of firms that implemented each of the management practices included in the three categories. The firms are further divided into two groups: firms that applied for patents from 2006 to 2008 and firms that did not.

Table 6.7 shows that both practices from category O1, "Cooperate across business units," are implemented by many firms, even by firms without patent applications. However, for category O2, for example, HRM, there is a clear difference between firms with patent applications and firms without. For firms with patent applications, the number of implementing firms was relatively evenly distributed among the three practices, for example, personnel assessment reflecting R&D outcome, incentive payments, and employment or reemployment of retired researchers or engineers. However, for firms without patent applications, employment or reemployment of retired researchers or engineers was more popular than other practices, and the personnel assessment reflecting R&D outcome was less popular. Table 6.7 also indicates that for firms without patent applications, the number of firms that implemented the two practices from category O3, “Restructuring R&D organization,” was much less than the number of firms that implemented practices from the other categories O1 or O2 while a substantial number of firms implemented practices from category O3 in the case of firms with patent applications.

Tables 6.6 and 6.7 show results that correspond to the case of Japanese firms. Given the example of Shiseido in the introduction of this chapter, the creation/relocation/integration/reorganization of R&D centers or divisions might be required to improve R&D productivity with the implementation of HRM. Another example, Takeda Pharmaceutical Company, is a global, research-driven pharmaceutical company that focuses R&D efforts on oncology, gastroenterology, and central nervous system therapeutic areas plus vaccines. Takeda conducts R&D both internally and with partners globally to stay at the leading edge of innovation. Christophe Weber became the new CEO for New Takeda in 2015 and has experience in pharmaceutical marketing for emerging countries. Weber implemented R&D personnel HRM over diverse nationalities with mixed experience. Moreover, Takeda announced plans to accelerate the R&D organization transformation by reinforcing three therapeutic areas and concentrating R&D activities in Japan and the USA. The transformation is considered critical to provide the company with the necessary organization and financial flexibility to drive innovations, enhance partnerships, and improve R&D productivity for long-term, sustainable growth. Takeda will optimize its R&D sites globally to build a world leading R&D organization and pipeline.[6]

Unfortunately, I do not have access to detailed information on each practice; however, these figures imply that there are significant differences in management practices between firms with patent applications and firms without. The difference might be caused by a necessity for HRM of R&D personnel to innovate; firms are initially not designed to apply for patents and thus fail to implement performance-based assessment applications. I conjecture that the difference should determine innovation outcome at the firm level while further investigation of this causal relationship represents another important subject for research.

[6]For more details, see the Nikkei website July 30, 2016: http://www.nikkei.com/ (accessed on September 20, 2016).

6.4 Concluding Remarks

This chapter elucidates the relationship between firms' innovation outcomes and the organizational design of R&D activities including HRM within a firm. First, this chapter reviews the related literature on the interaction between OHRM and innovation. The chapter then focuses on the following three types of management practices: (1) cooperation and coordination across firm business units or divisions overall, (2) R&D personnel HRM, and (3) restructuring the organization of R&D. This study focuses on patent applications as a direct innovation outcome and overviews the characteristics of Japanese firms' OHRM practices and patent applications by combining two datasets from the J-NIS 2009 and the IIP Database.

Based on the databases in this chapter, although the number of jointly submitted patents is smaller than the number of independently applied patents, I found that over 50% of firms with patent applications conducted innovation activities with other partners; firms co-applications tend to utilize various knowledge sources, particularly those with enterprises, universities, or higher education facilities as innovation partners. This chapter shows that firms with patent applications and firms without differ in their innovation activities; firms with patent applications use more innovation inputs and generate more innovation outputs. Firms with patent applications are larger in size, conduct more R&D, and use diverse sources of information for innovation. Similarly, firms with patent applications are more innovative with products and processes and show greater profits or results from innovation.

For OHRM of R&D activities, a significant number of firms with patent applications implemented more than one category of the three management practices, for example, (1), (2), and (3) in Sect. 6.3.3. Because firms with patent applications are much more involved in the three management categories of OHRM, I conjecture that there are some complementarities among various management practices. For the three management categories, firms with patent applications implemented personnel management and restructured R&D organization to a greater extent than firms without patent applications.

Generating value from innovation is much harder today for Japanese firms, particularly in the last two decades. Firms must reform their OHRM in accordance with recent changes in the functions of the central research institute, incentives to innovate, the attribution of invention to researchers, and the expansion of internal and external R&D. I am certain that this chapter indicates the importance of OHRM and identifies which management practices are more effective for efficient R&D by Japanese firms using quantitative information such as data from the J-NIS and IIP databases. The finding of this chapter must be useful for R&D managers/researchers/engineers in business.

Because I did not conduct an econometric analysis, further analysis using the information gained from the surveys is necessary to estimate the interrelation in detail between innovation outcome and organizational design of R&D activities. Analysis investigating the organizational management between firms with independent patent applications and those with joint applications is also necessary for further investigation. Given various data limitations, there is no detailed information on the assessment or payment system for each firm in this chapter. Similarly, this chapter does not address to what extent the wage level reflects the result of personnel assessment, which may affect researchers' motivation and change the rate and direction of innovation. Moreover, this chapter does not provide details on R&D organizational changes: whether an R&D center is closed, relocated, or integrated. Filling the gap between a quantitative analysis and a detailed case study would be necessary to understand the relationship between organizational designs of R&D activities.

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Chapter 7
R&D Alliances and the State of Market Competition

Tomoko Iwasa

Abstract The importance of the effective utilization of external resources by forming research and development (R&D) alliances has been extensively addressed by policy makers and researchers. This chapter examines the relationship between technological capabilities of firms and the utilization of external R&D resources via R&D alliances with a focus on how the state of competition affects such relationships. First, this chapter reviews the definition of R&D alliance and open innovation. Then, the determinants of R&D alliance, possible effects of R&D alliance on corporate performance, and the relationship with competition are examined by introducing prior research literature. Finally, the chapter attempts to examine the relationship between the use of external R&D resources and the state of competition based on the analytical framework in the historical study of Odagiri and Goto (*Technology and industrial development in Japan: Building capabilities by learning, innovation, and public policy*. Oxford: Oxford University Press, 1996). Using the longitudinal data of Japanese firms from the 1960s to the 2010s, the processes of technology acquirement, development of technological capability, and the restructuring of industries are a focus. The following issues are examined: the contribution of internal R&D activities and the use of joint research on the development of technological capabilities, the price-cost margin of various industries, and competitive pressure from domestic firms and foreign firms measured by the number of firms and import penetration ratios, respectively.

Keywords Competition • Joint research • Open innovation • Patents • R&D alliances • Technological capability

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T. Iwasa (✉)
Association of International Arts and Science Institute of Humanity and Social Science, Yokohama City University, 22-2 Seto, Kanazawa-ku, Kanagawa 236-0027, Japan
e-mail: iwasa@yokohama-cu.ac.jp

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7.1 Introduction

Firm competitiveness relies heavily on the capability to create innovation. Particularly, the technological capability of a firm plays a crucial role in developing and commercializing products and services. Firms mainly nourish their technological capabilities through internal research and development (R&D) activities. However, pioneering technologies can never be generated without an accurate grasp of state-of-the-art scientific and technological knowledge. Such knowledge may come from universities, public laboratories, and other firms both domestically and worldwide. Firms procure some of their R&D activities to supplement their own R&D resources. Internal R&D activities and the use of external R&D resources through R&D alliances with external organizations are complementary functions and together contribute to the development of a firm's technological capability.

Recently, attention has been given to the effective utilization of external R&D resources and open innovation as a means of coping with increasing global competition. For example, the 5th Science and Technology Basic Plan implemented from 2016 has emphasized the importance of an open innovation approach given the increasing severity of global competition.[1] This view is also shared by international policy makers. For example, Organisation for Economic Co-operation and Development (OECD) (2008) argued that firms are operating in an environment of fierce global competition where knowledge spreads around the world at much faster speeds and product life cycles are much shorter. In this context, the use of multiple sources of knowledge is one solution to the challenges that firms face.

This chapter examines the relationship between the technological capabilities of firms and the use of external R&D resources via R&D alliances with a focus on how the state of competition affects such relationships. Section 7.2 defines R&D alliance and reviews open innovation. Then, the determinants of R&D alliance, the possible effects of R&D alliance on corporate performance, and the relationship with competition are examined by introducing prior research literature in Sect. 7.3. Section 7.4 examines the relationship between the use of external R&D resources and the state of competition using a descriptive analysis from a Japanese longitudinal dataset. This analysis is based on the analytical framework in the historical study of Odagiri and Goto (1996). Thus, attention is paid to the process of technology acquirement, the development of technological capability, and the restructuring of industries.

[1]The Council for Science and Technology Policy chaired by the Prime Minister formulates the Basic Plan every 5 years.

7.2 The Concept of Open Innovation and R&D Alliance

The term "open innovation" is common these days. It was originally formulated by Chesbrough (2003) and defined as "a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology" (Chesbrough 2006, p. 1). Open innovation is proposed by the authors in contrast to the traditional vertical integration model of "closed innovation." Firms under closed innovation regimes rely mainly on in-house R&D. Such firms attempt to nourish innovation with their own researchers with the support of firms' complementary assets for innovation represented by production, marketing, and distribution facilities. All the effort is finally appropriated at the market. Research laboratories of large German chemical firms, General Electronics, or AT&T Bell laboratories are listed as examples of closed innovation regimes.

Chesbrough's (2003, 2006) argument is that closed innovation is costly and ineffective: R&D labor force mobility has gradually increased, and it has become costly to train and retain R&D labor at corporate laboratories. At the same time, increased skilled researchers educated at universities and graduate schools are working for bio start-ups and specialized R&D laboratories, encouraging division of labor in R&D activities. The shortened product life cycle and the increased competitive pressure from abroad have also augmented this trend. Thus, in this type of environment, firms can benefit from actively using external R&D resources rather than relying solely on internal resources. It is also considered beneficial to sell under-utilized R&D resources to other institutions. Therefore, the concept of open innovation implies uniting ideas produced both internally and externally in a more effective manner (Chesbrough 2003).

The various studies on open innovation are rooted in the traditional research areas of innovation and strategy. Kovács et al. (2015) used the bibliometric method to examine the research background of open innovation studies. From the Thomson Reuters Web of Science database, 358 scientific publications with the term "open" and "innovation" in the title, keywords, or abstract field were found for the period 2003–2013. Those studies have refereed 11,873 past publications: from these references, background research fields can be detected. Kovács et al. (2015) found that the open innovation-related studies are rooted in four clusters, namely, "Cluster a—Strategic Partnering and External Sourcing," "Cluster b—User-centric Innovation," "Cluster c—Technology and Innovation Management," and "Cluster d—Resource- and Knowledge-based View of the Firm."

The most cited cluster is "Cluster a—Strategic Partnering and External Sourcing." This cluster mainly concerns the inbound dimension of open innovation and studies on the determinants and effects of R&D alliances, which are the focus of this chapter and are included in this category. For "Cluster b—User-centric Innovation," studies focus on the importance of end-users in product development, user communities, and open source software. Therefore, open innovation studies mostly share the same research background as the traditional literature on R&D collaboration except for the studies on user-centric innovation. Therefore, I consider the term "open innovation" interchangeable with the issues concerning R&D alliance.

We next define R&D alliance. Odagiri (2002) first defined the concept of procured R&D as any form of external R&D resource use in the R&D process. Firms can procure part of their R&D works from external organizations. A variety of works can be purchased externally from routine services, such as data input, to the property rights of already obtained inventions. Four types of procured R&D – outsourcing, technology acquisition, commissioned research, and joint research – are examined, and among them, technology acquisition, commissioned research, and joint research are categorized as R&D alliances.

To differentiate between the four types of procured R&D, two axes of definability and predictability are introduced. Definability is determined by the complexity of the work to be procured. The more complex the work, the more difficult the work is to define; thus, the task of preparing the contract is expected to be difficult. The predictability of work depends on the timing of contracting. Making a contract for an already obtained research outcome should be easier than making a contract for ongoing research.

Using these two axes (see Fig. 7.1), various types of procured R&D can be distinguished. The higher the definability and predictability of the R&D, the easier the external research resource transactions. For example, outsourcing is the

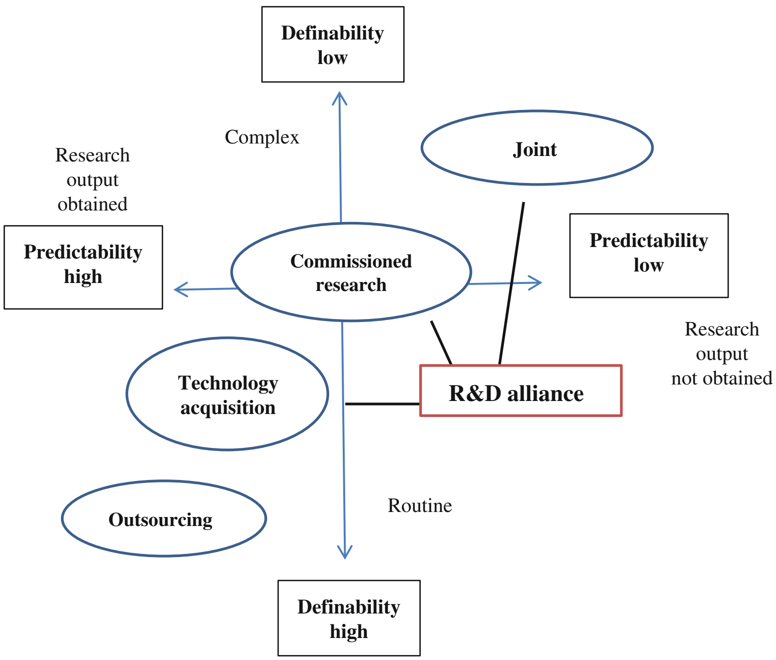


Fig. 7.1 Distinction of procured R&D: Definability and predictability (Source: Depicted based on Odagiri (2002))

procurement of routine services, and the complexity of the work is typically low; thus, the predictability and definability of outsourcing is expected to be high.

Technology acquisition is the transaction of technology in markets. Because the research outcome is already obtained and patented, the predictability and definability of the outcome are likely to be high. However, when the technology to be acquired necessitates further internal development work before commercialization, the predictability and definability could be at mid-level. Such examples can be found, for example, in the experience of technology acquisition by Japanese firms during the catching-up period.

By contrast, the predictability and definability of commissioned research and joint research are lower, and the transaction is expected to be more difficult than the above two examples. In commissioned research, commissioning party (A) pays for research expenditure and, in return, asks commissioned party (B) to implement a certain task defined in the predetermined contract. The property rights of the research outcomes belong to the commissioning party (A). In joint research, researchers from multiple organizations collaborate on a predetermined research theme. The research expenditures are shared by participating organizations and the property rights of the research output are also shared among them.

Among the four types of R&D procurement, the predictability and definability of joint research are the lowest and their management is the most complex: firms are always threatened by the possibility of free-riding. However, joint research is the most effective way to exploit the complementary capabilities possessed by different organizations. Therefore, when already obtained and known technological knowledge is required, technology acquisition can be an effective route, as was the case during the catching-up period of the Japanese experience. However when firms explore the technology frontier and need to create unexploited or state-of-the-art technology, the methods used shift toward commissioned research and joint research.

Overall, the concept of research alliances encompasses three types of procured R&D: technology acquisitions, commissioned research, and joint research. However, the routine work of outsourcing is not considered R&D alliance (Odagiri 2002).

7.3 R&D Alliance and Firms

Firms' competitiveness relies heavily on the capability to create innovation. Particularly, the technological capability of a firm plays a crucial role in developing (or improving) and commercializing products and services. Thus, technology capability is a focus of studies on National Innovation Systems (Nelson and Rosenberg 1993), which are concerned with the institutional framework to promote innovation. Based on this view, Kim (1993) defined technological capability as "one to assimilate, use, adapt, change, or create technology and to develop new products and processes in response to a changing economic environment." Moreover, Odagiri and Goto (1996) argued that technological capabilities together with entrepreneurship (supply) and demand stimulate the active entry of firms hoping to appropriate higher profits in a market. The resulting fierce competition encourages the pursuit of efficiency, eventually causing economic development. Therefore, the technological capability of firms affects competitiveness at the firm level but also industrial organization and economic development at the national level.

Firms nourish their technological capabilities through internal R&D activities. Firms hire researchers, invest in research facilities, and strive to innovate internally. These efforts stimulate growth in the technological capability of firms, but this does not mean they no longer rely on external knowledge. Pioneering technologies cannot be generated without an accurate grasp of state-of-the-art scientific and technological knowledge. Such knowledge may come from universities, public laboratories, and other firms both domestically and worldwide. At the same time, as seen in the previous section, firms procure some of their R&D activities, particularly routine works. Therefore, internal R&D and the use of external R&D resource functions complement the development of a firm's technological capability.

7.3.1 Determinants of In-House and Procured R&D

Is it possible to consider internal and external R&D resources as equivalent and interchangeable? Prior research suggests that firms encounter two problems in using external resources effectively. The first problem is the possession of absorptive capacity (Cohen and Levinthal 1989, 1990). When using external resources, firms must first recognize what type of resources they need. Then, firms must search and evaluate if an identified resource is the most suitable. Typically, a resource obtained from an external organization demands further adjustment and development before eventually commercializing a product. Cohen and Levinthal (1989, 1990) termed the ability to cope with such tasks "absorptive capacity." The authors argued that the extent of absorptive capability is determined by the level of prior related knowledge obtained as a by-product of firm's internal R&D activities. For example, scientific knowledge obtained from research organizations, such as universities, typically necessitates further R&D efforts to render it applicable for any practical purpose (Odagiri et al. 2002). Thus, when a firm hopes to absorb knowledge from a university using commissioned research or joint research, the firm cannot simply "buy and use" the knowledge: the firm must possess an adequate level of absorptive capacity through previous internal R&D efforts.

The second factor to be considered is transaction costs (Williamson 1975). Suppose a firm intends to use external R&D resources via market transactions. Then, the firm must search and choose desirable research partners or owners of that required resource. When the partners agree to cooperate, a contract should be drawn up that defines the coverage of the research tasks, treatment of research output (e.g., who will own the property rights), conditions if the research task turns out to be fruitless, and other contingency measures. After concluding the contract, the firms are required to monitor if the partners pursue their task without cheating. All of the resources, financial costs, and uncountable time and effort spent pursuing the task are, in total, considered transaction costs.

If the research output is already obtained, as was the case for technology acquisition in the previous section, developing the contracts is relatively easy given greater definability and predictability. In the case of commissioned R&D and joint R&D, definability and predictability is much lower compared to the case of technology acquisition and making contracts for future events is a complex task. Typically, the higher the transaction cost, the more advantageous it is for the firm to use internal R&D resources and not employ market transactions. At the same time, as Williamson (1975) noted, internal transactions also entail organizational costs to conduct the task internally with the involvement of multiple divisions. For example, internal organization costs may arise from a lack of market pressure or internal conflicts between divisions. Therefore, firms must seek a balance between the use of internal and external R&D resources and the expected costs and benefits.

Demonstrating such a balance, Nakamura and Odagiri (2005) empirically examined the determinants of firm boundaries for R&D using comprehensive data for 14,000 manufacturing firms in Japan. The concept of firm boundaries originated from the make-or-buy decisions in vertical chains of production. The concept can be applied to R&D and the decision to define to what extent the firm would procure its R&D tasks from external organizations.

The authors considered two fundamental theories that determine such a boundary: the already introduced transaction cost theory (Williamson 1975) and the capability theory. In applying transaction theory, the authors focused on the extent of definability and enforceability of property rights. The intellectual property rights system, particularly the patent system, may help transactions between contracting partners. The content of research output and the destination of property rights are stated clearly in the patents; thus, by involving the transaction of patents, developing contracts is simplified.

The origin of the capability theory is the theory of corporate resources advocated by Penrose (1959). Absorptive capacity, which was explained above, can be considered a part of corporate capability. Firms with greater capability in a certain area can fulfill a task faster and cheaper than firms with less capability. Therefore, a firm with less capability can benefit from delegating a task to a firm with greater capability. If a firm procures the entire research task to an external organization considering the short-term cost saving effect, the firm will lose absorptive capacity in the long run. Such a balance affects R&D firm boundaries from the perspective of capability theory.

The estimation results of Nakamura and Odagiri (2005) supported the two theories that affect the employment of three types of procured R&D (commissioned R&D, joint R&D, and technology acquisition). To examine the effect of firm capability, various firm characteristics, such as firm size, R&D intensity, diversification, vertical integration, ownership, and availability of cash flows are tested. The authors also tried to capture the effect of transaction cost by considering the appropriability of patents in the analysis. When the appropriability of patents is high, the inventor is expected to obtain more profits from innovation. This implies that the contents of the invention are solely defined in the patents, and the patents can function as an effective tool to protect the rights of the inventor. Therefore, the hypothesis is that such patents allow greater definability and predictability of the procured task, and the transaction costs are lowered.

Overall, the authors confirmed that the possession of broad absorptive capacity contributes positively to the employment of procured R&D while greater appropriability of patents induces active utilization of external R&D resources supporting the view that appropriability reduces transaction costs.

7.3.2 Effects of R&D Alliances on Firms' Performance

Does the active use of R&D alliance improve firms' performance? Two empirical studies that use the results of the Community Innovation Survey (CIS) explained in previous chapters are introduced here. First, Belderbos et al. (2004) used the survey results of Dutch firms from 1996 to 1998 and examined the effect of R&D alliance with different partners on corporate performance. Performance is measured by labor productivity (value added per employee) and productivity in innovative sales (sales generated by "new-to-the-market products" per employee). The authors recognized four types of R&D partners, competitors, suppliers, customers, and universities and research institutes. R&D alliances with those partners were expressed using dummy variables (which took the value of one for one partner while setting others as zero). The authors also differentiated between the effect occurring directly from the cooperation and the spillover effect obtained unintentionally for each of the partners. The impact of R&D expenditures was also considered.

The authors found that R&D alliance contributes to an increase in productivity, and the effect can be different depending on the type of alliance partners. Cooperation with suppliers and competitors had a positive effect on labor productivity growth while cooperation with universities and research institutes, and with competitors, had a positive effect on innovative sales productivity. We can expect from this result that R&D alliance with suppliers and competitors might contribute to lower the costs, and such contribution is reflected to the positive effects on labor productivity growth. Similarly, R&D alliances with universities and competitors might stimulate demand expansion-oriented innovations, and such innovations might be reflected to the positive effects on innovative sales productivity.

Laursen and Salter (2006) also used the Community Innovation Survey results from the UK for their study. Similarly, the authors tested the effect of R&D alliances on firms' performance. As the dependent variable, the authors used (1) sales of "new-to-the-world market products," (2) sales of "products new-to-the-firm," and (3) sales of "products significantly improved." As explanatory variables, the authors used the variable named BREADTH that was constructed by adding up the 16 dummy variables. In other words, if the value of the variable takes 16, this indicates that the firm makes alliances with 16 partners. The empirical results confirmed that the active use of alliances with external partners contributes positively to each type of innovative sales. Additionally, the authors showed that this effect occurs in an inverted-U shape, increasing up to a certain level but with a gradual weakening of the effect.

7.3.3 The Effect of Competition Policies on R&D Alliances

The previous studies introduced concerns mainly with R&D alliances and firms' attributes. This section shifts the focus to R&D alliances and the competition in an industry. Previous literature on the relationship between the form of R&D alliance and competition have been limited unlike the relationship between R&D itself and competition, which has been examined empirically by many scholars. However, Mowery (2009) is an interesting study that discussed the effect of competition policies on US open innovation.

Mowery (2009) provided an overview of the historical changes in the structure of US industrial R&D. Interest is placed on reexamining the uniqueness of current open innovation approaches to R&D management considering that the many elements of open innovation has already emerged from the development phase of the US industrial R&D system. The second Industrial Revolution at the end of the nineteenth century induced firms, particularly from the chemical and electrical machinery industries, to increase in-house R&D activities rather than rely on independent research laboratories, independent inventors, or universities through procured R&D. German chemical firms were the pioneers of this shift and profited from internally developed dyestuffs, and the US firms followed this tendency. The increase in industrial research resulted in higher profits but also induced "broader restructuring of manufacturing firms that transformed their scale, management structures, product lines, and global reach" (p. 2).

Similar to German chemical firms, US firms continued to use external R&D resources from independent R&D laboratories while increasing internal R&D until pre-1940 period. Turning to competition policy in the USA, judicial interpretations started to be more stringent from the end of the 1890s to the 1910s, and firms responded by integrating horizontally via mergers to maintain the control of prices and output. The government stopped such corporate efforts to strengthen market power using horizontal mergers, but firms, in turn, responded by promoting diversification. Here, the source of new business was sought by increasing in-house R&D and active utilization of external R&D resources. During the pre-1940 period, US competition policy did not affect the style of R&D management by US firms regardless of the degree of stringency. A pro-"open innovation" attitude was augmented by the reforms of US patent policy between 1890 and 1910. For university-industry collaboration, universities actively collaborated with industrial sectors during the prewar period given the absence of government intervention in the operation of universities.

Interestingly, there emerged a difference in R&D management styles between German and US firms after the 1940s due to a difference in competition policy. After World War II, US antitrust policy was unusually stringent. To avoid unnecessary suspicion of cooperative behavior, large US firms were discouraged from seeking R&D resources externally and began seeking sources of innovation only through in-house R&D activities. The share of contract-research firms employed in industrial research employment decreased during the twentieth century.

The next structural change in the US industrial R&D system began in the late 1970s. The shift from a heavy reliance on in-house R&D to active utilization of external R&D resources again occurred. Simultaneously, the success of many specialist IT firms and biotechnology industries contributed to the evolution of "vertical specialization" in computer, pharmaceutical, and semiconductor industries. The innovation process in such industries is now more connected via market transactions rather than vertical integration within one firm. Mowery (2009) argued that "this 21st-century structure resembled characteristics of the US industrial R&D structure of the early 20th century." This shift to vertical specialization and the subsequent active reliance on external R&D resources in the USA was gradually followed by large European and Japanese electronics industries during the late 1990s and since the year 2000.

Mowery (2009) persuasively argued the relationship between the structural factors and the historical development of R&D management. However, author's intention was to explain the effect of US competition policy on R&D management and not how the state of competition affects it. The stringent antitrust policy during the postwar period does not necessarily mean that US markets were competitive. However, if we suppose such policy brings about higher competition in the market, the US experience suggests that competitive markets might give negative effects on R&D alliance. This is the opposite of claims from advocates of open innovation. The following section provides a descriptive analysis of the relationship between R&D alliance and the state of competition since the 1960s in Japan.

7.4 R&D Alliance and the State of Competition

This section presents a descriptive analysis of the relationship between R&D alliance and the state of competition in Japan from the 1960s. The analysis is based on the historical study of Odagiri and Goto (1996). The authors proposed a comprehensive framework to understand technological and industrial development using cases from the development experience of Japan after the Meiji restoration in 1876. The authors' work was based on the idea that the acquirement of technology[2]

[2]Odagiri and Goto (1996) used the term acquisition of technology or technology acquisition to describe obtaining technological knowledge from external organizations and do not constrain the route for acquisition. In this paper, the term technology acquisition is already used as a form of R&D procurement in a narrower sense, almost equivalent to licensing. Therefore, to avoid confusion, the original term acquisition of technology and technology acquisition is replaced by acquirement of technology and technology acquirement in this chapter.

and the consequent development of technological capability result in industrial restructuring and economic development.

The idea was based on the fundamental theory of industrial organization and the concept of national systems of innovation advocated by Lundvall (1992) and Nelson (1993). Economic development occurs from three fundamental elements, technological capabilities, entrepreneurship, and demand, which represent technology, demand, and supply relationships. These fundamental factors determine the speed and the direction of industrial development: they induce active entry and competition among firms and contribute to improved efficiency of market mechanisms.

It is difficult to statistically examine the possible causality between the state of competition and the use of R&D alliances over time without using historical data at the firm level, which is not available in practice. Instead, I use longitudinal data at the industry level. These data cover over 50 years, from the 1960s to the 2010s, and this provides a perspective on the shift in industrial structure over time. Particularly in the 1960s, the Japanese economy was in the process of rapid recovery from devastation from the war: unfulfilled demand in domestic markets called for active entry by domestic firms, thus resulting in fierce competition. Additionally, the Japanese economy began with an absence of foreign competitors in the postwar period followed by gradual liberalizing of trade and inward foreign direct investment (FDI). Therefore, by constraining the analysis to the industry level, I can examine the longitudinal change in the level of competition for both domestic and foreign firms.

7.4.1 Historical Background of the Postwar Period

In 1946, compared to prewar peak levels (1934–1936), the production index for manufacturing reached approximately one-fourth, and the supply of food was limited to only 51%. The damage to production facilities (plant and equipment) remained one-third of prewar levels, but the lack of fuel, materials, and intermediate goods limited the recovery of production activities. Therefore, the economic condition of the immediate postwar period can be understood as extreme devastation with unfulfilled demand and malfunctioning supply (Odagiri and Goto 1996).

Then, Japan began to experience a high rate of growth in the 1950s: during the mid-1950s and the early 1970s, approximately 10% of economic growth was observed annually (Odagiri and Goto 1996). This rapidly expanding economy encouraged firms to enter markets and stimulated competition. Active entry was observed in crucial industries such as home electric appliances, automobiles, steel, aluminum smelting, and petro-chemistry (Goto 1993).

Growing markets stimulated firms' incentive to invest in new manufacturing facilities and new technology in the hope of achieving higher profits. Simultaneously, fierce competition among firms forced the failed firms to exit from the market. Because the import of technology from abroad was banned during wartime, firms had relied on internal R&D resources to pursue innovation. This allowed some firms to develop and maintain a certain level of absorptive capacity, but their technological capability was damaged by isolation from Western technologies. Therefore, after World War II, firms actively sought the opportunity to enhance their technological capability with both internal and external R&D resources. The importation of technology from abroad was a crucial source of the seeds of innovation (Odagiri and Goto 1996).

The channels for importing technology were varied: firms could learn from imported machinery and equipment by reverse engineering. Firms could also source foreign technology through technology acquirement such as licensing and the purchase of blueprints. However, to transfer more complex and nondefinable technological knowledge, closer interrelationships with foreign firms were required. For example, most of the Japanese automobile firms were eager to engage in technological alliances with the US or European automobile firms. Moreover, the postwar political system was tolerant in encouraging the trading of goods and technology and reinforced the active importation of technology from the US to European countries and Japan. The total payment of technology importation from Japan, France, and Germany increased 1.8 times in 1960 (Odagiri and Goto 1996).

This active technology acquirement from abroad slowed near the end of the 1960s. The first reason for the slowdown was that foreign firms became hesitant to export their technology unilaterally to Japan and began to demand the licensee's technology in return: the number of cross-licenses began to increase reflecting this tendency. In addition, new technology attainable via technology acquisition from abroad decreased: the ratio of completely new technology to total imported technology was 65% in 1963, but decreased to 30% in 1968. The *White Paper on Science and Technology* declared in 1969 that the age of merely importing Western technology developed after the prewar period was over (Goto 1993). The importable technology developed in the USA and in Europe during the war period was already exploited by the end of the 1960s.

This period marked a shift in Japan's development from catching-up to the Western nations to the exploration of the technology frontier. Through technology acquisition, which is in most cases through licensing, firms gain already developed research output. During the catching-up period, the type of technology the licensee hoped to obtain was not necessarily state of the art. Therefore, the possibility that technology could be licensed increased: such technology could be relatively obsolete for the licensor and the threat of the licensee as a competitor was not great. As Japanese firms began to explore the technology frontier, it became more difficult to attain technology through licensing, as was the case for technology imports from US firms to Japan at the end of the 1960s. At that time, firms could not solely rely on external technology and began to engage in the development process even when they used external R&D resources. Among the three types of R&D alliances, the shift from technology acquisition to commissioned and joint research should be observed.

In terms of the familiarity of joint research among Japanese firms, Goto (1993) introduced an example of joint research based on studies at the beginning of the 1900s. The trade associations of textiles and potteries organized joint research among member firms with success: their aim was to improve the quality of the products and to increase exports, and cooperation with public experimental stations was observed. This type of joint research organized by the trade associations has been commonly used in various industries.

Moreover, Odagiri and Goto (1996) suggested that the traditional management style by Japanese manufacturers also encouraged joint research: Japanese firms actively promoted division of labor along the vertical chain, which resulted in joint research among users and supplier firms. Given the close relationship between users and suppliers, for example, between steel manufacturer and shipbuilders, firms are less likely to suffer from high transaction costs and to benefit from R&D resources of partner firms. Rokuhara (1985) reported on survey results from joint research among manufacturing firms. This survey was implemented by the Japan Fair Trade Commission in 1982 and covered four industries: electronics and communications, automobile and parts, chemicals, and other materials. The survey results revealed that almost half of the responding firms conduct some form of joint research, and there are 8.7 studies per firm on average. Moreover, most of the joint research in the 1980s was implemented among user-suppliers and not with competitors.

7.4.2 Technology Acquirement and Technological Capability

Given the history of technology acquirement before the 1960s in Japan, I use descriptive statistics to examine the situation after the 1960s. First, I examine effort for technology acquirement using R&D expenditures and then analyze how firms develop technological capability using sole and joint patent application data. Figure 7.2 shows the change in internal R&D expenditures by selected industries: textile, chemical, pharmaceutical, iron and steel, machinery and precision, electricals and transportation from 1961 to 2014. As seen in the previous section, internal R&D contributes to growing internal R&D resources and enhancement of absorptive capacity, which is required for external R&D resource use. Overall, internal R&D expenditure is likely to proxy for firms' efforts to develop technological capability.

In 1961, the R&D expenditures of the electrical industry were the highest, followed by chemicals. At this stage, industrial variation in the size of expenditure was relatively limited. For example, the textile industry had the lowest expenditures among seven industries, and the electrical industry spent approximately seven times more than textiles in 1961. Since then, R&D expenditures for the electricals, chemicals, transportation, machinery, and precision industries have rapidly expanded, particularly since the 1980s. As a comparison, the electrical industry spent 25 times more than the textile industry in 2014: the difference between R&D intensive industries and the others has significantly increased. These findings imply that efforts to develop technological capability have varied among industries. Consequently, the relative level of technological acquirement from external R&D resources could be higher among R&D intensive industries but less so in others, reflecting the relative level of absorptive capacity.

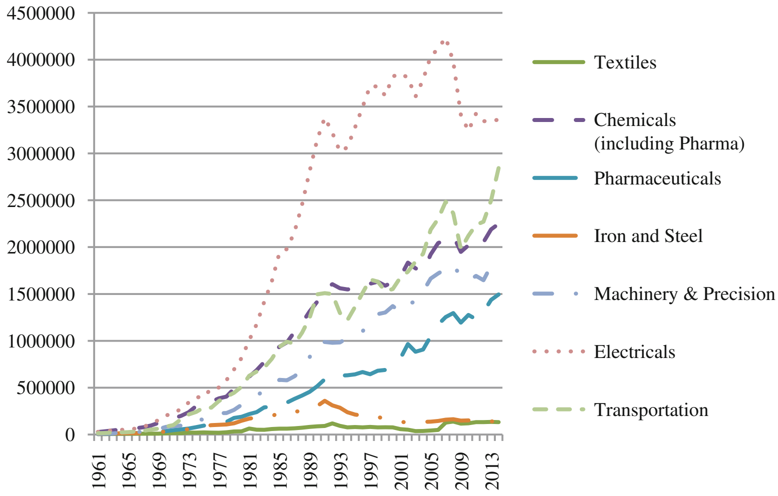


Fig. 7.2 Internal R&D expenditures by industry: 1961–2014. Note: Unit: One million yen (Source: I used data on Intramural expenditure on R&D (disbursement) by business enterprise from various years of the Survey of Research and Development, Statistics Bureau)

Of course, part of the difference in aggregated R&D expenditures stem from the industry characteristics: the differences in the relative importance of technology as a source of innovation. In some industries, for example, knowledge obtained from efficient operation of production facilities, or from sophisticated face-to-face sales, could be much more important than knowledge obtained from R&D activities as a factor to determine the capabilities of firms. Nevertheless, much of the technological progress is inevitably dependent on R&D activities in the modern corporate world. Thus, it is still worthwhile to focus on R&D activities as a source of technological capability.

Does the effort to develop technological capability lead to the outcome? We assume that the level of technological capability can be proxied by the number of registered patents. Moreover, we also assume that the capability developed using internal R&D resources can be depicted by the number of sole applications, and the capability developed using external R&D resources is captured by the number of joint applications. Here, I use the IIP Patent Database 2015 developed by the Institute of Intellectual Property (IIP) of Japan for this purpose.[3] This database consists of registered patents sorted by application years from 1964 to 2013. It contains information on applicants, inventors, and patent citations.

The bar graphs in Fig. 7.3 show the number of registered patents of R&D intensive industries (chemicals, machinery, electricals, and transport) applied for by sole applicants and joint applicants from 1964 to 2012, respectively. Those

[3]For details on this database, see Goto and Motohashi (2007).

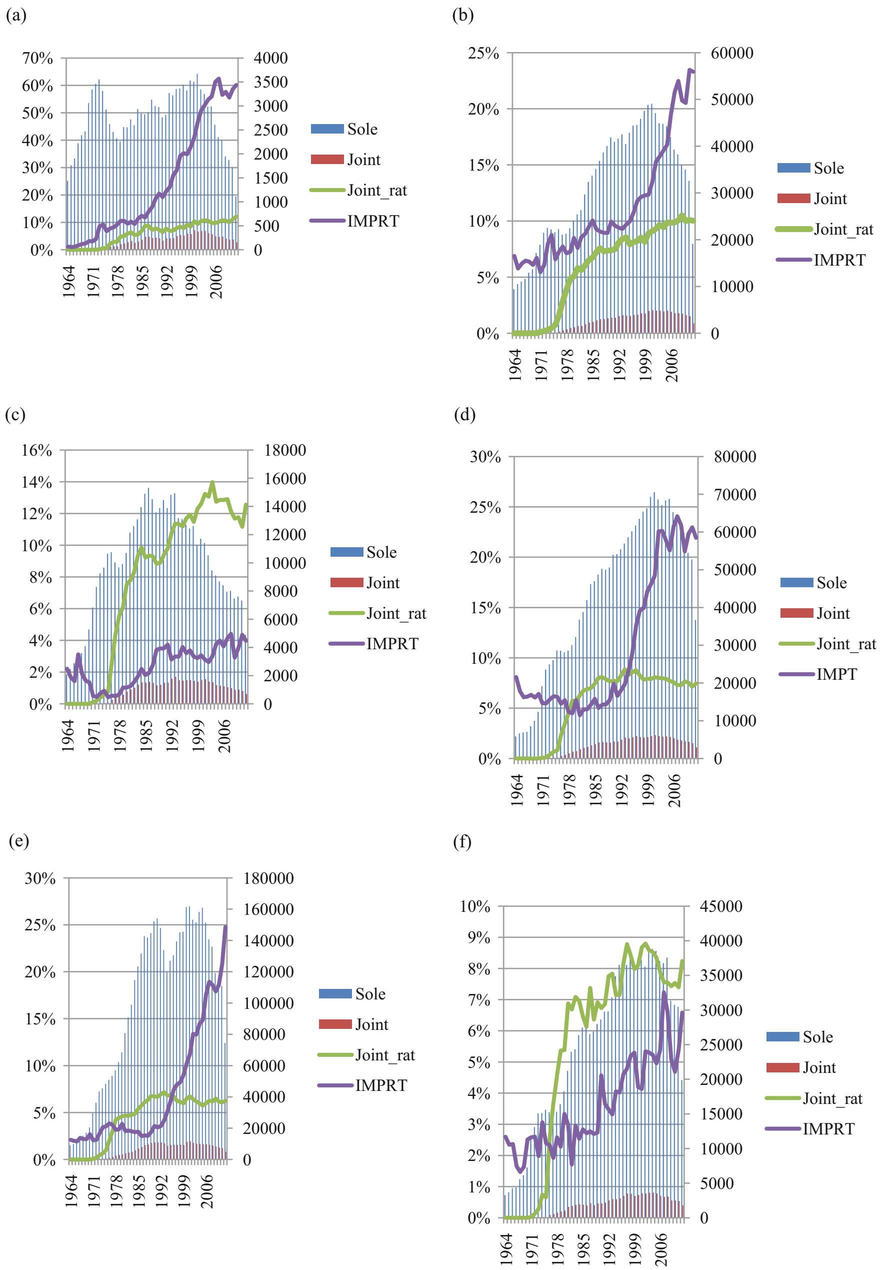


Fig. 7.3 The number of sole and joint patent applications, joint application ratio, and import penetration ratio: 1964–2012. (**a**) Textiles. (**b**) Chemicals. (**c**) Steel. (**d**) Machinery. (**e**) Electricals. (**f**) Transport (Sources: Patent-related variables are calculated using the IIP Patent Database for Japanese firms. Import penetration ratio is calculated using (1) Product shipment Values: Report by Commodity, Census of Manufacture, Ministry of Economy, Trade and Industry, (2) Imports and Exports: UN Comtrade (http://comtrade.un.org/), (3) Exchange Rates: Bank of Japan)

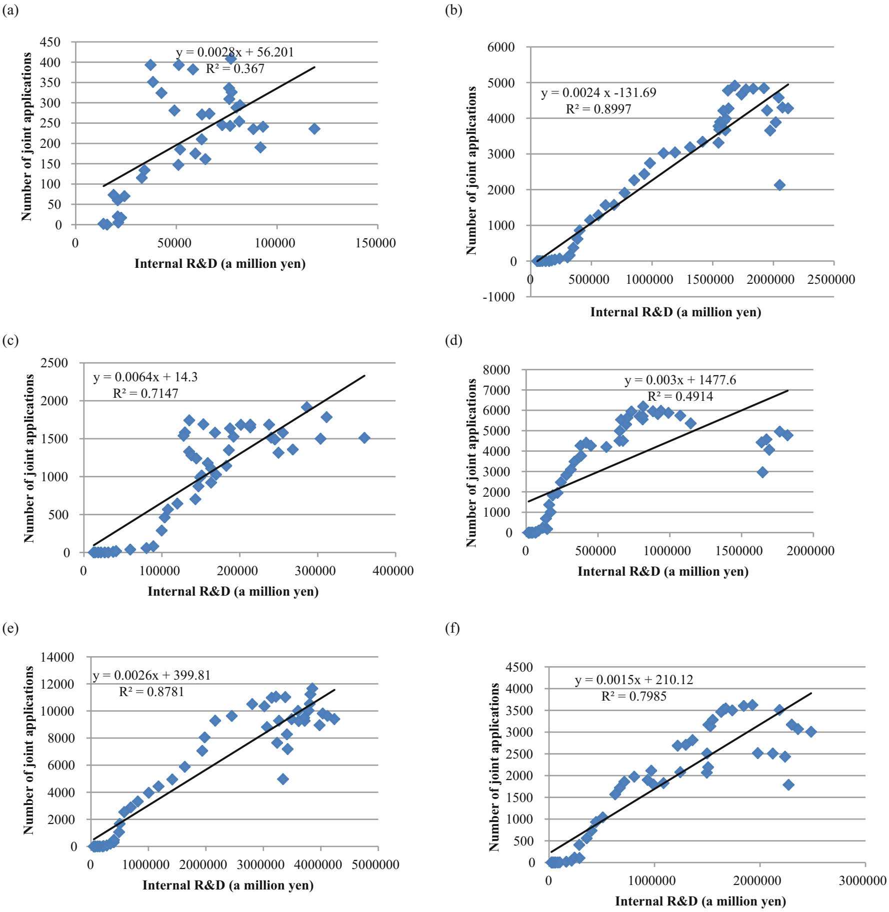


Fig. 7.4 Plotted internal R&D and the number of joint applications: 1964–2012. (**a**) Textiles. (**b**) Chemicals. (**c**) Steel. (**d**) Machinery. (**e**) Electricals. (**f**) Transport (Sources: Calculated using (1) Patents: The IIP Patent Database, (2) R&D expenditures: Intramural expenditure on R&D (disbursement) by business enterprise from various years of the Survey of Research and Development, Statistics Bureau)

industries increased patent applications from the 1960s, but the speed of growth has increased since the 1980s. On the other hand, the shape of the bar graphs for textiles (Fig. 7.3a) and steels (Fig. 7.3c) are skewed in the opposite direction, implying that their patent applications reached their peak relatively earlier than other R&D intensive industries and have gradually slowed down since then. In the case of textiles, patent applications reached their first peak in 1973 and, after a gradual recovery in the1980s, reached the second peak in the mid-1990s. Patent applications for the steel industry reached their peak in the mid-1980s and have decreased in number continuously since then.

The plotted charts between internal R&D expenditures and the number of sole patent applications from 1964 to 2012 (not listed in this chapter because of space limitations) show a positive relationship between R&D activities and the number of sole applications, except for textiles. This result supports the idea that the greater the effort to develop technological capability, the greater the achieved capability.

The bar charts in Fig. 7.3 also exhibit the number of joint patent applications.[4] The number does not fluctuate during the period for six industries, unlike the number of sole applications. Given relatively stable joint applications and fluctuating sole applications, the ratio of joint applications[5] is drawn in a line chart. The highest joint application ratio is observed for steel (13%) and textiles (12.1%) in 2012, for which the number of sole applications is the lowest among six industries. This result implies that the amount, rather than the proportion, of external R&D resources is relatively fixed among industries, although the absorptive capacity of each industry is varied, reflecting the level of prior R&D efforts. Figure 7.4 exhibits plotted graphs for internal R&D expenditures and the number of joint applications from 1964 to 2012 for each industry. The graphs show a positive relationship between the effort to acquire external R&D resources and the consequent research outcomes, except for the textile industry.

It is difficult to examine the reason for the relatively stable number of joint applications without more detailed analysis controlling for the type of partnering organizations, firms' capability, and industrial characteristics. Additionally, using the patent data information on joint applicants as a proxy for joint research has several limitations. First, not all research outcomes of joint research are patentable. Firms must publicize the content of inventions to register the patents, and because of the fear of leakage, many firms choose to keep new technological knowledge a trade secret. Registered patents can be protected effectively for up to 20 years after the application. However, even during the protection period, it is difficult to detect the violation of patents if the nature of technology is process-oriented: it is difficult to see the inside of production facilities for competing firms. Second, when inventors include university researchers, there is a possibility that researchers would not choose to be registered as joint applicants, particularly until the mid-1990s when various institutional arrangements for promoting industry-university collaboration had occurred. Moreover, commissioned research and technology acquisition cannot be captured by joint patent application. Therefore, another database such as the Basic Survey of Japanese Business Structure and Activities, implemented by the Ministry of Economy, Trade and Industry (METI) of Japan, should be examined.

[4]The number of joint applications from 1964 to 1970 for all patents is set to zero in the IIP Patent Database. However, given that a certain number of patents are jointly submitted from 1971, there is a possibility that zeros during the period 1964–1970 include nonzeros in practice.

[5]The joint application ratio is obtained by the following: joint application ratio (%) = (number of joint application/number of joint application + number of sole application) × 100.

7.4.3 Changes in Industrial Structure

Odagiri and Goto (1996) supposed that technological capability of industries affects the speed and direction of industrial restructuring. I now examine the changes in the industrial composition of patent applications from 1964 to 2012. Figure 7.5a reveals the change in industrial composition using total patent applications. In 1964, chemical and electricals dominated the largest share, approximately, followed by transportation and iron and steel. In 2012, electricals retained the largest share followed by machinery, transportation, and chemicals. The industries with relatively higher proportions remained dominant, but the distribution among them changed. The electrical industry increased its proportion from 26.6% to 44.3%, while machinery increased its proportion from 17.2% to 22.1%, and transportation's share increased from 9.6% to 12.1%. However, the share for chemicals decreased from 27.7% to 11.9% and for iron and steel from 6.1% to 3.1%.

For technological composition based on joint applications in Fig. 7.5b, industries with the highest proportion were electricals, chemicals, machinery, and iron and steel in 1971. By contrast, in 2012, electricals increased its share from 25.6% to 36.2%, machinery from 15.9% to 21.6%, chemicals from 24.4% to 15.5%, and iron and steel from 9.8% to 5.1%. There are fluctuations over time, but they are much less compared to those in Fig. 7.5a.

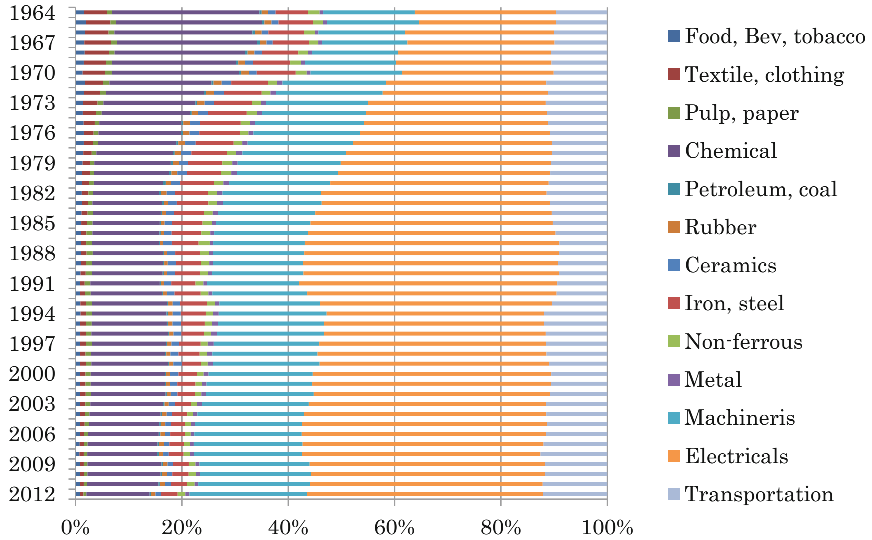
For technology, the industrial composition in Japan over 50 years has been relatively stable with no drastic changes, although the relative importance of technology has changed over time in favor of electronics, machinery, and transportation and away from chemicals and iron and steel. From the perspective of joint applications, the change over the past 50 years has been much more stable.

Figure 7.6 shows the change in the price-cost margin among the above-listed industries from 1962 to 2013. The price-cost margin is calculated by (gross value added − total cash wages and salaries paid) / product shipment values using data for various years of the Census of Manufacture implemented by the METI. Industries that increased the proportion of registered patents are electricals, machinery, and transportation, and their price-cost margins remained relatively stable over 50 years. On the other hand, chemicals and steel, which decreased their share, reveal more fluctuating price-cost margins for the period. Particularly, a downturn in the early 2000s is observed for both chemicals and steel.

7.4.4 Competition

Next, I analyze the changing state of competition in Japan over the past 50 years and its relationship with the use of external R&D resources represented by joint patent applications. During their recovery from a devastating economic condition, Japanese firms in the 1960s faced two types of competitive pressure (Odagiri and Goto 1996). The first type of competition was from domestic firms actively entering domestic markets. The second type of competitive pressure was from foreign

(a)



(b)

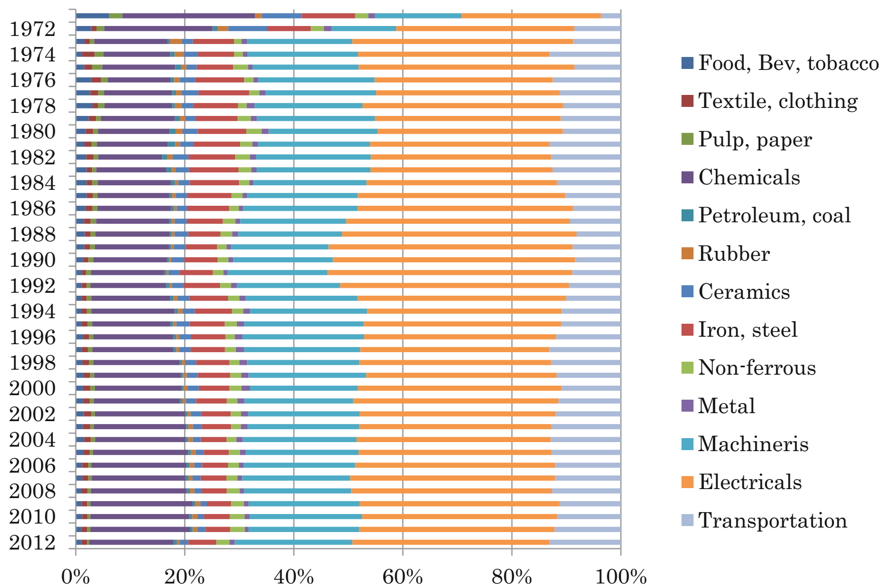


Fig. 7.5 Industrial composition of patent applications: 1964–2012. (**a**) Industrial composition of total patent applications: 1964–2012. (**b**) Industrial composition of joint applications: 1971–2012 (Source: Calculated using the IIP Patent Database for Japanese firms)

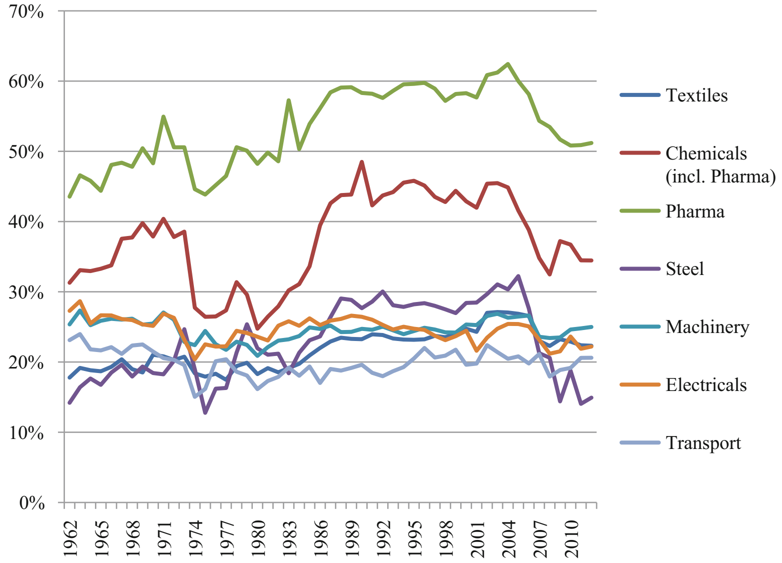


Fig. 7.6 Price-cost margin: 1962–2013. Note: Price-cost margin is calculated by (Gross Value Added − Total Cash Wages and Salaries Paid) / Product Shipment Values. Gross value added is calculated by the METI using the following formula: Gross value added = product shipment values − internal excise tax cost of raw materials (Source: Calculated based on various years of the Report by Enterprise, Census of Manufacture, METI)

competitors. Given the closed Japanese market in terms of both trade and FDI, the existence of foreign firms was not explicit. However, the government announced trade liberalization from the beginning of the 1960s and inward FDI from the end of the 1960s. Thus, Japanese firms were aware of potential entrants from abroad, and this also contributed to keeping the domestic market contestable. Despite liberalization measures since the 1960s, penetration into the Japanese markets was considered difficult for foreign firms. For many industries, this difficulty continued until the 1990s.

7.4.4.1 Domestic Competition

First, I examine the relationship between joint research and competition among domestic firms in the domestic market. To examine the state of domestic competition, I use the number of enterprises by industry. The dataset is obtained from the Reports by Enterprise of the Census of Manufacture. The concentration ratio is commonly used to examine the level of competition in a domestic market. The Herfindahl-Hirschman Index for six-digit commodity classification is available from the Reports by Enterprise, but only from the year 2002 and does not suffice for this analysis. Thus, because of data availability limitations, the number and average growth rate of enterprises are used in this chapter.

Table 7.1 Average growth rate of the number of enterprises in Japan

									(%)
	(1)	1963–1970	(2)	1968–1979	1980–1989	1990–1996	(3)	1997–2005	2006–2013
Food, beverages, tobacco, and feed		19.9		−0.1	−0.9	−7.6		0.1	−0.5
Textile mill products, clothing		7.6		0.0	1.1	−7.0		−1.8	−2.2
Lumber and wood products		5.4		−0.6	−1.6	−6.8		−3.7	−**3**.4
Furniture and fixtures		24.3		2.6	2.9	−10.3		−0.2	−0.2
Pulp, paper, and paper products		11.0		2.1	2.5	−5.4		−1.1	−1.4
Chemical and related products		4.0		−0.5	−0.2	−1.5		1.2	0.5
Petroleum and coal products		3.7		0.1	4.3	−0.1		1.2	0.3
Rubber products		11.0		4.0	4.5	−2.4		1.8	0.0
Leather tanning, leather products, and fur skins		21.0		3.6	0.5	−5.4		−1.2	−0.8
Ceramic, stone, and clay products		14.8		2.1	2.1	−4.9		−1.2	−0.6
Iron and steel		16.4		5.9	5.0	−2.5		−0.2	−3.8
Nonferrous metals and products		4.5		4.7	4.2	−2.9		0.2	−2.1
Fabricated metal products		19.1		5.3	5.5	−6.2		0.0	0.4
Machineries and precisions		6.9		5.6	4.5	−3.3		2.1	0.6
Electricals		7.8		7.9	4.0	−1.4		3.5	0.5
Transportation equipment		11.0		1.8	1.5	−4.5		−0.1	−0.2

Source: Calculated based on various years of Report by Enterprises, Census of Manufacture, METI
Note: The values in 1963–1967・1970 and 1997–2013 are number of enterprises based on establishments with four or more employees. For 1968–1969, 1971–1996, the values are based on establishments with 20 or more employees. Since they cannot be considered as consequential data, the dataset is separated into three different phases

Table 7.1 exhibits the average growth rate of the number of enterprises in Japan from 1963 to 2013. The table is divided into three phases due to the rule change in minimum number of employees to be included in the dataset. During the first period 1963–1967 and 1970, establishments with four or more employees are included in the statistics. Then, in the second period 1968–79, 1980–1989, 1990–1996, establishments with 20 or more employees are included. In the third period 1997–2005 and 2006–2013, again establishments with four or more employees are included. Therefore, those three periods cannot be treated as consequential dataset.

During 1963–1970, the growth rate was quite varied among industries. The highest rate was observed in industries such as “furniture and fixtures,” “leather tanning, leather products, and fur skins,” “food, beverages, tobacco, and feed,” “fabricated metal products,” and “iron and steel and ceramic, stone, and clay products.” There were no industries with negative growth rates. Then, during the period 1968–1979, the growth rates slowed: “food, beverages, tobacco, and feed,” “lumber and wood products,” and “chemical and related products” showed negative growth. This reflects the end of a high-growth period in Japan after the oil crisis in 1973, and the subsequent shift to the floating exchange rate regime. Further stagnation of growth rates can be observed during the period 1990–1996, reflecting the collapse of the bubble economy. During this period, all the industries showed negative growth rates. From the end of the 1990s until 2013, almost half of the industries returned to positive growth, particularly electricals and machinery.

Table 7.1 shows that fierce domestic competition took place during the 1960s, and even after that, a positive entry has been observed in many of the industries, except for the 1990–1996 period. The increase in the number of firms reflects active domestic entrants, and this competitive pressure contributed to maintaining market efficiency. Moreover, the average growth rates of the number of establishments in Japan provide illustrative figures.[6] During the period 1960–1965, all the industries exhibited high growth rates, but some began to slow down from the year 1966 to the year 1970. After the period 1976–1980, the number of establishments in most of the industries shrank. Together with the enduring positive growth rates of the enterprises observed in Table 7.1, this decreasing trend of establishments is likely to reflect the efforts of Japanese firms to restructure internally to pursue organizational efficiency.

Although not included in this chapter, the relationship between the number of enterprises and the number of sole and joint applications was descriptively examined by assessing the longitudinal movement and the plotted relationship. To summarize, the relationship between the number of enterprises and patents was relatively stable during the period 1971–1996 for 25 years. However, after 1997, it became more difficult to recognize a systematic relationship.

7.4.4.2 Foreign Competition

Measuring the degree of competitive pressure from abroad is complex. A certain measure is required that can assess the extent of foreign competition and be applied to this longitudinal dataset. Here, the import penetration ratio for the period 1962–2014 is used in the analysis. This is obtained by taking the ratio of imports to the domestically available products: imports/ (domestic production − exports + imports). The higher the import penetration ratio, the stronger the relative impact of global competition in the market. Tomiura (2003) argued that the import penetration

[6]The figure is not listed in this chapter because of space limitations.

ratio is susceptible to the coverage of a market, in other words, the digit level of the dataset. Because the purpose here is to see the crude transition of the level of competition, I use a two-digit commodity classification. This two-digit classification shares common codes with the industry classification of the Census of Manufacture by the METI. Adjusting for the revisions of classification, some of the categories are aggregated to maintain the longitudinal coherence. After this procedure, import penetration ratio is calculated for 16 categories.[7]

Longitudinal import and export data are obtained from the website of the UN Comtrade (http://comtrade.un.org/). The trade value ($) of imports and exports by Standard International Trade Classification (SITC) Revision 1 commodity classification is available from 1962 to 2015. I select corresponding categories in the Census of Manufacture, and the values are converted to yen. The exchange rates used are the basic rate of the Bank of Japan.[8]

An analysis of the import penetration ratios from the year 1962 to the year 2014 shows that the ratios have been relatively low for most categories. The exception is textile and clothing, for which the import penetration ratio began to increase in the 1980s. In 1962, categories such as petroleum, food, machinery, nonferrous metals, and chemicals show a higher rate than the remaining industries. In 2014, furniture, electricals, machinery, lumber and wood, and chemicals have an import penetration ratio of over 25%. The exchange rate was fixed at 360 yen per US dollar from 1949. The introduction of the floating rate in 1973 pushed the penetration rate upwards although the order of categories does not change. This figure supports the argument in the previous section that it was difficult for foreign firms to enter the Japanese market for a long time, even after the official liberalization of trade and FDI were implemented. However, the following steady appreciation of the yen, finally reaching below 100 in 1994, forced the export industries to shift production sites abroad while lowering import prices (Odagiri and Goto 1996). These figures confirm the increasing pressure from global competition.

Figure 7.3 shows the import penetration ratio and joint application ratio depicted as a line graph. In 1964, the import penetration ratios of chemicals and machinery were high followed by electricals and transport reflecting the low competitiveness of those industries. By contrast, the ratios for steel and textiles were relatively lower than the other industries. The import penetration ratio for textiles in Fig. 7.3 started to increase from the mid-1980s and reached 60% in 2012. However, the joint application ratio was stable around 10%. Figure 7.3 shows that the import penetration ratio for chemicals has been increasing since 1964 and increased in pace

[7]Food, beverages, tobacco, and feed; textile mill products, clothing; lumber and wood products; furniture and fixtures; pulp, paper, and paper products; chemical and related products; petroleum and coal products; rubber products; leather tanning, leather products, and fur skins; ceramic, stone, and clay products; iron and steel; nonferrous metals and products; fabricated metal products; machineries and precisions; electronics; transportation equipment.

[8]Downloadable from the Bureau of Statistics (http://www.stat.go.jp/data/chouki/18.htm). More recent exchange rates can be downloaded from the Bank of Japan (http://www.boj.or.jp/statistics/pub/boj_st/index.htm/).

from the 1990s. In 2012, the import penetration ratio reached approximately 23%. In Fig. 7.3, the import penetration ratio for steel was uniquely lower throughout the period compared to the other industries. Even in 2012, the ratio remained around 4%. The joint application ratio was relatively higher than in other industries. In 2012, 12% of total patents were joint submissions. Figure 7.3 shows that the import penetration rate for machinery was high (10%) in 1964 and reached 29% in 2012. The joint application ratio was stable at approximately 7%. The figure shows that the import penetration ratio for electricals abruptly increased from the 1990s and reached 25% in 2012, while the joint application ratio was stable around 6%. Import penetration for transport fluctuated throughout the period. The joint application ratio showed an abrupt increase in the mid-1970s and reached as high as 8%.

Figure 7.7 plots the import penetration and joint application ratio for six industries from the year 1964 to 2012. Here, the relationship between the degree

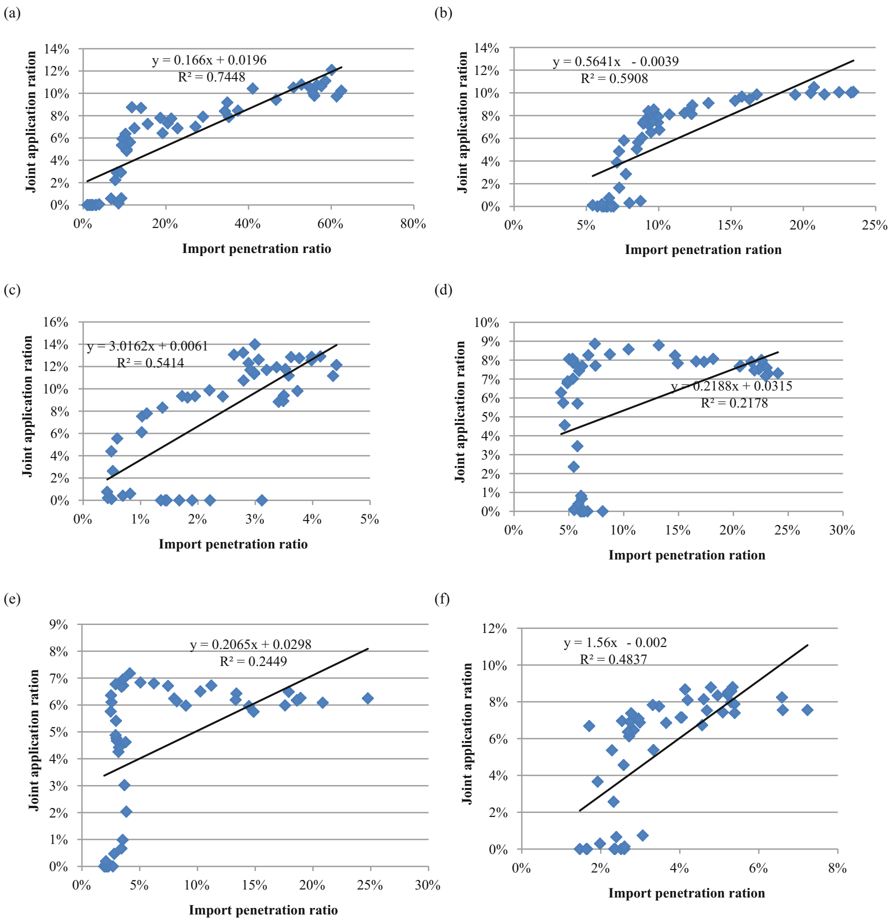


Fig. 7.7 Plotted import penetration ratio and joint application ratio: 1964–2012. (**a**) Textiles. (**b**) Chemicals. (**c**) Steel. (**d**) Machinery. (**e**) Electricals. (**f**) Transport

of foreign competition and the use of external R&D resources is depicted with the expectation of a positive relationship. A relatively stable relationship between the import penetration and joint application ratio is observed for textiles, chemicals, and steel while a relation cannot be found among machinery, electricals, and transportation. Textiles and steel are less R&D- intensive, but chemicals, machinery, electricals, and transportation are representative of R&D intensive industries (Fig. 7.2). The effort of these industries has resulted in the development of technological capabilities, except for textiles (Fig. 7.4). For the number of firms, the growth rate of textiles, steel, and transportation has been negative since 1990–1996, while the growth rate has been positive for chemicals, machinery, and electricals since 1997–2005. Therefore, the difference in Fig. 7.7 cannot be explained by the idea that higher technological capabilities function as the fundamental factor inducing industrial restructuring and the active use of external R&D resources.

As already explained, the import penetration ratio is not a perfect indicator to proxy for competition from abroad and is affected by various factors. First, as technological capabilities of a domestic industry increase, the import penetration ratio is expected to decrease. When the required technological level in the domestic industry is high, it becomes difficult for foreign products to penetrate domestic markets. Second, as the domestic factor prices decrease, the penetration ratio should lower. A lower factor price would induce domestic prices to decrease, creating difficulty for foreign products to penetrate domestic markets. Third, as the tariff and nontariff barriers increase, the penetration ratio should be lower as is politically intended. Finally, a higher import penetration ratio does not necessarily imply that domestic products are replaced by imported products. Compared to the period when the Japanese market first began liberalization, the business organization has become more complicated each year. Currently, many Japanese firms have globalized part of their vertical chain and rely on imported intermediate goods from foreign subsidiaries to produce final products or, reversely, Japanese firms export intermediate goods and import final products from foreign subsidiaries. Therefore, imports from abroad can no longer simply be considered substitutes for domestic products. There is a possibility that greater reliance on reverse imports among the machinery, electronics, and transport industries has caused difficulty in identifying a clear relationship with the joint application ratio (Fig. 7.7).

7.5 Conclusions

The importance of the effective use of external resources through R&D alliances has been a focus of policy makers and researchers. This chapter examines the relationship between the technological capabilities of firms and the use of external R&D resources via R&D alliances. This study considers the relationship with structural factors represented by the state of competition domestically and internationally.

The rapid development of IT and biotechnology sectors has affected the industrial structure with a trend toward vertical specialization and simultaneous active use of external technological knowledge. The changes in innovation management systems and industrial structure affect each other, and coevolution occurs. However, as noted by Mowery (2009), this phenomenon is not new. The scope of the descriptive study in this chapter is limited to the relationship between representative variables: R&D investment, sole and joint patent application, and domestic and foreign competition represented by the number of firms and the import penetration ratio. Based on the research framework presented by Odagiri and Goto (1996), careful examination of the relationships between these variables confirmed the contribution of technological acquirement toward the development of technological capabilities. In terms of the relationship between R&D alliances and foreign competition, I could recognize a relatively stable and positive correlation in some industries, but not in R&D-intensive industries such as machinery, electricals, and transportations. This suggests the existence of influential factors which could not take account in this analysis. However, the effort to shed some light on the empirical relationship between R&D management and industrial structure, at least to recognize the importance of a longitudinal perspective, thus leaves scope for more detailed forthcoming research.

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Chapter 8
High-Tech Start-Ups in Japan: The Case of the Biotechnology Industry

Yuji Honjo

Abstract This chapter explores the high-tech start-ups in the biotechnology industry in Japan. I provide evidence that many biotechnology start-ups originate from universities and that the emergence of some biotechnology start-ups is significantly associated with R&D activities in universities. I also find that emerging stock markets in Japan play a critical role in equity financing for biotechnology start-ups. Moreover, I examine whether biotechnology start-ups improve performance by going public. The results reveal that biotechnology start-ups increase equity financing, although they do not improve their performance after initial public offering.

Keywords Biotechnology • Equity financing • Post-IPO performance • Start-up • University

8.1 Introduction

To date, much literature has emphasized that entrepreneurship is an engine of economic and social development worldwide (e.g., Acs and Audretsch 2003). In the USA, some younger firms—for example, Amazon.com (founded in July 1994), Google (founded in September 1998), and Facebook (founded in February 2004)—have significantly contributed to the global growth of information and communications technology (ICT) and ICT-using industry. These firms have played a prominent role in industry growth, and their market values of equity (market capitalization) have been increasing sharply. Additionally, some fast-growing firms in the USA have emerged in the biotechnology industry. For instance, Gilead Sciences, which was founded in June 1987 and is developing innovative therapeutics

Y. Honjo (✉)
Faculty of Commerce, Chuo University, 742-1 Higashinakano, Hachioji, Tokyo 192-0393, Japan
e-mail: yhonjo@tamacc.chuo-u.ac.jp

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in the areas of unmet medical needs, is one of the fast-growing firms in this industry. Its market value was 146 billion US dollars at the end of December 2015.[1]

Start-up firms with new technologies, that is, high-tech start-ups play a vital role in the diffusion of technologies and the growth of industries. In some industrialized countries, including Japan, the emergence of start-up firms is expected not only to stimulate competition but also to promote innovation, whereas the role of large established firms is less certain. Many start-up firms emerge in technology-based (or science-based) industries such as the biotechnology and ICT industries. Rather, we can say that the emergence of start-up firms is essential to the growth of industries, thereby resulting in the revitalization of a stagnant economy.

This chapter explores high-tech start-ups, which are newly founded and devote their resources to research and development (R&D), in the case of the biotechnology industry in Japan. Biotechnology is expected to promote new products in life sciences, including the pharmaceutical and agricultural fields. Using a sample of biotechnology start-ups that have undertaken an initial public offering (IPO), I investigate the innovation and financing of high-tech start-ups. I provide evidence that many biotechnology start-ups originate from universities and that the emergence of some biotechnology start-ups is significantly associated with R&D activities in universities. I also find that emerging (stock) markets in Japan play a critical role in equity financing for biotechnology start-ups. Moreover, I examine whether biotechnology start-ups improve performance by going public. The results reveal that biotechnology start-ups increase equity financing, although they do not improve their post-IPO performance, which is measured by cumulative abnormal return (CAR) and buy-and-hold abnormal return (BHAR) methods.[2]

The remainder of this chapter is organized as follows. In the following section, I describe the features of biotechnology start-ups, including the environment for business start-up in Japan. Section 8.3 explains the data and sample used in this chapter, including some cases of innovation of biotechnology start-ups in Japan. Section 8.4 discusses the post-IPO performance using several empirical analyses. In the final section, I provide some concluding remarks.

[1]The top five-ranked firms in the biotechnology industry in the USA are Gilead Sciences, Amgen (122 billion US dollars), AbbVie (97 billion US dollars), Celgene (94 billion US dollars), and BioGen (68 billion US dollars), which are primarily classified as drug discovery (figures in parentheses are market capitalization at the end of December 2015). The market value of Gilead Sciences was larger than that of Takeda Pharmaceutical with 4793 billion yen (40 billion US dollars, 1 US dollar = 120 yen), which is the largest pharmaceutical company founded in Japan. Note that the age of Amgen and BioGen is over 30 years in 2015, and that AbbVie is the spin-off of a large pharmaceutical company, Abbott.

[2]Note that entrepreneurs typically play a major role in the performance of high-tech start-ups. However, this chapter mainly focuses on the relationship with external organizations and markets regarding capital and technologies. As space is limited, I am not concerned with the role of entrepreneurs' human capital. For more discussions on the role of entrepreneurs' human capital of start-up firms, see, for example, Kato and Honjo (2015).

8.2 Features of Biotechnology Start-Ups

8.2.1 High-Tech Start-Ups in Technology-Based Industries

The so-called "Schumpeterian hypothesis" states that market power is conducive to innovation, and indicates a positive effect of firm size and market concentration on innovation (e.g., Scherer 1967; Acs and Audretsch 1987). According to this hypothesis, large established firms have an inherent advantage in innovation, mainly because of economies of scale and scope for R&D. The learning effect also provides an advantage to large established firms. Given that this hypothesis is supported, large established firms are more likely to develop new technologies compared to start-up firms most of which are smaller in size.

Under this context, small firms have a disadvantage with respect to innovation. Small firms tend to face difficulties such as information asymmetries between firms and external organizations. Specifically, high-tech start-ups, which are young and mostly small, are more likely to encounter severe information asymmetries because they have a shorter operating history and lack a financial track record. In addition, specialized knowledge in technology-based industries increases information asymmetries. Such informational issues may cause high-tech start-ups to have less financial capital, which often discourage their investment in R&D projects.

Kamien and Schwartz (1978) emphasized two reasons for this phenomenon. First, external financing is difficult to obtain without substantial-related tangible collateral to be claimed by the lender if the project fails, and an R&D project that fails generally leaves behind few tangible assets of value. Second, the firm is reluctant to reveal detailed information about the project that would make it attractive to outside lenders, fearing its disclosure to potential rivals. High-tech start-ups that invest heavily in R&D are more likely to rely on external financing because of a large amount of R&D investment. However, R&D projects are riskier and, therefore, it is not easy for high-tech start-ups to raise funding for R&D from external suppliers of capital. Carpenter and Petersen (2002) argued that the returns to high-tech investment are skewed and highly uncertain, in part because R&D projects have a low probability of financial success. Colombo and Grilli (2007) also argued that greater uncertainty deters investments as there is greater risk of incurring sunk costs. Despite the high risk of R&D projects, most investments are used to produce firm-specific equipment, which is less desirable as collateral. Moreover, Himmelberg and Petersen (1994) argued that the nature of R&D and innovation-based physical investment precludes outsiders from making accurate appraisals of value. In addition, even when firms can costlessly transmit information to outsiders, strategic considerations may induce firms to actively maintain information asymmetries. Such information asymmetries induce adverse selection and moral hazard problems in technology-based industries. Moreover, as Czarnitzki and Hottenrott (2011) argued, high-tech start-ups are more financially constrained because they cannot use earlier profit accumulations for financing their R&D projects. Bank loans are also limited for R&D projects of high-tech start-ups because of their high default risk. Consequently, these features of R&D prevent high-tech start-ups from securing external financing.[3]

While high-tech start-ups face difficulties in conducting R&D projects, large established firms also have limitations to the advance of new technologies. Existing organizations do not always provide a suitable environment for the development of new technologies with creative ideas. Strategy, structure, and culture within large established firms may hinder organizational performance. In addition, large established firms face difficulties in flexibly corresponding to a change in the outcome of R&D projects because the outcome of R&D projects is highly uncertain. Moreover, when a large established firm has already invested in the development of a technology, such investment often impedes the shift to a different technology because it is more likely to become a sunk cost. These facts indicate that large established firms miss opportunities to make strategic decisions even when prompt actions are required.

Compared with large established firms, high-tech start-ups have more flexibility and potential abilities to adopt new technologies and, therefore, they may be able to nurture novel ideas more effectively. Acs and Audretsch (1987) argued that small firms tend to have a relative advantage in industries that are highly innovative, utilize a large component of skilled labor, and tend to be composed of a relatively high proportion of large firms. Additionally, limited liability, which is introduced in many industrialized countries, may promote the emergence of high-tech start-ups because limited liability enables high-tech start-ups' shareholders to guarantee the scope of responsibility, thereby externalizing the risk of failure. Therefore, when shareholders provide funds for uncertain business, the cost of bankruptcy can be reduced by founding many small-sized start-ups as a portfolio. Rather, high-tech start-ups have advantages in developing new technologies with high risk.

Many scholars suggest that new entrants play a significant role in innovation by stimulating competition in industries and that start-up firm innovation affects existing sources of market power by spurring the "gale of creative destruction" as described by Joseph Schumpeter (e.g., Gans et al. 2002). Anokhin and Wincent (2012) found a positive association between start-up rates and innovation in developed countries, based on cross-country estimation. Aghion et al. (2009) argued that the threat of technologically advanced entry spurs innovation incentives in sectors close to the technology frontier, where successful innovation allows incumbents to survive the threat, but discourages innovation in laggard sectors, where the threat reduces incumbents' expected rents from innovating. The emergence of high-tech start-ups, which indicates new entrants to the industry, has a significant impact on innovation through competition. In this respect, a better understanding of how to foster high-tech start-ups in technology-based industries is imperative to advance new technologies.

[3]For more discussion on the financing of R&D for start-up firms, see, for example, Hall (2002) and Honjo et al. (2014).

8.2.2 Biotechnology Industry

This chapter highlights biotechnology as a technology-based industry and examines start-up firms in this industry. According to the Biotechnology Innovation Organization, biotechnology is technology based on biology–biotechnology harnesses cellular and biomolecular processes to develop technologies and products.[4] The biological processes of microorganisms have been used for more than 6000 years to make useful food products, such as bread and cheese, and to preserve dairy products. Modern biotechnology provides breakthrough products and technologies and has applications in several industrial areas, such as medical products including drug discovery, agricultural products, industrial products, and energy and natural resources. The biotechnology industry, which is related to life sciences, such as pharmaceuticals, medical devices, and health-care technology, is often regarded as an industry with potential for future demand growth.[5]

More importantly, it is expected that biotechnology can be used to manufacture existing drugs cheaply and safely and to develop new drugs in the pharmaceutical industry. In the USA, some firms have developed new drugs and have significantly contributed to the growth of biotechnology. As a pioneering biotechnology firm, Genentech developed products with practical applications, for example, synthetic humanized insulin based on recombinant deoxyribonucleic acid (DNA) technology pioneered by Herbert Boyer and Stanley Cohen in the early 1970s.[6] The recent progress in biotechnology has shifted the main approach from chemical-based to biotechnology-based drug discovery, particularly for drugs targeting cancer and autoimmune diseases. Biopharmaceuticals (biotechnology-based drugs) account for a large portion of recent sales in drugs, and indeed some biopharmaceuticals have been top ranked for sales in recent years.[7] Biopharmaceuticals cannot be characterized fully in terms of their structure unlike low-molecular-weight drugs (chemical-based drugs), and the complicated protein-production processes and structures demand a paradigm shift in thinking compared to low-molecular-weight drugs (e.g., Crommelin et al. 2003).

In Japan, large pharmaceutical companies, such as Takeda Pharmaceutical and Daiichi Sankyo, have been central to the development of new drugs

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[4]For more detail on biotechnology, see, for example, Odagiri (2006) and the website of Biotechnology Innovation Organization.
https://www.bio.org/ [accessed on April 11, 2016].

[5]According to the Center for Research and Development Strategy (CRDS) of Japan Science and Technology Agency, R&D expenditures are the highest in life sciences and clinical research, at more than three trillion yen in FY 2014.
http://www.jst.go.jp/crds/report/report02/CRDS-FY2015-FR-07.html [accessed on May 23, 2016].

[6]For more detail on Genentech, see the website of Genentech.
http://www.gene.com/media/company-information/chronology [accessed on March 10, 2016].

[7]For the top 50 pharmaceutical products by global sales, see the website of PMLiVE.
http://www.pmlive.com/top_pharma_list/Top_50_pharmaceutical_products_by_global_sales [access on April 1, 2017].

and have developed low-molecular-weight drugs, including the so-called "blockbusters," using chemical-based manufacturing. However, the paradigm shift into biotechnology-based drugs exposes a slowdown in the launch of new drugs developed by the Japanese pharmaceutical companies. In fact, the development of biotechnology-based drugs by large pharmaceutical companies seems to be delayed in Japan because these companies do not always take advantage of experience in the development of low-molecular-weight drugs. In this context, biotechnology can be classified as a "disruptive technology" rather than a sustaining technology in the pharmaceutical industry.

In the biotechnology industry, research in the early stage, in which many biotechnology start-ups engage, is highly complex, which makes it difficult to specify the outcome of projects. Particularly for drug discovery, the outcome is highly uncertain, and the probability of success is extremely low. More importantly, the discovery process in the biotechnology industry often includes multiple stages. For instance, this process for drug discovery can be classified as "discovery and development," "preclinical research (in vitro/in vivo)," "clinical research (Phases I to III)," and "approval." Small, young firms and universities together have comparative advantage in undertaking discovery projects. Whereas biotechnology start-ups are likely to play a pivotal role in providing new drug candidates in the preclinical and clinical research of drug discovery or new drug-discovery technologies, it is quite difficult for biotechnology start-ups to integrate downstream production activities, such as clinical research (Phase III) and marketing approval, because their human and financial resources are limited. In other words, biotechnology start-ups tend to encounter R&D resource constraints. More specifically, biotechnology start-ups cannot commercialize their innovations for drug discovery independently because of limited resources. In this respect, the linkage between biotechnology start-ups and large pharmaceutical companies is indispensable for new drugs to be launched more efficiently. To increase the possibility of innovations in the biotechnology industry, many biotechnology start-ups are required, which can properly diversify a development risk portfolio, and successful start-ups among them can advance the development of their technologies through the linkage with large pharmaceutical companies.

For the biotechnology industry in Japan, the Japan Bioindustry Association (JBA) surveys the trend of biotechnology start-ups. Figure 8.1 describes the number of firms in the biotechnology industry in Japan. As Honjo and Nagaoka (2015) indicated, the number of firms increased after the mid-1990s and reached its peak in the 2000s. The biotechnology boom occurred during the period of the mid-1990s to the 2000s, but the number of firms decreased in the late 2000s. Whereas the stagnant economy and aging population mainly caused the low entry rate, the lack of new players may have jeopardized the development of new industries in Japan. In particular, Honjo et al. (2014) found that R&D support, in addition to drug discovery and health care, accounted for a large portion of biotechnology start-ups in Japan. Whereas the development of new drugs is expected to contribute to expanding life sciences, few biotechnology drugs developed by biotechnology start-ups, except for in-licensed products, have been launched in the market to date in Japan. As

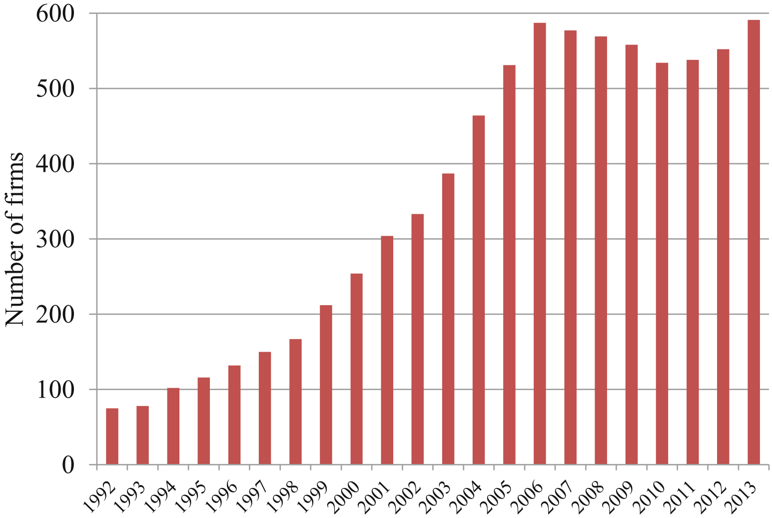

Fig. 8.1 Number of firms in the biotechnology industry in Japan (Source: Japan Biotechnology Association *2014-nen Bio Venture Tokei Doko Chosa Hokokusho* [2014 Survey on Bio-Ventures])

discussed later, overall, biotechnology start-ups do not achieve better performance. To my understanding, the performance of biotechnology start-ups does not fully meet Japanese expectations.

8.2.3 Linkage with External Organizations

The outcome of the discovery process is highly uncertain, and the probability of success is extremely low in the biotechnology industry. Additionally, the discovery process, particularly for drug discovery, often includes multiple stages. These special features of the biotechnology industry emphasize the role of the linkage between biotechnology start-ups and external organizations. Under such conditions, the division of labor is more effective for the development of technology-based industries.

Not surprisingly, technological seeds often stem from research in external organizations, such as universities and public research institutes, in technology-based industries. The outcome of R&D in these organizations may trigger the start of new business. In fact, university-based start-ups classified as biotechnology/health care/medical devices account for the largest portion of university-based start-ups in Japan. By taking technological seeds from external organizations, high-tech start-ups can dedicate themselves to the development of licensed seeds.

Additionally, early-stage investors, including venture capitalists, significantly contribute to providing high-tech start-ups with risk capital. Some scholars have argued that equity financing has several advantages over debt financing for high-tech start-ups (e.g., Carpenter and Petersen 2002; Brown et al. 2009). Lerner (2009) also emphasized that venture capital (VC) plays an important role in innovation, following interviews with entrepreneurs and venture capitalists. Unless high-tech start-ups with a large demand for R&D have sufficient internal financing, they must rely on external providers of capital such as VC firms. In fact, VC firms tend to invest in technology-based biotechnology industries, including ICT and biotechnology. According to the VEC Yearbook 2015 (edited by the Venture Enterprise Center), VC investments in biotechnology, medical, and health-care fields were 12.8 billion yen (106 million US dollars, 1 US dollar = 120 yen) and accounted for 18.1% of total VC investments in fiscal year (FY) 2014 while VC investments in ICT and related services were 31.9 billion yen (265 million US dollars) in Japan.[8]

While biotechnology start-ups tend to obtain technological seeds from universities and to raise funds from VC firms, they often rely on large established firms to commercialize their developed technologies because of the lack of complementary assets for commercialization and manufacturing know-how. As discussed, particularly for drug discovery, the linkage with large pharmaceutical companies is more productive for the development of new drugs because large pharmaceutical companies have more advantages for clinical research (Phase III) and marketing approval. Even when biotechnology start-ups succeed in the development of new technologies, the majority license out their technologies to partners, including large pharmaceutical firms, and, eventually, some are acquired through mergers and acquisitions (M&A).

From the above, I conclude that it is more effective to develop new products and services through the division of labor in technology-based industries such as biotechnology. This is because the discovery process is highly uncertain for these industries and often includes multiple stages. These specific features in technology-based industries would increase the significance of the role of high-tech start-ups and the importance of the linkage with external organizations, including licensing, alliance, and M&A. Thus, the development of technology-based industries through the division of labor is applicable to the concept of “open innovation,” which is a paradigm that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology (Chesbrough 2003). In other words, the biotechnology industry is a litmus test of whether linkage with external organizations can be successful in the economy.

[8]According to the NVCA Yearbook 2015 (edited by the National Venture Capital Association), VC investments in biotechnology in the USA were 5970 million US dollars, and accounted for 12.1% of total VC investments in 2014.

https://www.bio.org/ [accessed on April 11, 2016].

8.2.4 Environment for Start-Up Firms in Japan

The emergence of start-up firms—particularly, high-tech start-ups—is expected to stimulate the economy.[9] Some policy makers and scholars in Japan hope to see success in start-up firms whenever economic growth stagnates. Much attention has been paid to the emergence of growing high-tech start-ups in Japan. Specifically, a recent policy debate—the third arrow of the Abe administration's growth strategy, which seems to attract somewhat less attention today because of other policy debates—set a numerical target of a 10% entry rate. Shinzo Abe, Prime Minister of Japan, also declared at the New York Stock Exchange on September 27, 2013, "I would like to turn Japan into an entrepreneurial powerhouse brimming with the entrepreneurial spirit, just like the United States."[10] For this purpose, the environment for start-up firms has been improving for decades. In particular, I consider access to external organizations for technological seeds and financing to be more important to commence business because high-tech start-ups often encounter resource constraints.

Undoubtedly, technological seeds are strongly related to the emergence of high-tech start-ups. Additionally, technological seeds often stem from universities and public research institutes in technology-based industries. With regard to access to external organizations, a technological license organization (TLO) was introduced in 1998 to play an intermediary role between universities and industry and to promote technology transfer from universities in Japan. Through the TLO, universities can acquire patent rights for research outcomes and license out their technologies to private firms. While high-tech start-ups obtain new technologies from universities and ensure technological advantages, universities obtain a part of the resulting profits as research funds that further activate research projects. Such improvements promoted university–industry collaboration and led to "university-based start-ups (university-launched ventures)," which are high-tech start-ups originating from a university.[11] The Ministry of Economy, Trade, and Industry (METI) in Japan

[9]Many empirical studies have found the effect of entrepreneurship on economic growth, using data provided by the Global Entrepreneurship Monitor (GEM), which aims to explore the role of entrepreneurship in national economic growth (e.g., Van Stel et al. 2005; Wong et al. 2005).

[10]For more detail on the policy of entrepreneurship, see the website of the Prime Minister of Japan and His cabinet.

http://www.japan.go.jp/letters/message/abenomics/AbenomicsisProgressing_JP.pdf [accessed on June 24, 2016].

http://japan.kantei.go.jp/96_abe/statement/201309/25nyse_e.html [accessed on June 24, 2016].

[11]More precisely, the Law for Promoting University–industry Technology Transfer (*Daigaku-to Gijutsu Iten Sokushin Ho*) was enacted in 1998, and the Industrial Revitalization Law (*Sangyo Katsuryoku Saisei Tokubetsu Sochi Ho*) was enacted in 1999. After that, the Industrial Technology Enhancement Act (*Sangyo Gijutsuryoku Kyoka Ho*) was enacted in 2000, and the Industrial Competitiveness Enhancement Act (*Sangyo Kyosoryoku Kyoka Ho*) was enacted in 2013 to improve the environment for technology transfer. For more discussion on university–industry collaboration, see also Kato and Odagiri (2012).

proposed a policy entitled, "The 1000 University-launched Ventures Plan" in 2001 to promote industry–academia–government collaboration. After the reform of the TLO, university-based start-ups increased rapidly. According to a survey conducted by Nomura Research Institute, the number of university-based start-ups was 1773 in FY 2015, although the peak was 1807 in FY 2008.[12] More importantly, the number of university-based start-ups classified as biotechnology/health care/medical device was 540 in FY 2015, which is almost as high as university-based start-ups classified as ICT (application/software) in Japan. The target quantity (1000) has already been surpassed, but it is unclear whether the target quality has been attained, that is, university-based start-ups with growth potential emerging in the market.

Next, with respect to access to external organizations for finance, the environment for equity financing has been improving in recent decades in Japan. Specifically, emerging stock markets that provide funds for firms with growth potential were launched in the late 1990s and early 2000s. For instance, the Market of the High-growth and Emerging Stocks (MOTHERS) was launched on the Tokyo Stock Exchange (TSE) in 1999, which pursues the National Association of Securities Dealers Automated Quotations (NASDAQ) in the USA. Because the listing requirements for existing stock exchanges were more stringent for high-tech start-ups, emerging stock markets presented better opportunities to access public equity markets. The introduction of emerging stock markets leads to the emergence of university-based start-ups in stock markets; for example, AnGes MG and TransGenic went public in 2002 in the MOTHERS. Additionally, a taxation system for individual investors, namely, the "angel tax system," was introduced in 1997 to promote investment in firms with higher risk, and the 2008 amendment to the tax code enabled individual investors to deduct up to ten million yen of investment from taxable income.

Moreover, for public capital funds, the Organization for Small and Medium Enterprises and Regional Innovation, called "SME Support, Japan," was founded in July 2004 to provide capital for investment funding of new ventures. SME Support provides various support measures including consultation at advice counters and dispatching experts to resolve problems related to start-ups and new business development. Moreover, the Innovation Network Corporation of Japan (INCJ) was founded in July 2009 to promote innovation and enhance the value of businesses in Japan. The INCJ is capitalized at 300 billion yen with the Japanese government injecting 286 billion yen and 26 private firms providing a further 14 billion yen. The INCJ aims to provide financial, technological, and management support in order to promote the creation of next-generation businesses through open innovation or the

[12]For more details, see the website of the METI.
http://www.meti.go.jp/press/2016/04/20160408001/20160408001c.pdf [accessed on July 28, 2016].

flow of technology and expertise beyond the boundaries of existing organizational structures.[13]

Furthermore, to strengthen the global competitiveness of Japanese industries and to invigorate Japan's local economies, the METI in Japan proposed the "Industrial Cluster Project." For the Industrial Cluster Project, regional small and medium enterprises (SMEs) and start-up firms use innovative research results or "seeds" obtained from universities and research institutes to form industrial clusters in fields such as ICT, biotechnology, the environment, and manufacturing. The most salient key object of the Industrial Cluster Project is to prepare regional environments for a stream of innovations in regions throughout Japan and form broad networks through partnerships between businesses, universities, and government agencies, between businesses in the same industry, and across industrial sectors. These networks, through synergetic sharing of participant's intellectual and other resources, then generate new industries and businesses mainly in their regions (i.e., become productive industrial clusters). In practice, regional cluster projects have been launched in several areas such as the Hokkaido, Tokyo Metropolitan, Tokai, Kansai, and Kyushu areas.[14] These projects are expected to significantly impact the economy and society by marketing competitive products and commodities based on new technologies and ideas.

However, despite the improved environment for high-tech start-ups, entrepreneurship levels for business start-up remain low in Japan since the collapse of the bubble economy (e.g., Small and Medium Enterprise Agency 2015). According to the IMD World Competitiveness Yearbook 2015, in which entrepreneurship is defined as widespread entrepreneurship managers in business measured by a survey, entrepreneurship in Japan ranked 58th among 61 countries. Additionally, according to the Global Entrepreneurship Monitor, which is a worldwide survey of entrepreneurship, Japan is characterized by a low level of entrepreneurship (e.g., Honjo 2015). Policy debate continues on ways to promote innovation through high-tech start-ups.

[13] At the same time, the INCJ provided funds to established firms; for example, the INCJ attempted to bail out Sharp in 2016 when Sharp encountered a financial crisis. In this respect, it is doubtful whether the INCJ provides public capital funds to mainly promote the creation of next-generation businesses through open innovation.

[14] Hokkaido Bio-industry Development Project, Capital Sphere Bio-genome Venture Network, Tokai Bio-Factory Project, Kanto Bio-cluster Project, and Kyushu Bio Cluster Project were launched in these areas in the 2000s. For more detail on the Industrial Cluster Project, see the website of the METI.

http://www.meti.go.jp/policy/local_economy/tiikiinnovation/industrial_cluster.html [accessed on April 12, 2016].

http://www.meti.go.jp/policy/local_economy/tiikiinnovation/source/2009Cluster(E).pdf [access on July 28, 2016].

8.3 Data and Cases

8.3.1 Data Sources

To capture the characteristics of high-tech start-ups, I used the biotechnology industry as an example of an industry with growth potential in Japan. I constructed a sample of start-up firms in the biotechnology industry. I obtained a list of firms from a database compiled by Japan Venture Research (JVR), which is a research and consulting company that surveys not only VC but also new ventures backed by VC firms or other corporations. Additionally, I collected data on the firm's profile from each firm's website.

In the biotechnology industry, approximately 50 firms, regardless of firm age, experienced an IPO toward the end of 2015, and most firms had been founded within the past 30 years. Whereas many biotechnology start-ups are privately held (i.e., unlisted firms), public firms (i.e., listed firms or IPO firms) presumably play a more significant role in the development of this industry. I mainly focused on listed firms that have gone public in the biotechnology industry because data on the financial statements and market values of listed firms are more obtainable, although it is difficult to collect more detailed information on unlisted firms.

Moreover, I used the Nikkei Needs Financial Quest to collect data on financial statements and stock prices. I also obtained further information on pre-IPOs from listing prospectuses and annual securities reports through eol (corporate database).

8.3.2 Sample

For the analysis, I constructed a sample of listed firms in the biotechnology industry. According to Lerner et al. (2003), the biotechnology industry originated in the mid-1970s, and many start-up firms that sought to commercialize scientific development in genetic engineering were formed in the subsequent decades. In Japan, the number of firms increased after the mid-1990s, and reached its peak in the 2000s (e.g., Honjo and Nagaoka 2015). Although the biotechnology industry recently developed, compared with other industries, a few firms were founded a long time ago. Therefore, firms over 30 years old were excluded from the sample (I collected data in 2015). Consequently, the sample mainly used in this chapter consisted of firms aged 30 years and younger; that is, biotechnology start-ups in this chapter are defined as those founded during the period of 1986–2015.[15] Moreover, firms

[15] I define 30 years for the start-up period while Honjo and Nagaoka (2015) defined 20 years. Although this period seems longer for a start-up, it does not always seem longer for drug discovery. I also include contract research organization (CRO) and site management organization (SMO) in the sample.

that could not be identified as providers of products or services using biotechnology were excluded from the sample. The sample of listed firms was composed of 45 firms. Note that three firms (Takara Bio, Acucela, and MediciNova) of the 45 were not included for statistics, except for in Table 8.1, because Takara Bio was a subsidiary of a large established firm, and Acucela and MediciNova were founded in the USA and are located outside Japan, although they were listed on Japanese stock markets.

Table 8.1 describes the top ten-ranked firms, based on the market value of equity at the end of December 2015. Table 8.1 shows that PeptiDream is the largest firm with a market value of 214 billion yen (1.8 billion US dollars, 1 US dollar = 120 yen). Gilead Sciences is the most highly valued firm in the biotechnology industry in the USA with a market value of 146 billion US dollars. The market value of Gilead Sciences is approximately 80 times as large as that of PeptiDream, while the current GDP of the USA was four times less than that of Japan in 2015. The higher-ranked firms in the USA, such as Gilead Sciences and Celgene, devote themselves to drug discovery. On the other hand, some of the higher-ranked firms in Japan are classified in the category of drug discovery, including regenerative medicines, but these firms have special features for drug discovery.

More interestingly, Table 8.1 shows that six firms in the top ten-ranked firms (Sosei, Takara Bio, Healios, NanoCarrier, Japan Tissue Engineering, and Acucera)—most of them are developing new drugs or regenerative medicines—did not earn positive profits by conducting an IPO, and some did not earn positive profits in 2015 either. Even if biotechnology start-ups have gone public and are valued in stock markets, they do not necessarily earn positive profits. This fact indicates that biotechnology start-ups require a long period to earn positive profits, suggesting that an IPO is not a goal but a means to raise capital for high-tech start-ups. For biotechnology start-ups with negative profits, access to public equity markets is inevitable to secure funding for a large amount of R&D investment.

Figure 8.2 describes the distribution of business categories of biotechnology start-ups in the sample of 42 listed firms. For the business category, drug discovery, including regenerative medicines, accounts for more than half of biotechnology start-ups that have experienced an IPO. Table 8.2 also provides the summary statistics for firm age and time to IPO measured by the number of months. Biotechnology start-ups conduct an IPO within, on average, 97 months (about 8 years), although this average does not include those firms that have not experienced an IPO. In the sample, all the 42 listed firms went public in the emerging stock markets: CENTREX, HERUCLES (now JASDAQ), JASDAQ, MOTHERS, NEO (now JASDAQ), and Tokyo AIM (now Tokyo PRO). Among the IPOs, 26 firms (62%) went public in the MOTHERS. In this respect, the emerging stock markets in Japan play a role in providing biotechnology start-ups with access to public equity financing. However, eight firms (19%) were already delisted by the end of December 2015 and, among the eight firms, five firms went private through M&A.

Table 8.1 Top ten-ranked firms in the biotechnology industry in the Japanese stock markets: December 2015

					2015	Post-IPO		2015		
No	Firm	Foundation	IPO	Category	MV [B]	Sales [B]	Profits [B]	Sales [B]	Profits [B]	Linkage
1	PeptiDream	7/2006	6/2013	Drug	214	0.7	0.1	2.5	1.0	University
					(USD 1.8)	[6/2013]		[6/2015]		(U. Tokyo)
2	Sosei	6/1990	7/2004	Drug	167	0.2	−1.8	3.7	0.6	
					(USD 1.4)	[3/2005]		[3/2015]		
3	Euglena	8/2005	12/2012	Food	149	2.1	0.5	5.9	0.5	University
					(USD 1.2)	[9/2013]		[9/2015]		(U. Tokyo)
4*	Takara Bio	4/2002	12/2004	R&D support	146	13.7	−1.3	26.0	1.0	Subsidiary
					(USD 1.2)	[3/2005]		[3/2015]		(Takara)
5	SanBio	2/2013	4/2015	Drug	46	–	–	3.2	1.7	
					(USD 0.4)	–		[1/2015]		
6	Healios	2/2011	6/2015	Drug	46	0.1	−1.0	0.1	−1.0	
					(USD 0.4)	[12/2015]		[12/2015]		
7	OncoTherapy Science	4/2001	12/2003	Drug	45	1.6	0.3	0.8	−1.3	University
					(USD 0.4)	[3/2004]		[3/2015]		(U. Tokyo)
8	NanoCarrier	6/1996	3/2008	Drug	45	0.3	−0.5	0.7	−0.2	University
					(USD 0.4)	[3/2008]		[3/2015]		(U. Tokyo)
9	Japan Tissue Engineering	2/1999	12/2007	Drug	45	0.1	−1.1	1.3	−0.7	University
					(USD 0.4)	[3/2008]		[3/2015]		(Nagoya U.)
10*	Acucera	4/2002	2/2014	Drug	30	4.3	−0.2	2.9	−3.1	
					(USD 0.3)	[12/2014]		[12/2015]		

Source: Nikkei Needs Financial Quest, JVR database, eol, and website for each firm

Note: All firms were founded during the period of 1986–2015. MV indicates the market value of equity in billion yen at the end of December 2015. Figures in parentheses for MV are in billion USD, 1 USD = 120 yen. Sales and profits (net profits after tax) indicate annual values in billion yen in the accounting period. Drug (discovery) includes regenerative medicines. Takara Bio and Acucera are not included in the sample for analysis

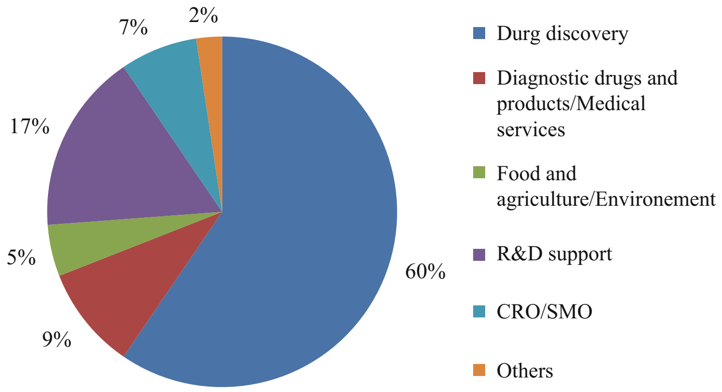

Fig. 8.2 Business categories of biotechnology start-ups. Note: The number of observations is 42 (Source: JVR database, eol, and website for each firm)

Table 8.2 Summary statistics for firm age and time to IPO

	Mean	SD	25%	Median	75%	*N*
Firm age (months)	177.4	63.3	140.0	168.5	202.0	42
Time to IPO (months)	97.0	51.5	57.0	92.5	128.0	42

Source: JVR database, eol, and website for each firm
Note: SD indicates standard deviation. *N* indicates the number of observations. Time to IPO indicates the number of months from funding to IPO

Table 8.3 provides the number of IPOs classified as university-based start-ups in the biotechnology industry.[16] I find that university-based start-ups account for approximately 64% (= 27/42) in the sample. Table 8.3 includes the distribution of non-IPOs and shows that university-based start-ups account for 49% (= 170/350) in the total sample of IPOs and non-IPOs. These results indicate that the emergence of biotechnology start-ups is associated with universities, suggesting that universities play a role in providing technological seeds in Japan. Table 8.3 also shows that the ratio of IPOs to non-IPOs for university-based start-ups (27/143 = 0.19) is higher than the ratio for others (15/165 = 0.09). This indicates that university-based start-ups are more likely to go public, which suggests that these start-ups require access to public equity markets for R&D. At the same time, outstanding technologies commercialized through spin-offs may be selected through rigorous screening processes of many technologies developed in universities. The results reveal that universities play a role in creating public firms in the biotechnology industry in Japan.

[16]Chiome Bioscience spun out from the public research institute, RIKEN, which is Japan's largest and most comprehensive research organization for basic and applied science. However, the portion of such spin-offs from public research institutes is small, and they are not regarded as a university-based start-up in this chapter.

Table 8.3 University-based start-ups and their IPOs

	IPO	Non-IPO	Total
University-based	27	143	170
Others	15	165	180
Total	42	308	350
$\chi^2 = 4.718$ [$p < 0.05$]			

Source: JVR database [accessed on August 5, 2016], eol, and website for each firm
Note: "University-based" represents biotechnology start-ups associated with universities. "IPO" and "Non-IPO" represent biotechnology start-ups that had experienced or had not experienced an IPO by December 2015, respectively

Table 8.4 Three major metropolitan and other regional start-ups and their IPOs

	IPO	Non-IPO	Total
Three major metropolitan	34	225	259
Other region	8	83	91
Total	42	308	350
$\chi^2 = 1.199$ [$p > 0.1$]			

Source: JVR database [accessed on August 5, 2016], eol, and website for each firm
Note: "Three major metropolitan" represents biotechnology start-ups located in Tokyo, Nagoya, and Osaka metropolitan areas while "Other region" represents those located in other areas. "IPO" and "Non-IPO" represent biotechnology start-ups that had experienced or had not experienced an IPO by December 2015, respectively

Furthermore, Table 8.4 provides the number of biotechnology start-ups located in three major metropolitan areas (Tokyo, Nagoya, and Osaka) and other regions. Based on the philosophy of the Industrial Cluster Project, high-tech start-ups are expected to emerge in regions other than metropolitan areas such as Tokyo. Although the government promotes regional innovation through industrial clusters in industries such as biotechnology, most biotechnology start-ups are concentrated in the three metropolitan areas. Table 8.4 shows that the total number of biotechnology start-ups in the three metropolitan areas accounts for 74% (= 259/350) and IPOs located in these areas account for 81% (= 34/42) of the sample.[17] However, the ratio of IPOs to non-IPOs does not differ between the three metropolitan areas and other regions.

Additionally, as discussed, biotechnology, medical, and health care account for one of the main VC investment fields in Japan. According to the JVR, three firms

[17] According to reports edited by the government, the concentration ratio of employed population or population in the three metropolitan areas is about 43% in recent years. For more details on the regional economy of Japan, see, for example, the following website.
http://kantou.mof.go.jp/content/000105133.pdf [accessed on October 26, 2016].

did not receive VC funding prior to their IPO, and they are classified in the category of R&D support or CRO. Conversely, 39 firms (39/42 = 0.93) were backed by VC firms prior to their IPO in the sample of 42 listed firms. VC firms in Japan play a critical role in IPOs, and the existence of VC firms may also affect the time to IPO in the biotechnology industry.[18]

8.3.3 Cases

Whereas biotechnology has been used to develop various products, drug discovery has had more impact on the development of the biotechnology industry, partly because it tends to lead to larger sales and higher market values of firms. However, the higher-ranked firms in Japan do not necessarily pursue drug discovery exclusively, and they may have a special business model. By discussing the cases of biotechnology start-ups, I describe the features of the biotechnology industry in Japan. Hereafter, I introduce three firms: PeptiDream, Sosei, and Euglena.[19] The three firms were ranked the top three for market value at the end of December 2015, as shown in Table 8.1.

PeptiDream (ranked first in Table 8.1) was founded in July 2006 by Kiichi Kubota (founder and CEO at the end of 2015) and commenced business based on novel peptide expression and platform-selection technologies developed by Hiroaki Suga (University of Tokyo). TODAI TLO (TLO wholly owned by the University of Tokyo) and the University of Tokyo Edge Capital (VC firm associated with the University of Tokyo) played a major role in the development of PeptiDream's business. In practice, PeptiDream is still using a venture incubation facility (University Corporate Relations Plaza; UCR Plaza) in the University of Tokyo. Therefore, PeptiDream is well known as a successful example of a university-based start-up. PeptiDream went public in the MOTHERS seven years after founding, and the annual sales and net profits were 0.7 billion yen and 0.1 billion yen, respectively, in June 2013 after the IPO. The annual sales increased 2.5 billion yen in June 2015.

PeptiDream produces libraries of peptides, which represent a rapidly growing therapeutic class of medicines with significant potential based on its proprietary Peptide Discovery Platform System (PDPS). PeptiDream's proprietary PDPS is a highly versatile peptide generation and selection platform consisting of three core

[18]Honjo and Nagaoka (2015), although their sample consisted of firms aged 20 years and younger and differs from the sample used in this chapter, showed that the time to IPO is 84 months in the biotechnology industry in Japan and found that biotechnology start-ups initially backed by VC firms are more likely to go public within a shorter period. On the other hand, Lerner (2009) found that the time to IPO is on average 86 months for VC-backed pharmaceuticals, while it is 178 months for non-VC-backed pharmaceuticals in the USA.

[19]For more details on these cases, see Toyo Keizai (2015a, b) and the website of PeptiDream, Sosei, and Euglena.

http://peptidream.com/en/index.html [Accessed on May 5, 2016].
http://www.sosei.com/en/ [Accessed on May 5, 2016].
http://www.euglena.jp/en/ [Accessed on May 5, 2016].

technologies: (i) flexizyme technology, (ii) translation, cyclization, and peptide-modifying technologies, and (iii) PD display technology. The combination of these three technologies into the PD platform allows PeptiDream to produce libraries of trillions of unique cyclic and helical nonstandard peptides with unparalleled diversity. PeptiDream has close collaboration with large pharmaceutical companies to develop peptide libraries and identify lead peptides with therapeutic and/or diagnostic potential against its partners' targets of interest. PeptiDream provides a business model of R&D collaboration with large pharmaceutical firm, such as Amgen, GlaxoSmithKline (GSK), and Novartis, by producing libraries of highly diverse, stable, and potent nonstandard macrocyclic peptides, although the clinical use of peptide therapeutics produced by conventional technologies has been limited because of issues with peptide stability, delivery/transport across membranes, rapid body clearance, and solubility.

Sosei (ranked second in Table 8.1) was founded in June 1990 by Shinichi Tamura (founder and CEO at the end of 2015). Although Sosei is often regarded as a first-generation biotechnology start-up in Japan, it has taken longer to go public. In fact, Sosei went public 14 years after founding, and the annual sales and net profits were 0.2 billion yen and −1.8 billion yen, respectively, in March 2005 after the IPO.

After going public, Sosei acquired a biotechnology firm in the UK, Arakis, which was developing glycopyrronium bromide, with 21 billion yen in August 2005. Glycopyrronium bromide is an inhaled long-acting muscarinic antagonist in development for the treatment of chronic obstructive pulmonary disease (COPD). At that time (in March 2005), the total assets of Sosei were less than ten billion yen and, as shown above, Sosei did not have positive profits. Therefore, this acquisition was a large purchase. After the acquisition, Sosei licensed exclusive worldwide development and marketing rights of glycopyrronium bromide to Novartis. Two new drugs (Seebri® and Ultibro®) developed by Novartis were approved in Japan in September 2012 and in September 2013, respectively, as maintenance bronchodilator treatments for COPD. Sosei received royalties on the sales of these new drugs. The sales of Sosei Group reached almost 2 billion yen in March 2013 while it had been less than 0.9 billion yen in March 2012. Sosei also acquired Heptares Therapeutics, which is a biotechnology firm for drug discovery in the UK, with 48 billion yen in February 2015.

Euglena (ranked third in Table 8.1) was founded in August 2005 by Mitsuru Izumo (founder and CEO at the end of 2015) with cofounder, Suzuki Kengo, who had engaged in R&D of euglena at the University of Tokyo. Euglena used the UCR Plaza in the University of Tokyo, and this firm, as well as PeptiDream, is a university-based start-up. Euglena went public in the MOTHERS in December 2012, and the annual sales and net profits were 2.1 billion yen and 0.5 billion yen, respectively, in September 2013 after the IPO.

Euglena produces food and energy using microalgae with a strong focus on euglena. The core technology of Euglena is mass cultivation technology of euglena, which Suzuki Kengo conducted in the post graduate course of the university, and it is protected by trade secret. While euglena contains most of the nutrients required for human survival as a food, it has the capability to create biofuels. Euglena engages in joint research with universities, such as the University of Tokyo, Osaka Prefecture

University, Kindai University, and the University of Hyogo, and develops new business and production technology through joint research. Euglena also engages in joint research with other firms such as JX Nippon Oil and Energy, and Hitachi. The joint project aims to change large amounts of high concentration CO_2 into jet fuels by constructing a euglena mass cultivation plant, which is expected to reduce CO_2 emissions. Moreover, Euglena began corporate VC and founded Euglena Investment in October 2014.

These cases indicate some important features of the biotechnology industry in Japan. First, the emergence of some biotechnology start-ups is significantly associated with R&D activities in universities. As discussed, biotechnology start-ups classified as biotechnology/health care/medical device account for the largest portion of university-based start-ups in Japan. In the above cases, I found that PeptiDream commenced business to commercialize technologies developed at the University of Tokyo, and Euglena still engages in joint research with some universities. These cases suggest that universities play a critical role in creating high-tech start-ups in technology-based industries. In addition to the linkage with universities, it is important to establish linkage with other firms for business expansion. Sosei earned large profits by licensing out products to large pharmaceutical companies.

Moreover, some biotechnology start-ups produce new products or services with unique ideas and technologies, and they tend to play an active part in the field other than simple drug discovery, including R&D support. Conversely, this indicates that biotechnology start-ups in Japan may have had less impact on drug discovery. Few biotechnology drugs developed by biotechnology start-ups in Japan were launched until today. Accordingly, large pharmaceutical companies may be favorable for technologies developed by foreign biotechnology start-ups. For instance, Takeda Pharmaceutical acquired Millennium Pharmaceuticals in the USA. Additionally, many firms conducting drug discovery often have more than one pipeline, and some continue business by developing in-licensed products, including biosimilar drugs. For instance, Gene Techno Science developed filgrastim biosimilar while developing in-house drugs.[20] These findings indicate the difficulties in financing drug discovery for biotechnology start-ups because of the extremely low probability of new drug discovery. At the same time, biotechnology start-ups themselves, rather than investors, must manage the portfolio of research projects.

8.4 Performance of Biotechnology Start-Ups.

8.4.1 Capital Structure and Operating Performance

I mainly focus on listed firms in the biotechnology industry because data on financial statements and market values of listed firms are obtainable for many, but not all, high-tech start-ups pursuing an IPO to secure access to public equity markets.

[20]For more details on filgrastim biosimilar, see the website of Gene Techno Science. http://www.g-gts.com/en/ [Accessed on April 1, 2017]

Table 8.5 Performance of biotechnology start-ups

	IPO	Mean	SD	25%	Median	75%	$\|t\|$
Total assets (TA) (billion yen)	Pre	1.920	1.655	0.755	1.281	2.748	
	Post	4.456	3.046	2.195	3.581	5.758	6.408***
Equity (billion yen)	Pre	1.733	1.671	0.511	1.065	2.302	
	Post	4.273	3.030	2.105	3.373	5.536	6.386***
Sales (billion yen)	Pre	0.960	1.262	0.178	0.488	1.286	
	Post	1.144	1.349	0.184	0.622	1.802	2.913***
FCF (billion yen)	Pre	−0.373	0.735	−0.717	−0.200	0.025	
	Post	−0.949	1.814	−1.261	−0.335	−0.036	3.042***
Equity/TA	Pre	0.893	0.216	0.924	1.000	1.000	
	Post	0.957	0.097	0.974	1.000	1.000	2.575**
FCF/TA	Pre	−0.242	0.343	−0.479	−0.202	0.021	
	Post	−0.209	0.267	−0.316	−0.109	−0.013	0.684

Source: Nikkei Needs Financial Quest and eol

Note: Pre and post indicate settlement dates before and after going public, respectively. SD indicates standard deviation. t indicates a test statistic for the hypothesis that the mean of the variable for pre-IPO equals that for post-IPO. FCF indicates free cash flow. The number of observations is 40 because among 42 IPOs, 2 firms did not settle the account after going public until December 2015

Financing—specifically, equity financing—is more important for high-tech start-ups' R&D and to continue their R&D activities. At the same time, financing may represent the expectation of capital markets for the firms.

Table 8.5 provides the operating performance of biotechnology start-ups pre- and post-IPO. These figures were measured on the first settlement date after going public; therefore, the timing differs between firms. The number of observations is 40 in Table 8.5 because two firms that went public in 2015 did not settle the account after going public until December 2015. The mean total assets are approximately 4.5 billion yen, and the mean equity is approximately 4.3 billion yen after going public. Table 8.5 shows that biotechnology start-ups significantly increase total assets and equity by securing access to public equity markets through IPOs. Total assets and equity are more than twice as large as post-IPO compared to pre-IPO. Additionally, the results reveal that equity financing accounts for a large part of total assets. Table 8.5 also presents the ratio of equity to total assets (equity ratio) for biotechnology start-ups. The mean equity ratio is 96% post-IPO while it is 89% pre-IPO. Whereas the equity ratio is higher pre-IPO, biotechnology start-ups increase the equity ratio by securing access to public capital markets.

Table 8.5 shows sales and profits. The mean sales are approximately 1.0 billion yen. Although sales as well as total assets are more likely to increase post-IPO, the growth ratio of sales is smaller than that of total assets, probably because it takes a longer time to expand sales in the biotechnology industry. I also capture operating performance by free cash flow. Table 8.5 shows that many biotechnology start-ups earn negative free cash flow even after going public. The mean free cash flow post-IPO is not higher than that pre-IPO. The results indicate that biotechnology start-ups cannot easily achieve positive profits, presumably because they require prolonged, large amounts of R&D investment.

Table 8.5 also shows the ratio of free cash flow to total assets for biotechnology start-ups. The mean ratio is −24% post-IPO while it is −21% pre-IPO. Table 8.5 reveals that biotechnology start-ups do not increase the ratio of free cash flow to total assets. The results indicate that biotechnology start-ups do not improve their operating performance after going public. The finding of no improvement is consistent with that of previous literature (e.g., Jain and Kini 1994; Cai and Wei 1997). This suggests that IPO is a stage for biotechnology firms to secure funding for their R&D activities by accessing public equity markets rather than to improve the level of profits.

8.4.2 Market Value of Equity

Sales, profits, and their rates were presented in the former subsection. However, high-tech start-ups, particularly biotechnology start-ups, may require a long period to gain sales and positive profits. Despite poor operating performance, some high-tech start-ups may have tremendous growth potential stemming from breakthrough technologies. In this context, high-tech start-ups should be evaluated from a long-term perspective. To do this, I provide the market values of equity as post-IPO performance. However, it is evident that the market values depend on market conditions, such as hot or cold markets. To evaluate the long-run performance of IPOs by controlling for the overall market conditions, previous studies have used two typical measures, CAR and BHAR, as long-run performance after an event (e.g., Ritter 1991; Barber and Lyon 1997; Yung et al. 2008).

Before calculating these measures, I first present the market value of equity for biotechnology start-ups post-IPO. Given that investors can evaluate the growth potential of high-tech start-ups in the market, the market value reflects the possibility of business success. In other words, market valuation represents investors' perception of the capability of high-tech start-ups. Moreover, a higher valuation leads to benefits for early-stage investors, including VC firms, and high-tech start-ups with a higher valuation can raise more funds from capital markets.

Table 8.6 shows the market value of equity at the end of the month after going public. The mean market value is approximately 29 billion yen and the median market value is approximately 14 billion yen. Additionally, the mean market value at the end of December 2015 is approximately 31 billion yen and the median market value is approximately 13 billion yen. Moreover, Table 8.6 provides a market-to-book ratio (MTB), defined as the ratio of the market value to the book value of equity on the first settlement date after going public, for 40 firms with available data on the book value of equity. The mean MTB is approximately seven, although the market and book values include capital increases at IPO. The market value of equity post-IPO is at least higher than its book value for biotechnology start-ups in Japan.

Table 8.6 Summary statistics of market values of equity

	Mean	SD	25%	Median	75%	*N*
MV post-IPO (billion yen)	28.7	35.0	6.3	14.4	40.5	42
MV in 2015 (billion yen)	30.5	48.8	5.9	12.6	24.2	34
MTB	6.8	9.0	1.4	3.6	7.9	40

Source: Nikkei Needs Financial Quest
Notes: SD indicates standard deviation. *N* indicates the number of observations. MV post-IPO indicates the market value of equity (market capitalization) in billion yen at the end of the month after going public. MV in 2015 indicates the market value of equity at the end of December 2015. MTB indicates a market-to-book ratio, which is defined as the ratio of the market value to the book value of equity on the first settlement date after going public. The number of observations is 34 for MV in 2015 because among 42 IPOs, 2 firms did not settle the account after going public until December 2015, and 8 firms did not remain public until December 2015. The number of observations for MTB is 40 because among 42 IPOs, 2 firms did not settle the account after going public until December 2015

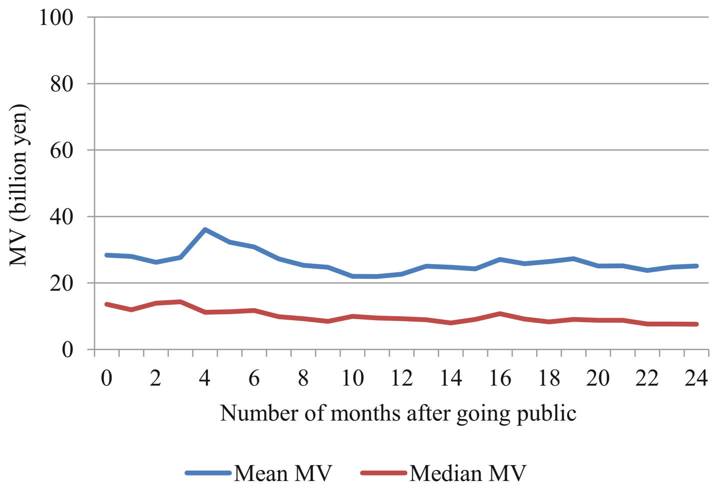

Fig. 8.3 Market value of equity for listed firms after going public in the biotechnology industry. Note: MV indicates the market value of equity (in billion yen). The number of observations (listed firms) is 37 (Source: Nikkei Needs Financial Quest)

Figure 8.3 also describes the market value of equity for biotechnology start-ups after going public. In Fig. 8.3, I restrict the analysis to 37 firms that went public before January 2014 and remained public for more than 2 years and describe the mean and median market values of equity for 24 months (2 years) after going public. While the mean market value appears to increase for 4 months after going public, the upward trend does not continue. Additionally, the median market value may have a slight downward trend. Overall, I cannot identify the upward trend in the market values of equity for biotechnology start-ups after going public.

Similarly, Fig. 8.4 presents the mean and median market values and the number of listed firms, based on calendar year, in the sample. In the early 2000s, much

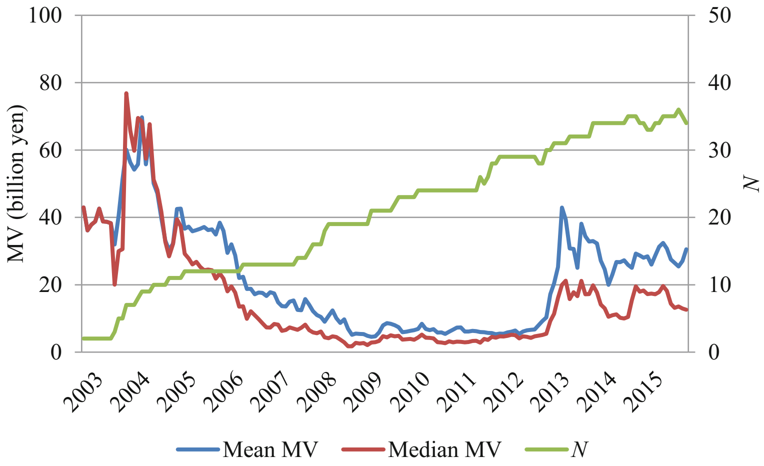

Fig. 8.4 Market value of equity for listed firms in the biotechnology industry: 2003–2015. Note: MV indicates the market value of equity (in billion yen). *N* indicates the number of firms (Source: Nikkei Needs Financial Quest)

attention was paid to the IPOs of university start-ups. AnGes MG, which was founded with technologies developed in Osaka University, went public in September 2002. Then, TransGenic, which was founded with technologies developed in Kumamoto University, went public in December 2002. As shown in Fig. 8.1, many firms in the biotechnology industry appeared after the mid-1990s. Honjo and Nagaoka (2015) also found that biotechnology start-ups founded in the late 1990s are more likely to go public within a shorter period, which may correspond to the introduction of emerging stock markets in the late 1990s in Japan. As also shown in Fig. 8.3, the market values of equity for biotechnology start-ups founded during the early 2000s, on average, increased by over 60 billion yen. This may indicate that first-generation IPOs are readily acceptable in the early rise of the emerging stock markets because the first generation for biotechnology start-ups, in addition to products and services through university–industry collaboration, were highly anticipated. However, first-generation IPOs did not fulfill expectations, and the market values decreased around 2005, indicating that the upward trend would not continue.

Figure 8.4, however, shows a subsequent upward trend, and the mean market value rose sharply after October 2012. This is mainly because the 2012 Nobel Prize in Physiology or Medicine awarded to Shinya Yamanaka, a professor at Kyoto University who successfully generated induced pluripotent stem (iPS) cells in mice and humans along with John B. Gurdon, was announced on October 8, 2012. The development of iPS cells triggered a rapid increase in the stock prices of biotechnology start-ups. This phenomenon indicates that innovation has a great impact on market values.

8.4.3 Aftermarket Performance

I provide evidence on how aftermarket performance varies over time, using CAR and BHAR. Let r_{it} denote return in month t after the IPO. Suppose that firm i goes public in s_i. The abnormal return of firm i in month t is defined as $AR_{it} = r_{it} - r_{mt}$ where r_{mt} is the relevant benchmark return. In this case, firm i's CAR and BHAR during the period from s_i to $s_i + \tau$ are defined as follows:

$$CAR_{i\tau} = \prod_{t=s_i}^{s_i+\tau} AR_{it}, \tag{8.1}$$

$$BHAR_{i\tau} = \left\{ \prod_{t=s_i}^{s_i+\tau} (1 + r_{it}) - 1 \right\} - \left\{ \prod_{t=s_i}^{s_i+\tau} (1 + r_{mt}) - 1 \right\}. \tag{8.2}$$

These returns are measured at monthly intervals and all the values are based on closing prices. In the analysis, the benchmark return is measured by the Tokyo Stock Price Index (TOPIX), which is a market capitalization-weighted index based on all domestic common stocks listed on the TSE.[21] While, as shown in Fig. 8.3, the market values of biotechnology start-ups depend heavily on market conditions, CAR and BHAR can be controlled for the overall market conditions. I present the mean and median CARs and BAHARs based on monthly data during the period from the firm's IPO date to τ, which indicates the number of months after going public.

Table 8.7 presents the mean and median CARs and BHARs when τ is 3, 6, 12, 24, 36, 48, and 60 months. In Table 8.7, the mean CAR for $\tau =$ 60 is higher than zero at the 5% significance level, indicating that biotechnology start-ups are highly valued in the sixth year after going public. However, the mean CAR, except for $\tau =$ 60, and the mean BHAR are insignificant. Additionally, the median CAR and BHAR do not have a significantly positive effect but, overall, the median tends to be negative during the observation period. These results suggest that while only a few start-ups are highly valued, many are not highly valued in the markets.[22] Loughran and Ritter (1995) noted the misevaluation of IPOs by investors and the poor, long-run performance of stock returns is almost universal and has been confirmed in previous studies (e.g., Loughran et al. 1994). The findings of this chapter suggest

[21] While some previous studies have used a market index as the benchmark return, Barber and Lyon (1997) noted that there are significant biases in test statistics when long-run abnormal returns are calculated using a market index. However, I use a market index to simplify the calculation of CAR and BHAR. Meanwhile, I use the JASDAQ index as the benchmark return. When using the JASDAQ index, I obtain similar results.

[22] Because, as shown in Table 8.3, university-based start-ups are more likely to go public, I examine the monthly CAR and BHAR only for university-based start-ups. However, I did not find that CAR and BHAR for university-based start-ups are higher than zero at the 5% significance level.

Table 8.7 CAR and BHAR post-IPO

CAR						
Post-IPO	Mean	SE	Median	$\|t\|$	$\|z\|$	*N*
3 months	0.113	0.097	−0.028	1.165	0.292	41
6 months	0.152	0.151	−0.142	1.001	0.162	41
12 months	0.152	0.181	−0.193	0.837	0.042	39
24 months	0.166	0.220	−0.014	0.755	0.309	37
36 months	0.352	0.270	0.070	1.305	0.972	32
48 months	0.581	0.441	0.087	1.318	0.820	28
60 months	1.276	0.623	0.750	2.047*	1.521	23
BHAR						
Post-IPO	Mean	SE	Median	$\|t\|$	$\|z\|$	*N*
3 months	0.133	0.128	−0.084	1.044	0.486	41
6 months	0.216	0.194	−0.174	1.116	0.551	41
12 months	0.172	0.239	−0.353	0.719	1.451	39
24 months	0.051	0.287	−0.455	0.177	2.105**	37
36 months	0.134	0.348	−0.398	0.385	1.459	32
48 months	−0.195	0.260	−0.517	0.748	1.844*	28
60 months	1.617	1.637	−0.484	0.987	0.760	23

Source: Nikkei Needs Financial Quest
Notes: SE indicates standard error. *N* indicates the number of observations. *t* indicates a test statistic for the hypothesis that mean equals zero. *z* indicates a test statistic for the hypothesis that median equals zero

that better performance of stock returns is not found for biotechnology start-ups in Japan, which does not contradict the previous studies.

While Lerner (1994) showed that biotechnology firms go public when equity valuations are high, Honjo and Nagaoka (2015) found that IPOs occur with little consideration of market conditions in the biotechnology industry in Japan and argued that biotechnology start-ups go public to secure funding for their R&D activities. From this perspective, although VC firms tend to commit IPOs in the biotechnology industry, it is possible that the screening process up to IPO is not effective enough to achieve post-IPO performance. Particularly in Japan, the private equity financial system is underdeveloped and, therefore, early-stage investors including VC firms simply use IPOs to recoup their investments. Accordingly, even if biotechnology start-ups are overvalued at IPO, their businesses may not attract investors with a long-term perspective.

8.5 Conclusions

This chapter has explored high-tech start-ups in the biotechnology start-ups in Japan. I provided evidence that many biotechnology start-ups originate from universities and that the emergence of some biotechnology start-ups is significantly associated with R&D activities in universities. I also found that emerging stock markets play a critical role in equity financing for biotechnology start-ups. In this respect, the linkage with external organizations, including access to equity markets, may, in part, be effective in developing biotechnology start-ups in Japan. Moreover, I examined whether biotechnology start-ups improve performance by going public. The results indicated that biotechnology start-ups increase equity financing, although they do not improve post-IPO performance.

Whereas it is expected that high-tech start-ups emerge in markets and stimulate a stagnant economy, the linkage between high-tech start-ups and external organizations, such as universities, large established corporations, and venture capitalists, is imperative to develop technology-based industries because of the limited human and financial resources of high-tech start-ups. As discussed, the target quantity for university-based start-ups was attained in response to government incentives, and some university-based start-ups did conduct an IPO. The linkage with universities appears in the biotechnology industry in Japan. However, the sizes or market values of biotechnology start-ups are not large, compared to those in the USA, and they do not achieve better performance. To foster high-tech start-ups with growth potential, there may be room for improvement in the industrial structure in Japan.

Kneller (2003) argued that Japanese companies have done well in industries suitable for autarkic innovation, but recently they have been at a disadvantage in industries where innovation occurs most effectively through interaction with universities and other companies. Moreover, Goto (2000) noted that for new technologies, accumulated know-how or skills specific to the firm become less important because knowledge and skills are codified in an abstract form and belong to those people who have the advanced and specialized knowledge to understand them. From this perspective, as Goto argued, Japan must improve new and more appropriate corporate and industrial structures to be successful in the field of biotechnology. The Japanese industrial structure, including the internal labor system, has provided advantages in the development of technologies in many industries such as automobiles and electronics. The close human relationship based on lifetime employment, which has been seen in traditional firms in Japan, may promote in-house R&D. However, there is no guarantee that such advantages apply to current technology-based industries, including the biotechnology industry, where linkage with external organizations is imperative—more precisely, innovation relies on inputs from universities and venture capitalists and, in part, on outputs to large establishment firms. In these industries, know-how or skills unspecific to the firm and the liquidity of resources could be encouraged to promote innovation by high-tech start-ups. For this purpose, industrial and corporate change toward innovation and growth, which may result in the loss of the Japanese traditional management system, would be required in technology-based industries in Japan.

The promotion of life science-related industries is salient, including the biotechnology industry. Such industries will be linked to considerable demand by the future aging population. A better understanding of conditions in the biotechnology industry would provide insights into ways to promote technology-based industries in Japan.

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Chapter 9
E-commerce and Employment Growth in Japan: An Empirical Analysis Based on the Establishment and Enterprise Census

Hyeog Ug Kwon

Abstract This study, using microdata from the Establishment and Enterprise Census, empirically examines the relationship between e-commerce and employment growth in Japanese firms from 2001 to 2006. The main findings from a multinomial logit model and an extension of a basic firm-growth model are as follows. (1) Regardless of which type of technology is considered, larger firms, foreign firms, and multinational firms conduct more e-commerce. (2) E-commerce has a large positive impact on employment growth. This suggests that new technology, such as e-commerce, complements to employment.

Keywords E-commerce • Employment growth

9.1 Introduction

The purpose of this study is to investigate empirically the relationship between the adoption of new technology as e-commerce and employment growth. The effect of technological progress on employment growth is an important research topic but despite the importance of and long-standing interest in the topic, there is a dearth of meaningful empirical studies on the effect of e-commerce on employment growth.

This study contributes to the literature in this field in two major respects. First, much of the existing work focuses on the effects of e-commerce on productivity growth rather than employment growth. This study is intended to fill this gap and provides the first steps to understanding the relationship between e-commerce and employment growth. Second, most previous studies have been confined to macro- and industry-level data. This study examines the relationship between e-commerce and employment growth using a comprehensive firm-level dataset.

The structure of the rest of this paper is as follows. Section 9.2 provides a brief literature review on technology adoption and employment growth. Section 9.3

H.U. Kwon (✉)
College of Economics, Nihon University, 1-3-2 Misakicho, Chiyoda-ku, Tokyo 101-8360, Japan
e-mail: kwon.hyeogug@nihon.ac.jp

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explains the data and variables in this study. Section 9.4 presents the determinants of e-commerce. Section 9.5 presents the effects of e-commerce on employment growth. Section 9.6 concludes.

9.2 Literature Review

There has been pessimistic concern that new technology will substitute for workers overall. As a well-known example, Nobel Laureate Wassily Leontief (1952) states that *labor will become less and less important ... More and more workers will be replaced by machines. I do not see that new industries can employ everybody who wants a job.* Brynjolfsson and McAfee (2011) show that even though information and communication technology (ICT) increases productivity and overall wealth, it can replace labor.[1] An important aspect of ICT technology is reduction of costs through savings on factors of production. However, new technology, such as ICT, might also complement labor, that is, increasing output as a result of new technology might boost employment. For instance, using the case of automated teller machines (ATMs) and bank tellers, Bessen (2015) finds a positive correlation between the growth of ATMs and changes in bank teller employment. Although the number of ATMs increased from 100,000 to 400,000 between 1995 and 2010 in USA, the number of bank tellers also increased from 500,000 to 550,000 from 1980 to 2010. This fact suggests that new technology, such as ATMs, and labor have a complementary relationship. Moreover, Acemoglu and Restrepo (2016) show that new technology can create demand for new occupations. They report that total employment in the USA grew by 17.5% during 1980–2007, half of which was accounted for by the additional employment growth in occupations with new job titles.

As noted above, with respect to the relationship between the adoption of new technology and employment growth, the empirical evidence remains inconclusive.

9.3 Data and Variables

9.3.1 Data

I use microdata on employment and e-commerce from the *Establishment and Enterprise Census* for 2001 and 2006. In this study, I use firm-level data rather than establishment-level data. Volume 1 of the *Establishment and Enterprise Census* reports establishment-level data for employees, while Volume 3 of the census reports

[1]For a detailed survey of empirical studies on the complementary relationship between ICT and productivity, see Draca et al. (2007).

the sum of firm-level numbers of employees. I use firm-level data of Volume 3 of the census. The total number of regular employees at firms (stock companies, general partnership companies, limited partnership companies, limited liability companies, and mutual companies) was 33.2 million in 2001 and 32.1 million in 2006. Regular employees refer to the sum of the number of permanent employees and the number of part-time workers. The total number of firms was 1.62 million in 2001 and 1.52 million in 2006.

9.3.2 Variables

Variables representing firm attributes are as follows.

1. Dummy variables relating to e-commerce: I prepare two sets of dummy variables relating to e-commerce in 2001, that is, whether the firm is engaged in e-commerce.
   - Dummy for firms that engage e-commerce using the Internet: the value of firms that are engaged in e-commerce using the Internet is 1, and that of other firms is 0.
   - Dummy for firms that are engaged in e-commerce using a computing network: the value of firms that are engaged in e-commerce using a computing network is 1, and that of other firms is 0.
2. Logarithmic value of the number of employees (full-time and part-time workers are included, but temporary workers are not included): represents firm size.
3. Logarithmic value of firm age: firm age is measured as the number of years since the registered establishment of the firm.
4. Dummy variables relating to ownership structure: I prepare two dummy variables relating to ownership structure as follows.
   - Dummy for firms that are affiliates of a Japanese firm: the value of firms that are 20–50% owned by a Japanese firm or majority-owned by a Japanese firm is 1 and that of other firms is 0.
   - Dummy for firms that are affiliates of a foreign firm: the value of firms that are 20–50% owned by a foreign firm or majority-owned by a foreign firm is 1 and that of other firms is 0.
   - For both dummy variables, the standard case involves independent Japanese firms (a firm that does not have any parent firm, a firm holding more than 50% of the voting rights, or a firm holding between 20% and 50% of the voting rights).
5. Dummy for firms that are single establishments: the value of firms that are single establishments is 1 and that of other firms is 0.
6. Dummy for multinational firms: dummy takes a value of 1 if the firm has employees abroad and that of other firms is 0.

Table 9.1 shows the descriptive statistics of each variable by years.

As can be observed from Table 9.1, the share of firms that are engaged in e-commerce using the Internet increased from 8% in 2001 to 12% in 2006. On the other hand, the share of firms that are engaged in e-commerce using a computing network decreased from 2.7% in 2001 to 2.5% in 2006. The share of firms that are engaged in e-commerce by industry is highest in the commerce sector, followed by the manufacturing and services sectors, in that order. In the services sector, although the share of firms that are engaged in e-commerce using the Internet increased in 2006 compared to 2001, it was still less than 10%.

Next, Fig. 9.1 shows the net increase of employment from e-commerce use during the period 2001–2006. As shown in Fig. 9.1, the number of employees of firms that are not engaged in e-commerce declined 0.36 million, while the number of employees of firms that are engaged in e-commerce increased 0.09 million. Next, I look at the relationship between technology type of e-commerce and net increase of employment. The net increase of employment at firms that are engaged in e-commerce using a computing network is higher than that at firms that are engaged in e-commerce using the Internet. Let us look at the relationship between e-commerce and the net increase of employment by sector. In the manufacturing sector, I find that a net decrease in employment occurred regardless of whether firms are engaged in e-commerce. Contrary to the manufacturing sector, I find that all firms increased employment in the commerce sector, irrespective of the categories of e-commerce. Among them, firms that are engaged in e-commerce using the Internet were the most active in employment growth. In the services sector, I find that only firms that are engaged in e-commerce using a computing network created jobs.

In summary, I find that firms that introduced new technology as e-commerce in nonmanufacturing sectors were sources of employment growth.

9.4 Determinants of E-commerce

9.4.1 Model

Let us analyze the determinants of whether a firm is engaged in a particular type of e-commerce in the first place. To do so, I estimate a multinomial logit model to discover what determines whether a firm is engaged in a particular type of e-commerce. Specifically, I consider two different outcomes: Internet and computing network. The probability that a firm is engaged in a particular type of e-commerce s in year t is given by

$$\text{Prob}\left(E_{ft} = s\right) = \frac{\exp\left(\beta_s Z_{ft}\right)}{1 + \sum_{k=1}^{2} \exp\left(\beta_k Z_{ft}\right)} \tag{9.1}$$

Table 9.1 Descriptive statistics

	Whole sample							
	2001				2006			
	Obs.	Mean	Max	Min	Obs.	Mean	Max	Min
Dummy for firms which engage e-commerce using Internet	1,617,600	0.078	1.000	0.000	1,515,835	0.121	1.000	0.000
Dummy for firms which engage e-commerce using computing network	1,617,600	0.027	1.000	0.000	1,515,835	0.025	1.000	0.000
Firm size (logarithmic value of the number of employees)	1,428,721	1.801	11.872	0.000	1,307,452	1.790	11.884	0.000
Logarithmic value of firm age	1,555,382	2.820	4.625	0.000	1,446,476	2.954	4.673	0.000
Dummy for firms which is an affiliate of a Japanese firm	1,617,600	0.063	1.000	0.000	1,515,835	0.056	1.000	0.000
Dummy for firms which is an affiliate of a foreign firm	1,617,600	0.002	1.000	0.000	1,515,835	0.003	1.000	0.000
Dummy for firms that are single establishments	1,617,600	0.870	1.000	0.000	1,515,835	0.865	1.000	0.000
Dummy for multinational firms	1,617,600	0.003	1.000	0.000	1,515,835	0.003	1.000	0.000
	Manufacturing sector							
Dummy for firms which engage e-commerce using Internet	297,614	0.089	1.000	0.000	263,518	0.133	1.000	0.000
Dummy for firms which engage e-commerce using computing network	297,614	0.029	1.000	0.000	263,518	0.030	1.000	0.000
Firm size (logarithmic value of the number of employees)	273,627	2.101	11.872	0.000	238,837	2.126	11.884	0.000
Logarithmic value of firm age	289,558	3.029	4.625	0.000	255,341	3.181	4.673	0.000
Dummy for firms which is an affiliate of a Japanese firm	297,614	0.086	1.000	0.000	263,518	0.076	1.000	0.000
Dummy for firms which is an affiliate of a foreign firm	297,614	0.003	1.000	0.000	263,518	0.004	1.000	0.000
Dummy for firms that are single establishments	297,614	0.869	1.000	0.000	263,518	0.858	1.000	0.000
Dummy for multinational firms	297,614	0.006	1.000	0.000	263,518	0.008	1.000	0.000

(continued)

Table 9.1 (continued)

	Whole sample							
	2001				2006			
	Obs.	Mean	Max	Min	Obs.	Mean	Max	Min
	Commerce sector							
Dummy for firms which engage e-commerce using Internet	493,601	0.095	1.000	0.000	442,412	0.157	1.000	0.000
Dummy for firms which engage e-commerce using computing network	493,601	0.047	1.000	0.000	442,412	0.042	1.000	0.000
Firm size (logarithmic value of the number of employees)	429,420	1.640	11.020	0.000	376,127	1.640	11.709	0.000
Logarithmic value of firm age	473,633	2.904	4.625	0.000	421,660	3.048	4.673	0.000
Dummy for firms which is an affiliate of a Japanese firm	493,601	0.054	1.000	0.000	442,412	0.050	1.000	0.000
Dummy for firms which is an affiliate of a foreign firm	493,601	0.004	1.000	0.000	442,412	0.005	1.000	0.000
Dummy for firms that are single establishments	493,601	0.832	1.000	0.000	442,412	0.827	1.000	0.000
Dummy for multinational firms	493,601	0.003	1.000	0.000	442,412	0.003	1.000	0.000
	Service sector							
Dummy for firms which engage e-commerce using Internet	816,733	0.064	1.000	0.000	800,183	0.099	1.000	0.000
Dummy for firms which engage e-commerce using computing network	816,733	0.014	1.000	0.000	800,183	0.015	1.000	0.000
Firm size (logarithmic value of the number of employees)	716,953	1.781	11.479	0.000	683,881	1.754	11.824	0.000
Logarithmic value of firm age	782,758	2.692	4.625	0.000	760,031	2.827	4.673	0.000
Dummy for firms which is an affiliate of a Japanese firm	816,733	0.059	1.000	0.000	800,183	0.053	1.000	0.000
Dummy for firms which is an affiliate of a foreign firm	816,733	0.002	1.000	0.000	800,183	0.002	1.000	0.000
Dummy for firms that are single establishments	816,733	0.893	1.000	0.000	800,183	0.888	1.000	0.000
Dummy for multinational firms	816,733	0.001	1.000	0.000	800,183	0.001	1.000	0.000

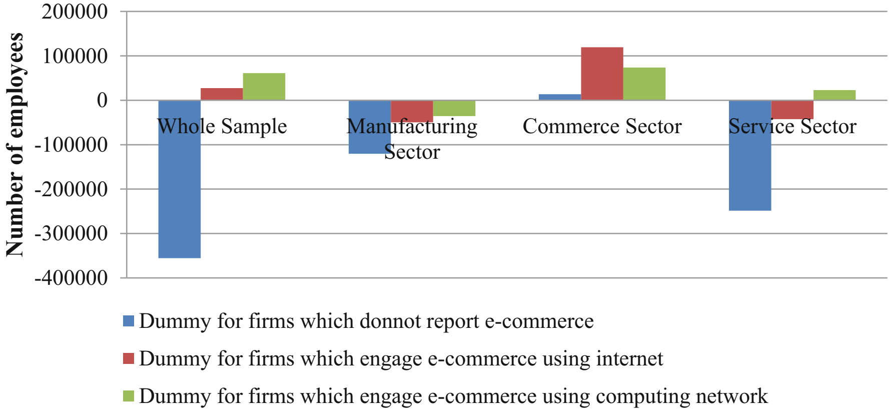

Fig. 9.1 Net increase of employment by e-commerce use: 2001–2006

where $s = 0, 1, 2$, and E_{ft} is the type of e-commerce s of firm f in year t. In other words, Eq. (9.1) addresses firms that are engaged in e-commerce using the Internet ($s = 1$), firms that are engaged in e-commerce using a computing network ($s = 2$), and firms that are not engaged in e-commerce ($s = 0$).[2] Z_{ft} is a vector of explanatory variables. For the explanatory variable, I use the logarithm of the number of employees, the logarithmic value of firm age, and several dummy variables reflecting firm characteristics, such as whether the firm is part of a corporate group, whether it is a single establishment, and whether it is engaged in foreign direct investment (FDI). In all regressions, I include industry dummies to control for unobserved industry characteristics. Furthermore, I investigate whether there are any differences across industries. To do so, I estimate Eq. (9.1) by dividing the whole sample into three sectors, that is, the manufacturing, commerce, and services sectors.

9.4.2 Hypotheses

The reason for the adoption of new technology as e-commerce is that it is possible that a firm reduces transaction costs across firms and adjustment costs within firms and is able to expand existing markets and to acquire new markets (Steinfield and Klein 1999).[3] Therefore, firms that expect significant reductions in transaction costs

[2]E-commerce using a computing network is likely to be used for interfirm transactions (B to B), while e-commerce using the internet is used for B to C. This suggests that differences in technology used bring about differences in transactions.

[3]The adoption of e-commerce is considered as process innovation.

and adjustment costs from the adoption of e-commerce are inclined to undertake e-commerce. Therefore, I propose the following hypothesis.

Hypothesis 1 Large firms, firms with multiple establishments, parent firms, and multinational firms tend to have significantly higher probability of adopting e-commerce.

Next, because incumbent firms face rigidity of organization, profit from old technology and high costs from the adoption of new technology, they are likely to be reluctant to introduce new technology, such as e-commerce (Kuemmerle 2006). This leads to my second hypothesis as follows.

Hypothesis 2 Smaller and younger firms are more inclined to undertake e-commerce than are larger and older firms.

It should be noted that there are conflicting elements in Hypotheses 1 and 2 with respect to firm size, and firms will choose the case in which the benefits from e-commerce are larger than the costs of e-commerce.

Furthermore, I am not aware of any research on the effects of the use of an interfirm network on the adoption of new technology. I infer that firm-specific technology promotes the use of an interfirm network. Therefore, I propose the following hypothesis.

Hypothesis 3 Affiliates of Japanese firms and older firms tend to prefer e-commerce using a computing network to e-commerce using the Internet.

9.4.3 Estimation Results

The estimation results of the multinomial logit model are presented in Tables 9.2 and 9.3. Starting with the results in Table 9.2 for whole sample, I find that the probability of introducing e-commerce using the Internet of firms with multiple establishments, parent firms, multinational firms, and younger firms is higher than that of other firms. This result is consistent with Hypotheses 1 and 2. With regard to the estimation results on firm size, Hypothesis 1 is supported. In line with Hypothesis 3, I find that the estimation results differ by technology type in the use of e-commerce. Contrary to the case of e-commerce that uses the Internet, I find that the probability of introducing e-commerce using a computing network is higher in older firms, affiliates of Japanese firms, and firms with single establishments. This result suggests that the introduction of e-commerce is dependent on strategic objectives and positioning of firms.

Turning to the estimation results for industries (Table 9.3), the estimation results for the manufacturing sector show that older firms conduct e-commerce using the Internet more than younger firms do. This result contrasts with the estimations results of the whole sample. On the other hand, the estimation results for the commerce and services sectors show that the coefficient of affiliates of Japanese

Table 9.2 Determinants of e-commerce: multinomial logit model

	Whole sample					
	Dummy for firms which engage e-commerce using Internet			Dummy for firms which engage e-commerce using computing network		
	Coefficients	Standard errors		Coefficients	Standard errors	
Firm size (logarithmic value of the number of employees)	0.253	0.002	***	0.449	0.003	***
Logarithmic value of firm age	−0.047	0.002	***	0.032	0.005	***
Dummy for firms which is an affiliate of a Japanese firm	−0.009	0.008	***	0.338	0.012	***
Dummy for firms which is an affiliate of a foreign firm	0.293	0.030	***	0.288	0.047	***
Dummy for firms that are single establishments	−0.158	0.006	***	0.125	0.011	***
Dummy for multinational firms	0.484	0.026	***	0.415	0.036	***
Industry dummies	Yes					
PseudoR-squared	0.0603					
Number of observation	2627516					

Notes: The firms which do not engage e-commerce are base. Standard errors are White-corrected for heteroskedasticity. ***$p < 0.01$

firms in the case of e-commerce that uses the Internet is opposite to the estimation results of the whole sample.

In summary, I find that regardless of which type of technology is considered, larger firms, foreign firms, and multinational firms conduct more e-commerce.

9.5 Effects of E-commerce on Employment Growth

9.5.1 Model

For the relationship between firm size and firm growth, many preceding works have tested Gibrat's law (i.e., firm growth is independent of firm size). Most preceding tests have rejected Gibrat's law and found that smaller firms have lower probability of survival but if they do survive, grow at higher rates than do larger firms. Furthermore, I can explain the relationship between firm age and firm growth by theoretical models based on Jovanovic (1982), in which firms obtain information about their own true productivity levels after entrance, and firms make decisions about whether to stay or exit after the revelation.

Table 9.3 Determinants of e-commerce by sectors: multinomial logit model

	Manufacturing sector					
	Dummy for firms which engage e-commerce using Internet			Dummy for firms which engage e-commerce using other computing network		
	Coefficients	Standard errors		Coefficients	Standard errors	
Firm size (logarithmic value of the number of employees)	0.367	0.004	***	0.615	0.007	***
Logarithmic value of firm age	0.043	0.006	***	0.141	0.012	***
Dummy for firms which is an affiliate of a Japanese firm	−0.272	0.017	***	0.241	0.024	***
Dummy for firms which is an affiliate of a foreign firm	0.227	0.063	***	0.410	0.087	***
Dummy for firms that are single establishments	−0.115	0.014	***	0.063	0.023	***
Dummy for multinational firms	0.161	0.042	***	0.010	0.056	
Industry dummies	Yes					
PseudoR-squared	0.0743					
Number of observation	498,545					
	Commerce sector					
	Dummy for firms which engage e-commerce using Internet			Dummy for firms which engage e-commerce using computing network		
	Coefficients	Standard errors		Coefficients	Standard errors	
Firm size (logarithmic value of the number of employees)	0.194	0.003	***	0.451	0.005	***
Logarithmic value of firm age	−0.106	0.004	***	−0.009	0.006	
Dummy for firms which is an affiliate of a Japanese firm	0.111	0.014	***	0.387	0.018	***
Dummy for firms which is an affiliate of a foreign firm	0.368	0.042	***	0.012	0.071	
Dummy for firms that are single establishments	−0.166	0.010	***	0.247	0.015	***
Dummy for multinational firms	0.674	0.044	***	0.438	0.060	***
Industry dummies	Yes					
PseudoR-squared	0.0241					
Number of observation	772,081					

(continued)

Table 9.3 (continued)

	Service sector					
	Dummy for firms which engage e-commerce using Internet			Dummy for firms which engage e-commerce using other computing network		
	Coefficients	Standard errors		Coefficients	Standard errors	
Firm size (logarithmic value of the number of employees)	0.237	0.003	***	0.298	0.006	***
Logarithmic value of firm age	−0.027	0.004	***	0.053	0.009	***
Dummy for firms which is an affiliate of a Japanese firm	0.037	0.012	***	0.352	0.023	***
Dummy for firms which is an affiliate of a foreign firm	0.177	0.056	***	0.545	0.095	***
Dummy for firms that are single establishments	−0.198	0.010	***	−0.087	0.021	***
Dummy for multinational firms	0.460	0.056	***	0.446	0.089	***
Industry dummies	Yes					
PseudoR-squared	0.0575					
Number of observation	1,339,979					

Notes: The firms which do not engage e-commerce are base. Standard errors are White-corrected for heteroskedasticity. ***$p < 0.01$

In order to investigate whether e-commerce might lead to an increase or reduction in employment, I consider the basic model by Evans (1987), in which firm growth is dependent on firm size and firm age. I extend the basic model by adding firm characteristics, such as e-commerce, ownership structure, FDI, and industry dummies reflecting the inherent effects of industry on explanatory variables. The model is specified as follows[4]:

$$\left[\ln\left(n_{f,t}\right) - \ln\left(n_{f,t-5}\right)\right]/5 = \alpha_0 + \alpha_1 D^{I}_{f,t-5} + \alpha_2 D^{C}_{f,t-5} + \alpha_3 \ln\left(n_{f,t-5}\right) + \alpha_4 \ln\left(age_{f,t-5}\right) + \delta Z_{ft-5} + \sum_j \gamma_j D_j + \varepsilon_{ft} \quad (9.2)$$

[4]Estimating the model might yield biased results due to potential endogeneity between employment growth and e-commerce. Since appropriate instruments are difficult to find in my dataset, I choose to take 5-year lags of all the independent variables.

In Eq. (9.2), $n_{f,t}$ is the number of employees of a firm in 2006 (the number of regular employees, both full-time and part-time; office and temporary workers are not included) and $n_{f,t-5}$ is the number of employees in 2001. The dependent variable is the employment growth rate (annual rate) of a firm from 2001 to 2006. For the explanatory variables, I use $D^{I}_{f,t-5}$ and $D^{C}_{f,t-5}$, which represent dummies for firms that are engaged in e-commerce using the Internet and a computing network, respectively. The logarithmic value of $n_{f,t-5}$ is added to measure the effect of the size of the firm (measured by the number of employees in 2001) on the employment growth rate. The variable $age_{f,t-5}$ represents the number of years from the registered establishment of the firm to 2001. I add the logarithmic value of $age_{f,t-5}$ as the explanatory variable to observe the effect of firm age on the employment growth rate.

Z is a variable representing other characteristics of the firm in 2001. I prepare two dummy variables relating to ownership structure (2001), that is, whether or not the firm is an affiliate of a Japanese firm or a foreign firm. Furthermore, I take into account additional firm characteristics, such as whether the firm is a single establishment and whether it is a multinational firm. In addition, I add a three-digit industry dummy variable to take industry characteristics into account.

In addition, the squares of firm size and age are included in order to allow for nonlinearity in the relationship between firm size, age, and employment growth. In order to capture the effects of e-commerce while controlling for firm size and age, I consider the interaction term of dummy variables of e-commerce and firm size and age. Furthermore, I run a separate regression for three industries—the manufacturing, commerce, and services sectors—to examine whether patterns differ across industries.

9.5.2 Hypotheses

A large number of studies have highlighted that the adoption of new technology as e-commerce is a key factor behind rising demand for skilled workers (Berman et al. 1994). However, there have been very few empirical studies on the relationship between new technology as e-commerce and employment growth. The adoption of e-commerce has two effects on employment growth. First, if e-commerce were a technology that saves labor, the adoption of e-commerce would increase employment. Second, even when e-commerce is a labor-saving technology, it can contribute to employment growth by growing output due to gains in market competitiveness from cost reduction. In addition, it is necessary to examine whether the effects of e-commerce on a firm's employment growth differ depending on the type of e-commerce. Against these conjectures, the following two hypotheses are derived with respect to the effects of e-commerce on employment growth.

Hypothesis 4 The employment growth rate is higher for firms that are engaged in e-commerce.

Hypothesis 5 Among firms conducting e-commerce, the employment growth rate is higher for firms that are engaged in e-commerce using a computing network than for firms that are engaged in e-commerce using the Internet.

Based on previous studies (Lotti et al. 2003) that reject Gibrat's law, the following two hypotheses are proposed.

Hypothesis 6 Smaller firms grow at higher rates than do larger firms.

Hypothesis 7 Younger firms grow at higher rates than do older firms.

Preceding studies (Dunne et al. 1989; Kwon et al. 2007) have found that the employment growth rate of firms with multiple establishments is higher than that of firms that are single establishments. Thus, I consider the following hypothesis.

Hypothesis 8 The employment growth rate of firms that are single establishments is lower than that of firms with multiple establishments.

Based on the knowledge-sharing hypothesis, which posits that knowledge and technology are shared freely within the boundaries of a firm, I propose the following hypothesis.

Hypothesis 9 The employment growth rate of affiliates of foreign and domestic firms is higher than that of independent firms.

Overseas activity tends to be associated with greater employment growth because competing in foreign markets requires more efficiency and productivity. Inui et al. (2008) report a positive link between overseas activity and employment growth, and thus, I propose the following hypothesis.

Hypothesis 10 The employment growth rate of multinational firms is higher than that of domestic firms.

9.5.3 Estimation Results

Table 9.4 shows the estimation results of the regression analysis for the whole sample. The estimated coefficient of the e-commerce variables is a positive value and statistically significant in all regressions. The results in Table 9.4 show that in model (iv), the employment growth rate of firms engaged in e-commerce using the Internet is 6.1 percentage points higher than that of firms that are not engaged in e-commerce. In addition, the results show that the employment growth rate of firms engaged in e-commerce using a computing network is 8.2 percentage points higher than that of firms that are not engaged in e-commerce. The estimation results indicate that the employment growth rate improves as a result of e-commerce compared to a reduction of employment associated with firm restructuring by e-commerce. This result suggests that the adoption of new technology is capable of simultaneously achieving efficiency and job creation.

In order to capture the effects of e-commerce controlling for firm size and age, an interaction term of e-commerce and firm size and age is included in models (iii)

Table 9.4 Effects of e-commerce on employment growth (whole sample)

	(i)		(ii)		(iii)		(iv)		(v)	
Dummy for firms which engage e-commerce using Internet	0.0126	***	0.0115	***	0.0106	***	0.0122	***	0.0093	***
	(27.88)		(25.77)		(5.90)		(27.08)		(5.17)	
Dummy for firms which engage e-commerce using computing network	0.0176	***	0.0135	***	0.0204	***	0.0165	***	0.0177	***
	(25.08)		(19.34)		(6.66)		(23.58)		(5.82)	
Firm size (logarithmic value of the number of employees)	−0.0199	***	−0.0614	***	−0.0616	***	−0.0230	***	−0.0619	***
	(−161.01)		(−159.07)		(−160.88)		(−158.73)		(−165.38)	
(Firm size)^2			0.0086	***	0.0087	***			0.0086	***
			(104.31)		(106.04)				(102.55)	
Logarithmic value of firm age	−0.0052	***	−0.0065	***	−0.0067	***	−0.0049	***	−0.0066	***
	(−30.47)		(−26.69)		(−26.66)		(−28.68)		(−26.45)	
(Logarithmic value of firm age)^2			0.0000		0.0000				0.0000	***
			(1.24)		(1.31)				(2.92)	
Dummy for firms which engage e-commerce using Internet*Firm size					−0.0016	***			−0.0013	***
					(−3.98)				(−3.37)	
Dummy for firms which engage e-commerce using other computing network*Firm size					−0.0036	***			−0.0035	***
					(−5.70)				(−5.50)	
Dummy for firms which engage e-commerce using Internet*Logarithmic value of firm age					0.0015	**			0.0018	***
					(2.53)				(3.06)	
Dummy for firms which engage e-commerce using other computing network*Logarithmic value of firm age					0.0008				0.0014	
					(0.81)				(1.46)	
Dummy for firms which is an affiliate of a Japanese firm							0.0310	***	0.0236	***
							(53.80)		(35.39)	

Dummy for firms which is an affiliate of a foreign firm							0.0424	***	0.0236	***
							(12.39)		(6.39)	
Dummy for firms that are single establishments							−0.0088	***	0.0011	**
							(−19.66)		(2.43)	
Dummy for multinational firms							0.0414	***	−0.0373	***
							(16.48)		(−13.36)	
Constant term	0.0336	***	0.0723	***	0.0726	***	0.0442	***	0.0709	***
	(63.28)		(102.55)		(100.33)		(57.50)		(82.85)	
Industry dummies	Yes		Yes		Yes		Yes		Yes	
R-squared	0.05		0.08		0.08		0.05		0.08	
Number of observation	902,019									

Notes: Heteroskedasticity-corrected *t* statistics are reported in parentheses. $^{**}p < 0.05$, $^{***}p < 0.01$
Dependent variable: net employment growth rate, (ln(number of employees in 2006) − ln(number of employees in 2001))/5

and (v). As shown, the interaction term of e-commerce and firm size is significantly negative. This implies that the effect of e-commerce on employment growth in larger firms tends to be lower than that of smaller firms. However, I find that the interaction term of e-commerce and firm age is positive, and is positive and significant if firms are engaged in e-commerce using the Internet. This result implies that the effect of e-commerce on employment growth is larger in older firms than in younger firms.

Based on the firm-specific and relation-specific technology hypothesis, I expect that the effect of e-commerce is stronger in the case of a computing network than the Internet. The results confirm my expectations.

The estimated coefficient of firm size is a negative value and is statistically significant. The smaller firms are, the higher is their employment growth rate. With regard to the age of firms, the results show that the younger firms are, the higher is their employment growth rate. These results are consistent with Hypotheses 6 and 7.

As for ownership structure, I obtain a statistically significant result—that the employment growth rate of affiliates owned by domestic firms or foreign firms is higher than that of independent firms when firm size, firm age, e-commerce, and industry are controlled. It is not surprising that the employment growth rate of affiliates owned by another firm is higher than that of independent firms, because having many affiliates is considered to expand the operations of the parent company and because many affiliates benefit from the transfer of technologies and expertise from parent companies.

Next, the estimated coefficient of firms that are single establishments is significantly negative, while that of multinational firms is significantly positive in the case of the basic model. If the interaction term of e-commerce and firm size and age were added to the model, the coefficients of the two variables are reversed. This might reflect that FDI and the number of establishments of firms are correlated with the strategic decisions of firms with regard to e-commerce.

The results for each sector—manufacturing, commerce, and services—are mostly the same. The effect of e-commerce on employment growth is more obvious in the manufacturing sector than it is in the commerce and services sectors (Tables 9.5, 9.6 and 9.7).

9.6 Conclusion

This study examined the determinants and effects of e-commerce on employment growth using firm-level data. The findings can be summarized as follows. First, regardless of which type of technology is considered, larger firms, foreign firms, and multinational firms conduct more e-commerce. Second, e-commerce has a large positive impact on employment growth. This suggests that new technology, such as e-commerce, complements employment.

In future research, the source of the positive relationship between e-commerce and employment growth should be investigated in greater detail. New technology does not necessarily increase the demand for all workers. More work should be

Table 9.5 Effects of e-commerce on employment growth (manufacturing sector)

	(i)		(ii)		(iii)		(iv)		(v)	
Dummy for firms which engage e-commerce using Internet	0.0138	***	0.0138	***	0.0240	***	0.0140	***	0.0229	***
	(17.47)		(17.59)		(6.13)		(17.70)		(5.86)	
Dummy for firms which engage e-commerce using computing network	0.0188	***	0.0132	***	0.0432	***	0.0178	***	0.0386	***
	(14.82)		(10.21)		(5.70)		(14.06)		(5.13)	
Firm sizs (logarithmic value of the number of employees)	−0.0110	***	−0.0417	***	−0.0427	***	−0.0132	***	−0.0437	***
	(−50.60)		(−63.11)		(−64.84)		(−49.79)		(−66.01)	
(Firm size)^2			0.0057	***	0.0061	***			0.0064	***
			(48.64)		(51.00)				(50.09)	
Logarithmic value of firm age	−0.0063	***	−0.0064	***	−0.0064	***	−0.0058	***	−0.0062	***
	(−16.66)		(−11.49)		(−11.30)		(−15.40)		(−11.03)	
(Logarithmic value of firm age)^2			0.0000		0.0000				0.0000	
			(1.22)		(−1.16)				(−0.27)	
Dummy for firms which engage e-commerce using Internet*Firm size					−0.0044	***			−0.0039	***
					(−6.24)				(−5.50)	
Dummy for firms which engage e-commerce using other computing network*Firm size					−0.0101	***			−0.0098	***
					(−9.14)				(−8.99)	
Dummy for firms which engage e-commerce using Internet*Logarithmic value of firm age					0.0005				0.0006	
					(0.40)				(0.46)	
Dummy for firms which engage e-commerce using other computing network*Logarithmic value of firm age					0.0010				0.0021	
					(0.45)				(0.94)	
Dummy for firms which is an affiliate of a Japanese firm							0.0196	***	0.0121	***
							(21.88)		(13.27)	

(continued)

Table 9.5 (continued)

	(i)		(ii)		(iii)		(iv)		(v)	
Dummy for firms which is an affiliate of a foreign firm							0.0218	***	0.0008	
							(4.39)		(0.14)	
Dummy for firms that are single establishments							−0.0046	***	0.0056	***
							(−5.41)		(6.41)	
Dummy for multinational firms							0.0234	***	−0.0305	***
							(8.16)		(−9.38)	
Constant term	0.0276	***	0.0585	***	0.0584	***	0.0331	***	0.0523	***
	(23.17)		(35.87)		(35.00)		(20.24)		(27.42)	
Industry dummies	Yes		Yes		Yes		Yes		Yes	
R-squared	0.04		0.06		0.06		0.04		0.06	
Number of observation	186,986									

Notes: Heteroskedasticity-corrected t statistics are reported in parentheses. *** $p < 0.01$
Dependent variable: net employment growth rate (ln(number of employees in 2006) − ln(number of employees in 2001))/5

Table 9.6 Effects of e-commerce on employment growth (commerce sector)

	(i)		(ii)		(iii)		(iv)		(v)	
Dummy for firms which engage e-commerce using Internet	0.0102	***	0.0093	***	0.0064	**	0.0097	***	0.0054	*
	(13.41)		(12.44)		(2.17)		(12.87)		(1.85)	
Dummy for firms which engage e-commerce using computing network	0.0137	***	0.0117	***	0.0123	***	0.0130	***	0.0108	***
	(14.15)		(12.29)		(3.19)		(13.39)		(2.79)	
Firm size (Logarithmic value of the number of employees)	−0.0177	***	−0.0608	***	−0.0608	***	−0.0194	***	−0.0602	***
	(−85.09)		(−102.19)		(−102.38)		(−75.84)		(−102.06)	
(Firm size)^2			0.0094	***	0.0095	***			0.0094	***
			(70.65)		(70.83)				(68.11)	
Logarithmic value of firm age	−0.0076	***	−0.0093	***	−0.0096	***	−0.0072	***	−0.0094	***
	(−26.17)		(−21.47)		(−21.44)		(−24.65)		(−20.98)	
(Logarithmic value of firm age)^2			0.0000		0.0000				0.0000	
			(0.87)		(0.96)				(1.62)	
Dummy for firms which engage e-commerce using Internet*Firm size					−0.0023	***			−0.0022	***
					(−3.46)				(−3.31)	
Dummy for firms which engage e-commerce using other computing network*Firm size					−0.0030	***			−0.0030	***
					(−3.56)				(−3.67)	
Dummy for firms which engage e-commerce using Internet*Logarithmic value of firm age					0.0025	***			0.0028	***
					(2.69)				(2.96)	
Dummy for firms which engage e-commerce using other computing network*Logarithmic value of firm age					0.0020	*			0.0024	**
					(1.68)				(2.04)	
Dummy for firms which is an affiliate of a Japanese firm							0.0319	***	0.0205	***
							(28.29)		(18.01)	

(continued)

Table 9.6 (continued)

	(i)		(ii)		(iii)		(iv)		(v)	
Dummy for firms which is an affiliate of a foreign firm							0.0411	***	0.0260	***
							(8.60)		(5.13)	
Dummy for firms that are single establishments							−0.0010		0.0045	***
							(−1.29)		(6.04)	
Dummy for multinational firms							0.0328	***	−0.0194	***
							(7.30)		(−4.06)	
Constant term	0.0355	***	0.0732	***	0.0739	***	0.0362	***	0.0679	***
	(37.18)		(59.35)		(57.09)		(26.94)		(44.13)	
Industry dummies	Yes		Yes		Yes		Yes		Yes	
R-squared	0.04		0.07		0.07		0.04		0.07	
Number of observation	263,058									

Notes: Heteroskedasticity corrected t statistics are reported in parentheses. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$
Dependent variable: net employment growth rate, (ln(number of employees in 2006) − ln(number of employees in 2001))/5

Table 9.7 Effects of e-commerce on employment growth (service sector)

	(i)		(ii)		(iii)		(iv)		(v)	
Dummy for firms which engage e-commerce using Internet	0.0120	***	0.0106	***	0.0113	***	0.0114	***	0.0100	***
	(15.67)		(13.92)		(3.94)		(14.88)		(3.49)	
Dummy for firms which engage e-commerce using computing network	0.0144	***	0.0108	***	0.0224	***	0.0128	***	0.0194	***
	(9.36)		(7.01)		(3.28)		(8.36)		(2.87)	
Firm size (logarithmic value of the number of employees)	−0.0260	***	−0.0706	***	−0.0708	***	−0.0301	***	−0.0712	***
	(−127.72)		(−106.07)		(−108.36)		(−131.92)		(−112.93)	
(Firm size)^2			0.0094	***	0.0095	***			0.0093	***
			(63.30)		(65.64)				(63.10)	
Logarithmic value of firm age	−0.0029	***	−0.0048	***	−0.0049	***	−0.0027	***	−0.0048	***
	(−11.32)		(−13.49)		(−13.53)		(−10.47)		(−13.32)	
(Logarithmic value of firm age)^2			0.0000	***	0.0000	***			0.0000	***
			(4.00)		(4.06)				(4.89)	
Dummy for firms which engage e-commerce using Internet*Firm size					−0.0018	***			−0.0018	***
					(−2.52)				(−2.47)	
Dummy for firms which engage e-commerce using other computing network*Firm size					−0.0063	***			−0.0061	***
					(−3.42)				(−3.45)	
Dummy for firms which engage e-commerce using Internet*Logarithmic value of firm age					0.0012				0.0016	
					(1.15)				(1.58)	
Dummy for firms which engage e-commerce using other computing network*Logarithmic value of firm age					0.0012				0.0019	
					(0.51)				(0.83)	
Dummy for firms which is an affiliate of a Japanese firm							0.0361	***	0.0259	***
							(38.47)		(27.42)	

(continued)

Table 9.7 (continued)

	(i)		(ii)		(iii)		(iv)		(v)	
Dummy for firms which is an affiliate of a foreign firm							0.0526	***	0.0389	***
							(6.32)		(4.31)	
Dummy for firms that are single establishments							−0.0164	***	−0.0020	**
							(−22.26)		(2.51)	
Dummy for multinational firms							0.0484	***	−0.0580	***
							(6.55)		(−7.39)	
Constant term	0.0357	***	0.0774	***	0.0774	***	0.0552	***	0.0791	***
	(47.13)		(75.47)		(74.44)		(47.69)		(63.35)	
Industry dummies	Yes		Yes		Yes		Yes		Yes	
R-squared	0.06		0.09		0.09		0.07		0.10	
Number of observation	445,770									

Notes: Heteroskedasticity corrected t statistics are reported in parentheses. $^{**}p < 0.05$, $^{***}p < 0.01$
Dependent variable: net employment growth rate, (ln(number of employees in 2006) − ln(number of employees in 2001))/5

conducted to investigate whether rising demand for skilled labor can explain the positive relationship between e-commerce and employment growth.

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Chapter 10
Market Reaction to Cross-Border Acquisitions by Japanese Firms

Takuji Saito

Abstract This study analyzes the effects of the acquisition of foreign firms by Japanese firms on the shareholder value. I estimate the market reaction to 99 announcements of cross-border acquisitions by Japanese firms valued above 50 billion yen between 1996 and 2016. In contrast to the prevailing notion that Japanese firms are not good at overseas acquisitions, I find that the market reaction to the announcement of acquisitions is not negative. In addition, the institutional characteristics and cultural differences of the target-firm country affect returns. The market reacts positively to the acquisition of firms located in countries with weak shareholder protection and that are culturally distant.

Keywords Corporate governance • Cross-border mergers and acquisitions • Japanese firms

10.1 Introduction

In recent years, many Japanese companies have made acquisitions overseas. According to the report by Recof, there were 2,333 incidences of mergers and acquisitions (M&A) in 2015 wherein a Japanese firm was the buyer, of which 560, or 25%, were overseas acquisitions. In financial terms, Japanese firms spent around 15.113 trillion yen on acquisitions that year, of which 11.192 trillion, or 74%, was on overseas acquisitions. Indeed, the proportion being spent on overseas acquisitions is at its highest ever, from around 50% in the bubble era in the early 1990s. Moreover, this increase in cross-border M&A activity is not restricted to Japanese firms. Erel et al. (2012) show that the volume of cross-border acquisitions has been growing worldwide, from 23% of the total merger volume in 1998 to 45% in 2007.

The reasons cross-border M&A occur are presumed to be essentially the same as those behind domestic M&A. That is, acquisitions are made when the merger of the two firms will increase value. In general, this increase in value through

T. Saito (✉)
Graduate School of Business Administration, Keio University, 4-1-1 Hiyoshi Kohoku-ku, Yokohama, Kanagawa 223-8526, Japan
e-mail: tsaito@kbs.keio.ac.jp

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M&A is termed *synergy*. However, when the acquiring and target companies are located in different countries, the differences between the countries in question can either impede or facilitate M&A. Institutional differences may affect the acquisition, for example. In cases where the firm acquired is in a country that emphasizes protecting employee rights, performance may be poor as cost synergies will not emerge because of the difficulty of streamlining the workforce in the post-acquisition period. Further, when corporate governance is typically poor in the target country, the acquisition may improve the target firm's corporate governance and, thus, increase its value. The performance of an acquisition may also be affected by cultural differences between countries. For instance, the reason for the failure of the merger between Germany's Daimler and Chrysler of the US is often said to have been because of differences in culture.

Research into the effects of a country's laws, regulations, and cultural differences on cross-border M&A has expanded in recent years. In this body of work, Rossi and Volpin (2004) and Erel et al. (2012) analyze the determinants of cross-border M&A. A number of studies (e.g., Moeller and Schlingemann 2005) have examined the stock returns made by the acquiring firm and target firm in cross-border acquisitions, while further research has analyzed the factors that influence the performance of cross-border acquisitions (e.g., Chakrabarti et al. 2009).

However, little research has focused on the cross-border M&A conducted by Japanese firms. Based on this gap in the literature, this study seeks to examine the effects of the acquisition of foreign firms by Japanese firms on the shareholder value and the influence of the characteristics of the target country on the stock return to the acquirer when Japanese companies acquire firms overseas.

Cross-border M&A by Japanese firms is considered to be generally disappointing, particularly by the business press, with the majority of acquisitions during the bubble era (e.g., Matsushita/MCA, Mitsubishi Estate/Rockefeller) having ended in failure. The June 7, 2014, edition of *Toyo Keizai* noted that 90% of overseas acquisitions by Japanese firms were failures. As a result, the general perception that Japanese firms are bad at overseas acquisitions has emerged. However, research that has empirically verified this fact remains scarce.

In addition, there has been no clarification regarding the influence of the characteristics of the target country on cross-border M&A by Japanese firms. Previous research has analyzed the effects of a country's characteristics on cross-border M&A performance, but it is far from certain that the results apply to Japanese firms. In fact, Japanese firms remain "outliers" in a great deal of comparative research. La Porta et al. (1997) argue that countries that offer strong protection for minority shareholders show increases in shareholder value, whereas Arikawa et al. (2016) show that although minority-shareholder protection in Japan is greater than that in the US, its Tobin's q remains the lowest among developed countries. A great deal of research argues that Japan's corporate system is unique and, therefore, very different from those of the US firms (e.g., Aoki 1990; Odagiri 1992). Therefore, the goal of this study is to clarify whether the results of other studies also apply to acquisitions by Japanese firms.

This study examines the overseas acquisitions by Japanese firms announced between April 1996 and March 2016 in which the value of the deal was above 50 billion yen. This led to a sample size of 99. The target firms were in 20 countries, but over half of those targeted were in the US. The sample period was 20 years, but over half of the acquisitions have occurred since 2011.

To analyze the performance of overseas acquisitions by Japanese firms, I calculate the cumulative abnormal returns (CAR) of the acquiring firms (the Japanese firms) when the acquisition was announced. I find that CAR during the announcements of overseas acquisitions by Japanese firms had a positive mean and negative median, statistically insignificant in both cases. This finding means that despite the tendency of the business press and others to be negative, the market does not react negatively when the acquisition is announced. The reaction of the market in Japan is thus similar to that in the US when US companies announce overseas acquisitions. Moeller and Schlingemann (2005) analyze M&A by US firms between 1985 and 1995 and show that the reaction of the market to overseas acquisitions is positive but not statistically significant.

Next, I analyze the effects on the Japanese firm's returns stemming from the features of the acquiring and target firms and the institutional and cultural effects of the target firm's country. I consider regulations as being the strength of shareholder and employee protection in a country, and utilize Hofstede's measure as the basis of cultural differences.

In cases wherein the target firm is not listed on a stock exchange, the market reaction to the announcement of the acquisition is found to be significantly positive. In particular, when the firm acquired was a subsidiary, returns were high. This finding is consistent with the results of previous research in the US (e.g., Faccio et al. 2006). Furthermore, to the extent that the acquiring firm had a high proportion of overseas sales before the acquisition, this resulted in a statistically significant increase in returns on the announcement of the acquisition. This result shows that large-scale overseas acquisitions by firms with limited overseas experience are viewed negatively by the market.

With regard to a country's regulations, weak shareholder protection in the target country results in statistically significant increases in returns to the buyer. This finding indicates that the existence of spillover effects from improving the firm's corporate governance when acquiring firms comes from countries in which corporate governance is weak. This result is consistent with those of Martynova and Renneboog (2008). With regard to national culture, returns were highest on the announcement of an M&A by a Japanese firm when the firm being acquired was in a country that has cultural characteristics distinct from those of Japan. This result is in contrast to the possibility of a culture clash occurring when the acquired firm is in a culturally distant country, but consistent with the conclusions of Chakrabarti et al. (2009). The reason for this, according to Chakrabarti et al. (2009), is that while cultural differences make post-merger integration more difficult, mergers between firms from culturally disparate countries may arm the acquirer with higher synergies and organizational strengths that help in their functioning in the global marketplace.

While the general perception that Japanese firms are not good at overseas acquisitions continues to prevail, the reaction of the market to these acquisitions is largely identical to overseas acquisitions by firms in other countries. Therefore, it seems that the market does not consider cross-border acquisitions by Japanese firms to be distinct from cross-border acquisitions by firms in other countries.

The remainder of this chapter is structured as follows. Section 10.2 offers an overview of M&A by Japanese firms. Previous research is surveyed in Sect. 10.3. Section 10.4 provides details of the sample and data used, while Sect. 10.5 provides the CAR results. Section 10.6 analyzes the influence on the acquiring firm's shareholder return of the acquiring firm, target firm, and target country. Section 10.7 concludes.

10.2 M&A by Japanese Firms

M&A is less common in Japan than in the US (Kester 1991). Odagiri and Yamawaki (1986) report that of the firms listed on the Tokyo Stock Exchange in 1964, 67 (or 7.5%) gave delisting as the reason for M&A up to 1984. One reason for the limited M&A activity in Japan is that Japanese firms seek internal rather than external growth through the activity (Odagiri 1992).

Odagiri and Hase (1989) argue that another reason M&A is limited is the labor practices in Japan. In large firms in Japan, lifetime employment is standard, with the majority of employees continuing to work for the firm they join after graduating from university. It is common for management to prioritize the maintenance of employment. Yoshimori (1995) reports that when given a choice between maintaining employment or dividends, 89.2% of those involved in business in the US would maintain dividends, while 97.1% of Japanese businesses would maintain employment. Such labor practices mean that a company is seen as a single community and M&A as a kind of intrusion. Moreover, while internal growth provides opportunities for increasing employment, M&A does not necessarily provide such opportunities. Owing to lifetime employment, the acquisition of firm-specific skills is encouraged, whereas M&A reduces the value of these. For the above reasons, M&A remains uncommon in Japan.

However, this does not mean that M&A does not occur in Japan, with a number of M&A activities taking place every year. As in the US, many incidences of M&A can occur in waves. In Japan before WWII, M&A was used by firms for strategic expansion or as a means of restructuring. At the beginning of the twentieth century, mergers among firms in textiles, sugar manufacturing, and electric power generation were common, while many large-scale mergers in the iron and paper industries occurred in the 1930s, following the Showa depression. Post-WWII, the 1950s saw the reassembly of firms that had been split up as a result of the dissolution of the *zaibatsu*, while the 1960s saw M&A occurring between firms in the same industry to protect against acquisitions by overseas firms, which had been made possible by the

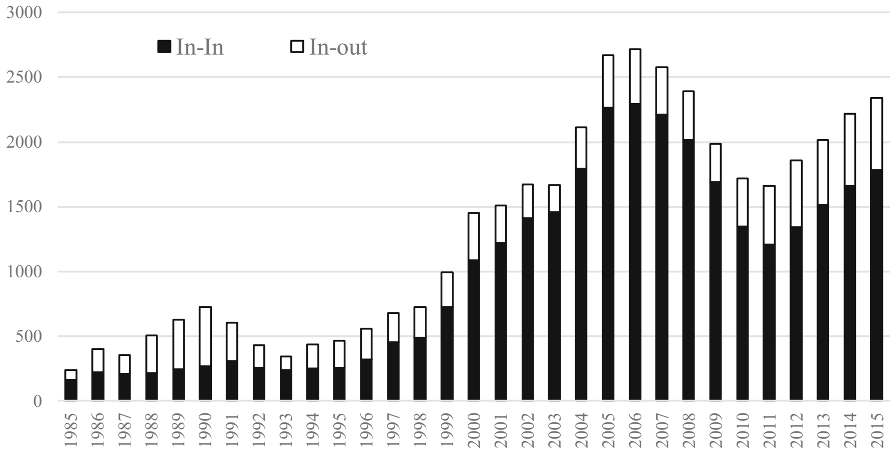

Fig. 10.1 Total number of M&A deals by Japanese firms (Source: RECOF Mergers and Acquisitions Database)

liberalization of investment and trade. However, M&A remained uncommon after this.

The latter half of the 1980s saw incidences of M&A increase once again. Figure 10.1 shows M&A by Japanese firms between 1985 and 2015. While the number of M&A activities decreased in the first half of the 1990s as the bubble era burst, their incidence steadily increased between 1993 and 2006. Arikawa and Miyajima (2006) analyze the factors behind this increase in M&A since the 1990s. They report that the shocks to profitability and growth that accompanied technology development, deregulation, and the expansion or contraction of demand induced this increase in M&A and emphasize that from the late 1990s onwards, M&A began to play an important role in the redistribution of resources.

After the financial crisis in 2008, M&A declined until 2011, before rising again thereafter. One reason for this increase is the acquisition of overseas firms by Japanese companies. The current wave of cross-border M&A by Japanese firms is not the first. As Fig. 10.1 shows, there were many incidences of overseas acquisitions by Japanese firms during the bubble era. In 1990, there were around 460 acquisitions, making up 63% of M&A by Japanese firms. Well-known examples during the bubble era include the acquisition of Firestone by Bridgestone in 1988 (valued at 330 billion yen), Columbia Pictures by Sony in 1990 (520 billion yen), and MCA Inc. by Matsushita Electric Industrial Company in 1991 (780 billion yen). Sony and Matsushita subsequently posted enormous losses on the back of these acquisitions. Consequently, they are frequently cited as examples of failed M&A. The reason cross-border M&A was increasing at that time was the appreciation of the yen and the high level of excess cash held by Japanese firms. The yen exchange rate went overnight from around 250 yen to the dollar to 130 yen as a result of the Plaza Accord. As for cash holdings, Matsushita at the time had 2.5 trillion yen in

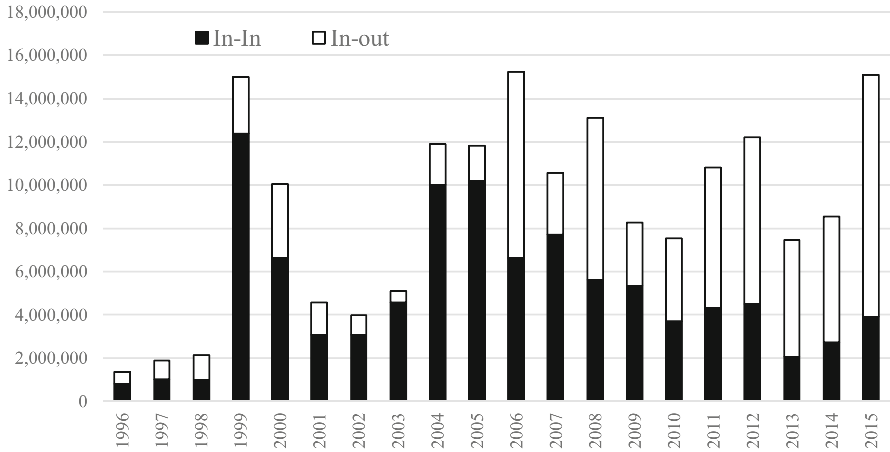

Fig. 10.2 Total value of M&A deals by Japanese firms (million yen) (Source: RECOF Mergers and Acquisitions Database)

cash, and was known as the Matsushita bank. After this, with the bursting of the bubble, performance by Japanese firms was bleak and incidences of cross-border M&A declined.

However, from around 2000, incidences of cross-border M&A climbed to 300 a year, with this figure rising after 2010 and reaching over 500 a year from 2012, a greater rate of M&A than that in 1990. Cross-border M&A has risen in recent years because of the appreciation of the yen and decline in Japan's population. The exchange rate with the dollar was about 115 yen before the financial crisis, but declined to 80 yen in 2011. Likewise, Japan's population began to decline in 2015 and the lack of growth in the Japanese market was cited as another reason for the increase in cross-border M&A. Most firms engaged in cross-border M&A do so in the pursuit of growth.

A particular feature of cross-border M&A by Japanese firms is the prevalence of large-scale deals. Figure 10.2 shows the total value of M&A between 1996 and 2015. As the figure shows, compared with the proportion of cross-border M&A undertaken by Japanese firms, the proportion of the value they account for is much higher. For 2015, cross-border M&A accounted for 24% of the number of M&A, but 74% of the value of M&A. Table 10.1 shows the 25 largest cross-border M&A deals by value. As the table shows, apart from Matsushita's acquisition of MCA Inc. in 1990 and Japan Tobacco's of RJR International in 1999, the rest are all from after 2000, with the bulk of them occurring after 2008. As the table runs to 2015, it does not include the September 2016 acquisition of the British semiconductor manufacturer Arm by Softbank for $31 billion, which became the largest cross-border acquisition by a Japanese company.

Table 10.1 Top 25 largest cross-border acquisitions by Japanese firms

Date	Acquirer	Target	Country	Deal size ($M)
10/15/2012	Soft Bank	Sprint Nextel Corp	US	21,640
12/15/2006	JT	Gallaher Group PLC	UK	18,800
01/13/2014	Suntory Holdings	Beam Inc	US	15,688
05/19/2011	Takeda Pharmaceutical	Nycomed Intl Mgmt GmbH	Switzerland	13,686
11/30/2000	NTT Docomo	AT&T Wireless Group	US	9,805
04/10/2008	Takeda Pharmaceutical	Millennium Pharmaceuticals Inc	US	8,128
03/08/1999	JT	RJ Reynolds International	US	7,833
09/22/2008	Mitsubishi UFJ	Morgan Stanley	US	7,800
06/10/2015	Tokio Marine & Nichido Fire	HCC Insurance Holdings Inc	US	7,541
09/24/1990	Matsushita Electric Industrial	MCA Inc	US	7,086
05/05/2000	NTT Communications	Verio Inc	US	6321
02/18/2015	Japan Post	Toll Holdings Ltd	Australia	6,021
01/20/2015	Itochu	CITIC Ltd	Hong-Kong	5,924
06/03/2014	The Dai-ichi Life Insurance	Protective Life Corp	US	5,708
11/09/2011	Mitsubishi Corp	Anglo American Sur SA	Chile	5,390
09/08/2015	Mitsui Sumitomo Insurance	Amlin PLC	UK	5,296
07/02/2013	Bank of Tokyo-Mitsubishi UFJ	Bank of Ayudhya PCL	Thailand	5,279
09/29/2015	JT	Reynolds American Inc	US	5,005
07/23/2015	Meiji Yasuda Life Insurance	StanCorp Financial Group	US	4,961
07/23/2008	Tokio Marine Holdings	Philadelphia Consolidated Hold	US	4,692
09/25/1989	Sony	Columbia Pictures	US	4,654
07/12/2012	Dentsu	Aegis Group PLC	UK	4,311
10/31/2005	Nippon Sheet Glass	Pilkington PLC	UK	4,001
01/24/2010	KDDI	Liberty Global-Subsidiaries	US	4,000
09/26/2013	LIXIL	Grohe AG	Germany	3,960

Source: RECOF Mergers and Acquisitions Database

10.3 Previous Research

10.3.1 Determinants of M&A

Through M&A, firms are able to change their focus and alter the boundaries of their enterprise. This in itself is an important reason why M&A occurs. If a market existed in which transactions had no costs, all firms would lose the reason for their existence. However, in the real world, firms exist because transactions have costs (Coase 1937; Williamson 1985). When transaction costs in a market are high, firms undertake activities within their organization. Therefore, when the costs of transactions increase in a market, firms internalize operations by making acquisitions. Conversely, when the costs of internal transactions are greater than that of the market, firms seek to dispose of those operations. When the transaction costs within a company or market change, firms undertake M&A.

As a result, shocks to growth or profitability at the industry level alter the transaction costs of all the firms within that industry, resulting in an M&A wave. Mitchell and Mulherin (1996) and Harford (2005) show that M&A activity is concentrated in particular industries. They argue that when a shock to growth or profitability occurs that necessitates the large-scale redistribution of resources between industries, incidences of M&A increase rapidly, as M&A is an effective means of redistributing resources. Shocks that affect growth and profits in such a manner include precipitous changes in the price of raw materials such as oil shocks, technology developments, and deregulation. For example, as a result of the large-scale reforms to the financial system in Japan between 1996 and 2001, mergers increased and the 20 largest banks in the country consolidated into just six firms. In the pharmaceutical industry, the liberalization of drug prices saw consolidation with the merger of Daiichi Pharmaceutical Company and Sankyo Pharmaceuticals. In the slumping economy that followed the bursting of the bubble, domestic demand dramatically reduced and this led to much M&A among paper manufacturers and oil companies.

M&A can also occur because of price differentials in the stock market. Shleifer and Vishny (2003) theoretically identify the potential for management that recognize that a firm's market valuation is greater than its fundamental value to have an incentive to earn profits through acquisition using a stock exchange. Similarly, a management focused on short-term targets may ignore anticipated long-term profits and have an incentive to sell their own firms when advantageous conditions are gained from the buyer. Rhodes-Kropf and Viswanathan (2004) show that divergences between a firm's stock price and its fundamental value influence M&A. Furthermore, they hypothesize that although the management of the acquiring firm will possess perfect information about their own firm's value, the other firm's management will be unable to accurately calculate future synergies stemming from the M&A. Hence, theoretically, when there is a steep rise in the stock market, the management of the target firm without perfect information will, on the basis of a vast overestimation of future synergies, recommend acquisition through an exchange of stock with the overvalued acquiring firm. As a consequence of this way of thinking, when the market becomes hot, it is easier to take the stock exchange route rather than pay cash to acquire a target. Indeed, during the M&A boom in the 1980s' US bear market, payment in cash, using LBOs and the like, was more common, while in the 1990s' bull market, M&As in the IT bubble were largely settled through stock exchanges.

Fundamentally, cross-border M&A occurs for the same reason as for domestic M&A. However, the borders, which are not a factor in domestic M&A, have an effect. For example, geographical factors, cultural distance, and differences in national regulations can give rise to costs that do not arise in domestic M&A. In addition, stock exchanges and stock markets can be the determinants of cross-border M&A. Erel et al. (2012) empirically analyze the determining factors behind the 56,978 incidences of cross-border M&A between 1990 and 2007 and report strong patterns between pairs of countries. They discover that cross-border M&A occurs more often between countries close to one another, and firms from economically developed countries and the countries which have better accounting standards tend to become the buyer. They also note that exchange rates and the state of the stock market are influential. In many cases, firms in countries whose currency is appreciating become the acquirers, while those in countries whose currency is depreciating are the targets. They also report that firms in countries where the stock market's performance is good are the acquirers, and firms in poorly performing countries become targets.

10.3.2 Performance of M&A

Whether M&A actually increases value has long been a topic of research. In particular, studies of CAR based on market models are common. CAR measures the return on individual stocks, which cannot be explained through market moves, accumulated within a fixed period. Jensen and Ruback (1983) summarize existing research, and report that when the acquisition was successful, increases in the CAR of the target firm's stock of 30% on tender offers and 20% on mergers can be seen, whereas the CAR of the acquiring firm increases by 4% on tender offers and by 0% on mergers, concluding that total returns are positive and that markets for corporate control create value. The more recent survey by Bruner (2004) reports that while the CAR of the target firms increases by 20–30%, the CAR of the acquiring firms is close to zero.

Studies that analyze the performance of cross-border M&A have recently become common. Moeller and Schlingemann (2005) analyze 4,430 incidences of M&A by US firms from 1985 to 1995, reporting that compared with domestic acquisitions, overseas acquisitions not only reduce company returns by about 1% but also reduce profitability after the acquisition. Eckbo and Thorburn (2000) compare the acquisition of domestic and US firms by Canadian companies. They show that when the target was a domestic firm rather than a US firm, the returns for the acquiring firm were higher and the same trend can be seen in higher profits. Thus, research to date reports that returns for the acquiring firm are lower in cross-border M&A than in domestic transactions.

Several studies have analyzed the cause of low returns from cross-border acquisitions. Generally, it appears that when cultural differences are large, cultural clashes easily occur, post-merger integration becomes problematic, and it is difficult to develop synergies through acquisition. Chakrabarti et al. (2009) empirically analyze the effects of cultural factors on the long-term performance of cross-border M&A. They study 800 incidences of cross-border acquisitions from 1991 to 2004, and report that contrary to predictions, the acquisition of firms in culturally distant countries results in superior long-term performance. In response, Ahern et al. (2015) analyze cross-border M&A from 1991 to 2008, and report that M&A between culturally distant pairs of countries is rare. Furthermore, they argue that to the extent that cultural differences exist, particularly with regard to trust and individualism, the combined announcement return of cross-border M&A is low. Thus, they conclude that when the cultural difference is large, synergies from M&A are small.

Bris and Cabolis (2008) and Martynova and Renneboog (2008) point out that national regulations relating to corporate governance, such as protection for minority shareholders, have a large influence on returns from cross-border M&A. Bris and Cabolis (2008) note that the difference between the acquiring and target nation on the anti-director rights index has a positive influence on CAR. Martynova and Renneboog (2008) point out that when the corporate governance of the acquiring firm is superior to that of the target, it spills over to the selling firm, creating value.

Labor law and regulations also influence cross-border M&A. For synergies to emerge after an acquisition, employment is typically streamlined to cut costs. When employment protection is strong and it is difficult to dismiss people, the possibilities for synergy will be lower than when it is not because it is difficult to restructure the workforce. Although not specifically related to cross-border M&A, John et al. (2015) focus on differences in labor laws and regulations across US states and analyze the influence of employee rights on M&A. They find that when either the acquirer or the target is located in a state with strong employment protection, combined announcement returns decline and the synergies achievable through M&A are restricted.

10.3.3 Research in Japan

Research analyzing M&A by Japanese firms is much less common than that in the US. Ikeda and Doi (1983) analyze the financial performance of 43 Japanese manufacturers after mergers and report that in over half the cases the rate of return on equity increased, while the rate of return on total assets also improved half the time. Odagiri and Hase (1989) analyze 243 incidences of M&A between 1980 and 1987 and note no signs of improvements in profitability and growth as a result of M&A.

In research that has measured CAR by using case studies of M&A by Japanese firms, the results have differed from studies carried out in the US. Pettway and Yamada (1986) measure CAR from mergers between Japanese firms between 1977 and 1984 and report that CAR for the acquiring firm is positive. Kang et al. (2000) analyze 154 incidences of mergers between 1977 and 1993 and find that acquiring firms receive significantly positive excess returns. In addition, they note that the closer the buyer's relationship with their main bank, the higher the returns. Inoue and Kato (2006) calculate the CAR of M&A occurring between 1990 and 2002 and report that the CAR of both the acquiring and the target firms is positive to a statistically significant degree.

Prior studies have therefore shown that Japan differs from the US, in which acquirers' returns are negative while those of the target are largely positive. One reason for this difference is equal mergers. Owing to Japan's employment practices, domestic M&A often pays attention to the interest of the labor force as well as shareholders. When Sega Enterprises and Bandai agreed to a merger in 1997, for example, it was called off when the employees of Bandai opposed the deal. In such situations, an equal merger that does not distinguish between the acquirer and target is necessary to protect the interests of all employees. In equal mergers, as the distinction between the buyer and seller is unclear, the buyer reduces the premium paid on the shares of the seller, while benefiting from the rise in its share price.

Research studying cross-border M&A by Japanese companies is limited. Ings and Inoue (2012) analyze the CAR of cross-border acquisitions by Japanese companies between 2000 and 2010. They find that the returns to the buyer are higher than for those for domestic acquisitions and that the acquisition of firms in emerging countries results in higher returns compared with the acquiring one in a G7 country.

10.4 Data

10.4.1 Sample

This study seeks to examine the influence of a country's characteristics by estimating the CAR of cross-border M&A by Japanese firms. I analyze the completed cross-border deals announced by Japanese firms between April 1996 and March 2016 in the Recof M&A database. I disregarded the following deals from the sample. To focus on large-scale deals that influence the share price, I did not consider deals worth less than 50 billion yen (about 450 million US dollars). Deals wherein the invested proportion was less than 50% of the firm's value were excluded to restrict the sample to M&A deals in which control changed hands. Because of the influence of regulations and differences in financial data, cases in which the acquisition was by a financial institution were omitted. Deals where the acquisition appeared to be a pure investment by a trading firm were also excluded. For the same reasons, acquisitions to acquire interests in natural resources were also disregarded.

Table 10.2 Sample deals by year

Year	Number
1996	2
1997	0
1998	2
1999	3
2000	2
2001	1
2002	1
2003	1
2004	0
2005	3
2006	5
2007	5
2008	9
2009	5
2010	7
2011	11
2012	7
2013	11
2014	13
2015	9
2016	2
Sum	99

The sample used by this study thus comprises the 99 cases of cross-border M&A by Japanese firms that remained after the data had been screened.

Table 10.2 shows acquisitions by year. This combines the shifts in cross-border M&A by Japanese firms displayed in Figs. 10.1 and 10.2, showing that large cross-border acquisitions were rare in the early 2000s, increased from 2008 onward, and now involve around 10 deals annually. Table 10.3 shows incidences by country. The table indicates that with 56 deals, US firms are the overwhelming majority of those acquired. Next is the acquisition of UK companies. Given that 17 deals include acquiring companies from continental European countries, it is clear that Japanese companies target firms in developed countries for large-scale, cross-border acquisitions. Among developing countries, acquisitions are concentrated in Asian nations.

10.4.2 Descriptive Statistics

Table 10.4 provides the descriptive statistics for the deals. Panel A shows the characteristics of the target firm. The average deal value was 229.7 billion yen (about 2.1 billion US dollars), while the median value was 110.7 billion yen (about

Table 10.3 Sample deals by nation

Target nations	Number
United States	56
United Kingdom	11
Australia	4
Germany	3
Italy	3
Netherlands	3
India	2
Switzerland	2
Sweden	2
Belgium	1
Brazil	1
Cyprus	1
Finland	1
France	1
Korea	1
Luxembourg	1
Malsia	1
Myanmar	1
Philippines	1
Singapore	1
Sum	99

1 billion US dollars). The difference here is caused by a few extremely large deals. The largest such deal was Japan Tobacco's acquisition of the UK's Gallaher Group, worth 2.25 trillion yen (about 20.5 billion US dollars). The second largest was Softbank's deal for the US cellphone company Sprint, valued at 1.81 trillion yen (about 16.5 billion US dollars). Altogether, 37% of the companies acquired had been listed on public exchanges, and the remaining 63% had not been listed.[1] Among the unlisted companies, subsidiary firms of other companies made up 36% and those invested in by private equity investment vehicles were 27%. In general, larger firms tend to be listed; however, targets for cross-border acquisition by Japanese firms are often unlisted, with many being purchased from funds. Representative examples of acquiring a fund investment include the 2011 purchase by Takeda Pharmaceutical Company of the Swiss drug maker Nycomed and Japan Tobacco's 1999 acquisition of the tobacco business outside the US from R.J. Reynolds. All the acquisitions examined in this study were through cash, not including any stock exchanges. While large acquisitions commonly make use of stock exchanges, most Japanese firms are not listed on foreign stock exchanges and the appeal of Japanese stocks is not high as a means of payment. Therefore, there is little choice but to transact through cash.

[1] I could not obtain the financial data of some non-listed firms.

Table 10.4 Descriptive statistics of targets and acquirers

Panel A: Target statistics						
	Mean	Median	10th	25th	75th	90th
Deal value (million YEN)	229,719	110,700	54,289	70,868	243,800	499,491
Unlisted	0.63	1	0	0	1	1
Subsidiary	0.23	0	0	0	0	1
Fund	0.17	0	0	0	0	1
Other	0.22	0	0	0	0	1
Panel B: Acquirer statistics						
	Mean	Median	10th	25th	75th	90th
Market value (million YEN)	2,019,184	1,092,315	195,209	596,705	2,126,249	4,713,144
Enterprise value (million YEN)	2,608,693	1,434,012	298,774	851,683	2,784,030	6,186,606
Relative size	0.21	0.10	0.02	0.05	0.23	0.57
Total sales (million YEN)	2,170,602	1,332,510	214,268	629,856	2,195,795	6,398,505
EBIT margin	0.095	0.074	0.035	0.050	0.121	0.189
Foreign sales ratio	0.34	0.31	0.10	0.13	0.49	0.61
Total assets (million YEN)	2,842,615	1,461,305	276,435	716,440	2,849,279	721,872
Debt ratio	0.18	0.20	0.00	0.06	0.25	0.36
Cash ratio	0.12	0.08	0.03	0.05	0.17	0.21

Panel B shows the characteristics of Japanese acquiring firms. The average value of the buyers just before announcing the acquisition was 2 trillion yen (about 18 billion US dollars), with a median of 1.1 trillion yen (about 10 billion US dollars). The average enterprise value (market value + debt – cash) of the buyers was 2.6 trillion yen (about 24 billion US dollars), while the median was 1.43 trillion yen (about 13 billion US dollars). The average relative size of the deal value to enterprise value was 0.21, with the median being 0.1. With the 75th percentile also coming to 0.23, the majority of Japanese firms acquire overseas companies that are less than a third as large as they are; however, in 16 deals, the relative size was greater than a third. In the 2006 deal, where the NSG group acquired the UK's Pilkington, the relative size was greater than 1, with the company acquired being larger than the buyer. The foreign sales ratio shows the proportion of foreign sales to total sales. However, under Japanese accounting rules, when the foreign sales ratio is less than 10%, there is no obligation to disclose overseas sales. Therefore, when not disclosed, the foreign sales ratio is presumed to be 10%. The average foreign sales ratio is 0.34 and the median is 0.31. Surprisingly, this was just 0.13 at the 25th percentile, with 22 companies having a foreign sales ratio of less than 0.1. That is, firms with virtually no overseas operations can still acquire foreign companies.

Table 10.5 CAR for the announcement of the acquisitions

	−2 to 2	−1 to 1
Mean	0.0044	0.0069
t-stat	*0.7255*	*0.5723*
Median	−0.0033	−0.0035
Z-stat	*0.2020*	*0.0940*
Min	−0.1670	−0.1592
10th	−0.0722	−0.0867
25th	−0.0253	−0.0293
75th	0.0309	0.0270
90th	0.0646	0.0663
Max	0.4710	0.6097

10.5 Cumulative Abnormal Return

I rely on standard event study procedures to calculate the CAR on the announcement of cross-border acquisitions by Japanese firms. I use a 5-day (−2 to 2) and a 3-day (−1 to 1) event window starting the day before the announcement of the acquisitions and ending on the day after. Abnormal returns are calculated for each day in the event window. The abnormal return on any given day is the market model residual, which is the difference between the stock's actual return and the predicted return based on the market model parameter estimates and market return for that day. CAR is the accumulation of abnormal returns. The parameters of the market model are estimated over a 200-day period beginning 220 days before the announcement and ending 20 days before the announcement. TOPIX is used as the proxy for market returns.

Table 10.5 shows the CAR on the announcement of cross-border acquisitions by Japanese firms. The mean announcement-period abnormal returns are 0.44% over a five-day event window and 0.69% over a three-day event window. The median returns are −0.33% over a five-day event window and −0.35% over a three-day event window. None of the cumulative returns for cross-border acquisitions by Japanese firms are statistically significant. This finding shows that while the business press adjudges most cross-border M&A by Japanese firms to be a failure, the market reaction to these acquisitions is by no means all negative.

10.6 Empirical Analysis

10.6.1 Effects of Acquirer and Target Characteristics

Before analyzing the effect of the target's country on the buyer's return, I analyze the effects of the characteristics of the acquirer and target characteristics. A regression analysis was conducted with the characteristics of the acquirer and target as the

Table 10.6 The effects of acquirer and target characteristics on CAR

	Dependent variable: Acquirer five-day CAR					
	(1)	(2)	(3)	(4)	(5)	(6)
LN (acquirer EV)	0.003	0.004	0.002	0.003	0.002	0.004
	(0.006)	(0.007)	(0.005)	(0.007)	(0.006)	(0.008)
Relative size	0.126*	0.129*	0.132**	0.134**	0.134**	0.136**
	(0.067)	(0.067)	(0.066)	(0.067)	(0.066)	(0.067)
Unlisted	0.041**		0.045**	0.049**		
	(0.019)		(0.018)	(0.019)		
Subsidiary		0.057***			0.057***	0.062***
		(0.014)			(0.014)	(0.014)
Fund		0.018			0.022	0.025
		(0.016)			(0.016)	(0.017)
Other		0.043			0.050*	0.054*
		(0.030)			(0.029)	(0.030)
Acquirer EBIT margin			0.066	0.030	0.057	0.020
			(0.086)	(0.113)	(0.092)	(0.125)
Acquirer foreign sales ratio			0.081***	0.074***	0.080***	0.073***
			(0.017)	(0.017)	(0.020)	(0.020)
Acquirer debt ratio			0.060		0.053	
			(0.037)		(0.036)	
Acquirer cash ratio				0.007		0.017
				(0.081)		(0.083)
Intercept	YES	YES	YES	YES	YES	YES
R-squared	0.223	0.240	0.257	0.250	0.271	0.266
Observations	99	99	99	99	99	99

Note: Robust standard error with clustering by target nation are reported in parenthesis. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively

explanatory variables and CAR as the dependent variable. Table 10.6 presents the results.

First, I analyzed the effect of the target firm being listed on the buyer's return. Faccio et al. (2006) estimate the acquirer's CAR in 17 countries between 1996 and 2001, finding that the return for the buyer was −0.38% when the target firm was listed, whereas it was 1.48% when the target was not listed. Officer (2007) notes that the price paid for unlisted companies is between 15% and 30% lower than that for listed companies. This type of discount for unlisted firms is called the illiquidity discount. As shown by the results of Model 1, even when I control for the buyer's scale and relative size, the return to the buyer when acquiring an unlisted firm is significantly higher. That is, this result hints that even when Japanese firms acquire companies overseas, there is an illiquidity discount for unlisted firms. Model 2 shows the results of dividing the unlisted firms into unlisted subsidiaries, fund investments, and the other. The other unlisted firms are stand-alone unlisted firms, many in which the founding family primarily holds the stocks. The effect of unlisted subsidiary is a statistically significant positive increase of about 1%.

Next, I examine the influence of the buyer's characteristics on the buyer's return. The proportion of foreign sales of the buyer before acquisition had a 1% statistically significant positive effect on the buyer's return. That is, the market evaluation of the cross-border acquisitions of companies that lacked an overseas presence was poor. Hence, when the quantity of business done overseas was small, the market anticipated that even after acquisition, it would be difficult for cost synergies to emerge and that overseas management expertise would be lacking.

All the deals in this sample were settled in cash. When the acquirer did not hold the necessary cash to complete the deal, short-term fundraising was necessary. Therefore, cross-border acquisitions by Japanese firms generally borrow some of the requisite capital from banks. In such cases, if a firm with a high debt ratio undertakes cross-border M&A, expectations over subsequent seasoned equity offering may depress the stock price. However, as shown by Models 3 and 5, the debt ratio coefficient was not statistically significant and the proportion borrowed by the buyer did not affect its return.

Models 4 and 6 use the acquirer's cash ratio as the explanatory variable instead of its debt ratio. Jensen (1986) indicates that an increase in free cash flow can lead to overinvestment. He uses the example of US oil companies that failed to return the free cash flow caused by the massive spike in the price of oil following the oil shock, and instead continued to search for new oil fields, invest in plants and equipment, and diversify their business. Retaining excessive cash can similarly result in an M&A damaging the firm's share price. Therefore, the market may react negatively to cross-border M&A by firms holding large quantities of cash. However, the effect of cash ratio was not statistically significant, indicating that the cash holdings of the buyer did not affect its return.

As the above discussion shows, for cross-border acquisitions by Japanese firms, the characteristics of both the seller and the buyer have a statistically significant influence on the buyer's returns. The buyer's returns are greater when the acquiring company already has overseas operations or when the target company is unlisted.

10.6.2 Effects of Countries' Characteristics

Next, I analyze the effect of characteristics of different countries on the returns to Japanese companies of cross-border acquisitions. This study focuses on the following characteristics of countries: corporate governance, employment protection, and culture. Table 10.7 presents these characteristics for the main countries.

The level of investor protection is used to show the corporate governance. La Porta et al. (1998) introduce a now famous index of six shareholder protection rules in 49 countries, finding systematic differences in the legal rights of investors across countries and showing that common-law countries provide stronger investor protection than civil law countries. La Porta et al. (1997) show that stronger investor

Table 10.7 Country characteristics

	Source	Japan	US	UK	Australia	Germany	Italy	Netherlands	India	Switzerland	Sweden
Anti-director index	Djankov et al. (2008)	4.5	3	5	4	3.5	2	2.5	5	3	3.5
Corrected anti-director index	Spamann (2010)	5	2	4	4	4	2	4	4	3	4
Employment laws index	Botero et al. (2004)	0.16	0.22	0.28	0.35	0.70	0.65	0.73	0.44	0.45	0.74
Hiring and firing practices	World Economic Forum	3.12	5.23	4.26	3.73	2.59	2.60	2.98	3.43	5.64	2.82
Power distance	Hofstede	54	40	35	36	35	50	38	77	34	31
Individualism	Hofstede	46	91	89	90	67	76	80	48	68	71
Masculinity	Hofstede	95	62	66	61	66	70	14	56	70	5
Uncertainty avoidance	Hofstede	92	46	35	51	65	75	53	40	58	29
Long-term orientation	Hofstede	88	26	51	21	83	61	67	51	74	53
Indulgence	Hofstede	42	68	69	71	40	30	68	26	66	78
Cultural distance		0	16.62	15.27	17.02	8.17	8.67	17.17	13.32	9.77	20.91

protection is associated with larger capital markets. The anti-director rights index is composed of six components. Three are concerned with shareholder voting (voting by mail, voting without blocking of shares, and calling an extraordinary meeting) and three with minority protection (proportional board representation, preemptive rights, and judicial remedies). La Porta et al. (1998) aggregate these six dimensions of shareholder protection into an anti-director rights index by simply adding a 1 when the law is protective along one of the dimensions and a 0 when it is not. I use the anti-director rights index revised by Djankov et al. (2008). In addition, I use the index corrected by Spamann (2010). As Table 10.7 shows, Japan's anti-director rights index is higher than that of the US, and is one of the highest worldwide. Following Bris and Cabolis (2008), I can thus infer that a low anti-director rights index in the target country increases returns for the buyer.

As for the employment system, I first use the Employment Laws index based on Botero et al. (2004). This employee protection index indicates the extent to which employees are protected from being dismissed by a company. The Employment Laws index is composed of four components: the average of alternative employment contracts, cost of increasing hours worked, cost of firing workers, and dismissal procedures. When this index is high, it indicates that the level of protection is high.

On the contrary, whether employment can be adjusted flexibly is affected not only by the legal system such as labor laws, but also by a variety of factors such as social tolerance and the customs related to employee dismissal. To incorporate this perspective into my analyses, I use an index that measures the flexibility of employment adjustments based on survey research conducted among managers. The Executive Opinion Survey by the World Economic Forum, which is a survey conducted among management executives in 144 countries, indexes managers' perceptions in business practice. This is a part of the Global Competitiveness Index published by the Forum. The 2014 Survey (carried out in 2013) data used in this study were prepared based on the responses from management executives at more than 13,000 companies globally. For example, the data for Japan are constructed from responses from 179 companies to the survey thanks to the cooperation of the Japan Association of Corporate Executives. The hiring and firing practice used in this study is an index created based on how flexibly a company can hire new personnel and fire excess workers. This variable may affect actual managerial decision-making. When this index is high, it implies that managers feel they can flexibly make employment adjustments. Table 10.7 shows that Japan's employment laws index is low compared with the US, indicating a high degree of flexibility in the labor market, but that the hiring and firing practices index is also lower than that of the US, showing that there is little flexibility to adjust employment. While the numerical values garnered through the surveys are different, the surveys show distinctions in employment legislation. Arikawa et al. (2016) also show that the average profitability of Japanese firms is the lowest among OECD countries and that this low profitability is partly attributed to the low score on the hiring and firing practices index. Following John et al. (2015), I can thus infer that low employee protection in the target country increases returns for the buyer.

I use Hofstede's measures to determine the cultural difference between Japan and the countries of target firms. Hofstede (1980, 2001) categorizes culture into six dimensions: power distance (the extent to which society accepts unequally distributed power), individualism (the extent to which society places priority on personal goals over the goals of collectives), masculinity (the extent to which society emphasizes achievement, assertiveness, and material successes, particularly for men), uncertainty avoidance (the extent to which members of society feel uncomfortable with uncertainty and ambiguity), long-term orientation (the extent to which society focuses on future-oriented values), and indulgence (the extent to which society allows the gratification of natural human needs). Hofstede measures national culture along these six dimensions, using survey responses from over 88,000 IBM employees in 40 countries in 20 languages in the 1960s and 1970s. The culture distances are then calculated from the numerical values of these six dimensions. The measure is calculated as follows:

$$\text{Culture distance} = \frac{\sqrt{\sum_{i=1}^{6} \left(S_{J,i} - S_{T,i}\right)^2}}{6}$$

where $S_{J,i}$ is the Japanese score on dimension i and $S_{T,i}$ is the target score on dimension i.

As Table 10.7 shows, compared with other countries, Japan's power distance score is average, those for individualism and indulgence are low, while those for masculinity, uncertainty avoidance, and long-term orientation are high. The country from which it is most culturally distant is Sweden, followed by the Netherlands and Austria. The countries with which it is culturally closest are Germany, Italy, and Switzerland. Its distance from the US, the target of most cross-border investment by Japanese firms, is average at 16.62.

Table 10.8 shows the results when the investor protection, employee protection, and cultural difference indexes are added as independent variables. In addition, OECD dummy variable was added to the explanatory variables to control for a country's development. This dummy variable takes one, when the target country was an OECD nation. The results of this OECD dummy variable were not statistically significant, with no difference in returns to the buyer regardless of whether the target country was developed or developing.

The effect of the anti-director index was negatively significant, with the acquisition of firms in countries with weak investor protection showing higher returns for Japanese buyers. Consistent with Martynova and Renneboog (2008), this result shows that corporate governance spillovers result from acquisitions by Japanese firms, given that investor protection in Japan is high. However, when Spamann's (2010) corrected index was used as an explanatory variable, the effect of the anti-director index was not significant.

Irrespective of whether the employment laws or hiring and firing practices indexes were used to show the strength of employee protection, the results were

Table 10.8 The effects of country characteristics on CAR

	Dependent variable: Acquirer five-day CAR						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
LN(acquirer EV)	0.002	0.002	0.001	0.002	0.002	0.004	0.005
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Relative size	0.132*	0.141**	0.133*	0.140**	0.142**	0.145**	0.157**
	(0.066)	(0.061)	(0.065)	(0.062)	(0.061)	(0.059)	(0.060)
Unlisted	0.044**	0.045**	0.045**	0.044**	0.046**	0.051**	0.050***
	(0.018)	(0.017)	(0.018)	(0.018)	(0.017)	(0.014)	(0.013)
Acquirer EBIT margin	0.065	0.053	0.057	0.054	0.056	0.052	0.013
	(0.086)	(0.082)	(0.079)	(0.079)	(0.081)	(0.078)	(0.069)
Acquirer foreign sales ratio	0.080***	0.073***	0.078***	0.077***	0.072***	0.075***	0.081***
	(0.015)	(0.017)	(0.016)	(0.016)	(0.016)	(0.015)	(0.016)
Acquirer debt ratio	0.060	0.072*	0.072*	0.077*	0.070*	0.074*	0.015
	(0.036)	(0.040)	(0.040)	(0.041)	(0.037)	(0.039)	(0.051)
Target OECD (dummy)	0.005	−0.030	−0.017	−0.033	−0.030	−0.034	0.107
	(0.035)	(0.046)	(0.048)	(0.048)	(0.047)	(0.048)	(0.074)
Anti-director index		−0.020***		−0.021***	−0.020***	−0.022***	0.006
		(0.006)		(0.006)	(0.007)	(0.007)	(0.016)
Corrected anti-director index			−0.011				
			(0.007)				
Employment laws index				−0.015			
				(0.053)			
Hiring and firing practices					−0.003	−0.010	−0.005
					(0.010)	(0.008)	(0.012)
Culture distance						0.006*	
						(0.003)	
Power distance							0.002*
							(0.001)

(continued)

Table 10.8 (continued)

	Dependent variable: Acquirer five-day CAR						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Individualism							0.000
							(0.001)
Uncertainty avoidance							−0.001
							(0.001)
Masculinity							0.001
							(0.001)
Long-term orientation							−0.002**
							(0.001)
Indulgence vs. restraint							0.000
							(0.001)
Intercept	YES	YES	YES	YES	YES	YES	YES
R-squared	0.257	0.276	0.268	0.279	0.277	0.294	0.342
Observations	99	97	97	97	97	97	97

Note: Robust standard error with clustering by target nation are reported in parenthesis. Statistical significance at the 1%, 5%, and 10% levels are denoted by ***, **, and *, respectively

not statistically significant. Given that Japanese firms acquiring overseas companies rarely seek synergies by cutting costs, the strength of employee protection has no effect on returns.

The effect of cultural distance was statistically positively significant at the 10% level. This finding accords with those of Chakrabarti et al. (2009), with returns to the buyer highest when cross-border acquisitions by Japanese firms are made with companies located in culturally distant countries.

Overall, market reactions to cross-border acquisitions by Japanese firms differ depending on the target country. There is a tendency for returns to Japanese buyers to be higher when the firms acquired are in countries with low levels of investor protection or in culturally distant countries. This result concurs with those of earlier research in countries other than Japan.

10.7 Conclusions

This study examined the market reaction to the acquisition of overseas firms by Japanese companies. The business press typically emphasizes overseas acquisition failures by Japanese firms and the impression that Japanese firms are not good at acquiring companies overseas is strong. However, the empirical results presented herein show that the market reaction to announcements of overseas acquisitions by Japanese firms is neutral rather than negative.

The characteristics of the country in which the target company is located also have an effect on market reaction. Returns to the buyer rise if investment protection in the country of the target firm is lower. This result appears to show that when the target company's corporate governance is poor, the market anticipates it will be improved by the acquisition. Cultural difference increases returns to the buyer the further the target country is from Japan according to the Hofstede measure.

In addition, the empirical results show that the characteristics of the target and acquiring firms affect returns. When the target firm is not listed, particularly when it is a subsidiary company, this results in a statistically significant increase in returns for the buyer. Furthermore, returns for the buyer are statistically higher when the acquiring firm already has a high proportion of sales overseas. These results essentially agree with those of previous studies of US firms. Contrary to what is generally perceived, the market reaction to Japanese firms acquiring overseas companies is largely the same as that for other countries.

This study adopted CAR, as indicated by the market reaction, as a proxy for M&A performance. Therefore, the results are strongly based on what the market thinks. However, large-scale mergers by Japanese firms have increased notably in recent years, and it is by no means the case that the market is always right. As such, it will be necessary in the future to further examine financial performance and returns in the long term.

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Chapter 11
Entry of Foreign Multinational Firms and Productivity Growth of Domestic Firms: The Case for Japanese Firms

Keiko Ito

Abstract This chapter examines whether and how the entry of foreign multinational firms affects productivity growth of domestically owned firms, using Japanese firm-level data. The data are taken from a comprehensive annual survey conducted by the Japanese government on firms in manufacturing, wholesale, retail, information services, business services, and other service industries. The results of the analysis suggest that foreign multinationals perform better than domestically owned firms in many sectors. Moreover, once firm-specific fixed effects are controlled for, the presence of foreign firms in an industry tends to negatively affect the productivity growth rate of domestically owned firms in that industry. However, firms that are catching up toward the productivity frontier enjoy positive foreign direct investment spillovers, implying that foreign entry accelerates productivity catch-up.

Keywords Foreign direct investment • Productivity • Service sector • Spillovers

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K. Ito (✉)
School of Economics, Senshu University, 2-1-1 Higashi-mita, Tama-ku, Kawasaki, Kanagawa 214-8580, Japan
e-mail: keiko-i@isc.senshu-u.ac.jp

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11.1 Introduction

Foreign direct investment (FDI) can play an important role in a country's economic development and productivity growth. In addition to the entry effect associated with FDI, that is, the entry of high-productivity foreign firms raises the overall productivity level in the economy, many countries have adopted policies to promote inward FDI[1] to leverage positive spillover effects. FDI spillovers can occur through various channels. For example, if a new technology is successfully introduced by a foreign-owned firm, this will encourage domestic firms to adopt that technology. This channel, the so-called demonstration or imitation effect, involves the spillover of technologies and/or know-how. Another important channel is the increased competition induced by the entry of foreign firms. Competition from foreign-owned firms provides an incentive for domestic firms to be more productive by using existing resources more efficiently and adopting new technologies. However, FDI spillovers are not always positive and depend on various factors such as the entry mode of FDI as well as the characteristics of foreign firms and of the domestic economy, sector, and firms.[2]

Although FDI spillovers have already been widely investigated, empirical analyses based on firm-level data produce mixed results. For example, Aitken and Harrison (1999) examined Venezuelan manufacturing plants and found that foreign investment negatively affected the productivity of domestically owned firms while Haskel et al. (2007), using plant-level data for UK manufacturing establishments, found positive spillover effects. Given these mixed results, some studies have examined the conditions under which FDI has positive spillover effects. Girma (2005) and Damijan et al. (2013), for example, highlighted the importance of the absorptive capacity of domestic firms. On the other hand, Javorcik (2004) suggested that positive FDI spillovers may occur through backward linkages based on evidence that an increase in foreign presence in downstream sectors is associated with a rise in productivity in domestically owned firms in supplying industries.[3]

Another strand of literature focuses on the relationship between innovation incentives and FDI spillovers. Aghion et al. (2009) found that the productivity growth of incumbent firms is positively correlated with greenfield, foreign firm entry in technologically advanced industries but not in lagging(or laggard) industries. This suggests that the entry of technologically advanced foreign firms encourages incumbent innovation and productivity growth in sectors that are close to the tech-

[1]In this chapter, "inward FDI" denotes the entry of foreign-owned firms or expansion of activities by foreign-owned firms through direct investment.

[2]See Crespo and Fontoura (2007) for a survey of the literature on FDI spillovers.

[3]Along similar lines, Kugler (2006) highlighted the importance of outsourcing foreign multinational firms' relationships with local upstream suppliers as a channel for technology diffusion and argued that positive FDI spillover effects can be seen between industries but not within industries.

nological frontier, whereas it discourages incumbent innovation and productivity growth in sectors further behind the frontier. Thus, the empirical evidence available to date is insufficient for definitive conclusions on the factors resulting in positive FDI spillovers.

Moreover, most previous empirical studies are confined to analyses of the manufacturing sector. Few empirical studies address foreign entry effects in the service sector, mainly because of data constraints. One of the few exceptions is Arnold et al. (2011). Focusing on the case of the Czech Republic, the study found that opening the service sectors to foreign providers is a key channel for services liberalization contributing to improved performance in downstream manufacturing sectors. However, the study did not examine FDI spillover effects on domestic firms in the service sector itself. Therefore, particularly for the non-manufacturing sector, our knowledge on this subject remains limited, and there is ample room for research on the factors that are relevant for recipient economies to enjoy positive FDI spillovers.

In fact, foreign entry may be more important for the non-manufacturing sector than the manufacturing sector. Because international transactions in the form of cross-border trade are sometimes difficult for certain types of services, the service sector is less likely to be exposed to international competition than the manufacturing sector and, hence, to learn foreign advanced technology and management know-how from exporting and importing services. Domestic service firms have few chances to learn from foreign firms unless foreign firms enter the domestic market and provide services by establishing their affiliates. In this sense, foreign entry should be particularly important for the service sector to improve productivity through competition effect and learning effect.[4]

In the case of Japan, the government set a target in 2003 to double inward FDI within 5 years to boost the stagnant economy. Moreover, given that the service sector (including construction and utilities) accounts for nearly 80% of total GDP, raising productivity growth in the non-manufacturing sector has been a policy priority in efforts to increase the long-term growth potential of the economy. However, the impact of inward FDI promotion policy has not yet been sufficiently evaluated.[5]

To address the various shortcomings highlighted so far, I examine whether the productivity of domestic firms is correlated with the presence of FDI in their industry using a Japanese large-scale, firm-level dataset. The major contribution of this chapter is to add to the literature by examining the spillover effects of foreign-owned firms on domestic firms in the service sector. Some empirical studies on the manufacturing sector suggest that FDI improves productivity in the recipient

[4]Ito (2015), using data on listed Japanese firms, found that firms in the non-manufacturing sector achieved faster productivity growth at home than firms in the manufacturing sector after conducting direct investment abroad. This result suggests that the learning effect of FDI is larger for services firms than for manufacturing firms.

[5]Kiyota (2014) surveyed papers on the impact of foreign firms in Japan, and he also discussed that there is limited and mixed evidence on this subject.

economy through technology diffusion and other channels. It is possible, however, that such channels of FDI spillover may not operate to the same extent in the service sector because inter-industry or inter-firm linkages tend to be more limited for some types of services than for assembly-type manufacturing sectors. Given the scarcity of empirical evidence on the service sector, this chapter will examine the existence of FDI spillovers in the service sector. To the best of my knowledge, this study is the first rigorous empirical analysis of FDI spillover effects based on large-scale, firm-level panel data for the service sector.

The major findings of this chapter are as follows. Foreign-owned firms tend to be larger and more productive than domestic firms both in the manufacturing and non-manufacturing sectors. This questions whether the presence of "superior" foreign-owned firms contributes to productivity improvements among domestically owned firms through learning and competition effects. However, in the empirical analysis, negative FDI spillover effects on the productivity of domestically owned firms are found once firm-fixed effects are controlled for both the manufacturing and the service sector. Moreover, the negative FDI spillover effect tends to be greater for the service sector than the manufacturing sector, implying that there may be systematic differences in FDI spillover effects between the manufacturing and the non-manufacturing sectors. In both sectors, firms with relatively high productivity growth experience fewer negative spillover effects from foreign-owned firms in the same industry. In the long run, however, productivity growth of such high-growth firms and the share of foreign-owned firms are positively correlated. These results imply that foreign entry will not raise the overall productivity level of domestic firms unless low productivity firms are forced to exit or policies for raising the productivity levels of less productive firms concur with foreign entry.

The remainder of this chapter is organized as follows. Section 11.2 provides an overview of the presence of foreign-owned firms in Japan in terms of employment and value added. Section 11.3 presents the empirical model for the productivity spillover analysis while Sect. 11.4 presents the empirical results. Section 11.5 concludes.

11.2 Productivity Trends in the Japanese Economy and the Presence of Foreign-Owned Firms in Japan

While productivity in the Japanese economy overall has stagnated "only" since the 1990s, productivity in the Japanese service sector has, in fact, fallen sharply and both the level and the growth rate of productivity in the Japanese service sector are significantly much lower than in the manufacturing sector (e.g., the Ministry of Health, Labor and Welfare 2008). For example, Fukao et al. (2007) showed that total factor productivity (TFP) growth in the service sector has been low since the 1970s and has further deteriorated since the 1990s. Similarly, Shinada (2003) showed that service sector TFP in the Japanese service sector in the 1990s was substantially lower than in the 1980s.[6] Moreover, an international comparative study on sectoral productivity levels undertaken by the EU KLEMS project (e.g., Inklaar and Timmer 2008) reported that the productivity level in some service industries in Japan, such as trade and business services, is only around 40–50% of the US level in 1997, and the relative productivity levels further deteriorated in 2005 compared with the corresponding levels in 1997 for most of the sectors.[7]

Based on these findings, improving productivity, particularly in the service sector, is a priority for the Japanese economy (METI 2007).[8] Inward FDI is expected to raise productivity in the Japanese economy by intensifying market competition and generating knowledge spillovers to domestic firms. However, the effects of foreign entry on the productivity of domestic firms are still unclear, particularly in the case of service industries.

We first examine the share of foreign-owned firms in the Japanese economy using the sector-level aggregated data compiled by the Ministry of Economy, Trade and Industry (METI). The sector-level data are based on the *Basic Survey on Japanese Business Structure and Activities* (BSJBSA) collected annually by METI. Figure 11.1 shows the number of foreign-owned firms and the share of foreign-owned firms in the total number of firms in the BSJBSA for the period 2000–2014. In the BSJBSA, foreign-owned firms are defined as firms with 33.4% or more foreign ownership.[9] Although the survey started in 1992 (data for fiscal year 1991), Fig. 11.1 shows the data from the year 2000 because observations for the non-manufacturing sector increased substantially for the 2001 survey (data for fiscal year 2000). The figure shows that while the number of foreign-owned firms has been stable in the manufacturing sector, it has gradually increased in the non-manufacturing sector. However, the share of foreign-owned firms is only 2.6% as of 2014 in terms of the

[6]OECD (2001), comparing service sector labor productivity across countries, also reported that labor productivity growth in Japan drastically declined in major service industries. For example, labor productivity growth in wholesale and retail trade and the transportation and telecommunication industry stood at 4.4% and 4.1%, respectively, for the period 1979–1989, the highest among the ten major developed countries. However, for the period 1990–1997, the corresponding growth rates dropped to 1% (placing Japan fifth among the ten countries) and 0.5% (the lowest among the ten countries). On the other hand, Morikawa (2007), using Japanese firm-level data for the period 2000–2004, found that productivity levels in service industries are not significantly lower than those in manufacturing industries, although the dispersion in productivity within the former is greater than the dispersion in productivity in the latter.

[7]In contrast, for the US, service industries were the drivers of overall productivity growth (e.g., Triplett and Bosworth 2004).

[8]Morikawa (2008), for example, argued that to improve service sector productivity, the diffusion of best practice and greater firm and industry-level dynamism through firm entry and exit is necessary.

[9]In Japan, the Commercial Law prescribes that important matters should be decided by obtaining more than two-thirds of the voting rights at a shareholders' meeting. Therefore, an ownership share of 33.4% is critical to exercise a veto. For this reason, METI defines foreign-owned firms as firms with a foreign ownership ratio of 33.4% or more. However, the number and share of foreign-owned firms show a similar trend when defining foreign-owned firms as firms with 50% or more foreign ownership.

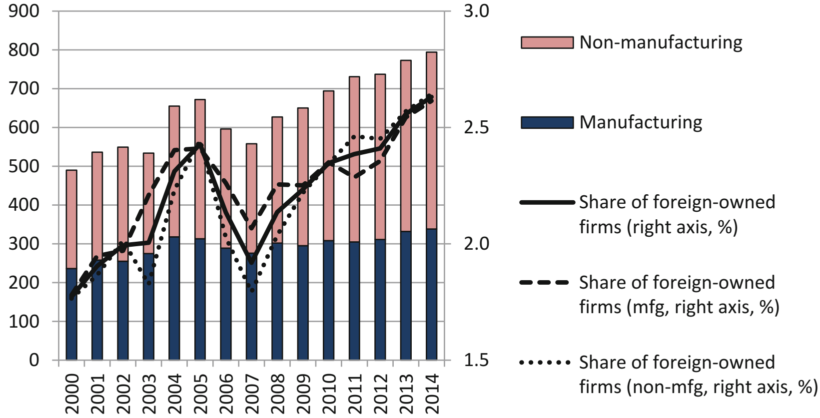

Fig. 11.1 Number of foreign-owned firms in Japan. Notes: The figures include only firms with at least 50 employees or 30 million paid-in capital (Source: Compiled by the author using the figures taken from METI's reports of *Basic Survey of Japanese Business Structure and Activities*)

number of firms, although the share is calculated for relatively large firms because the BSJBSA includes only firms with at least 50 employees or 30 million yen of paid-in capital.[10] In addition, the trends in the number of foreign-owned firms are similar among manufacturing and non-manufacturing sectors, although the number of foreign-owned firms has been stable in the manufacturing sector, reflecting a decrease in the total number of manufacturing firms.

Figure 11.2 shows the number of workers employed by foreign-owned firms and the foreign-owned firms' share in total employment. Foreign-owned firms tend to be larger than domestically owned firms, and the foreign-owned firms' share in total employment is much larger than their share in terms of the number of firms. The foreign-owned firms' share has more than doubled from 4.2% in 2000 to 9.2% in 2014 in all industries. Although the share of foreign-owned firms was similar between manufacturing and non-manufacturing sectors in terms of the number of firms (Fig. 11.1), the employment share of foreign-owned firms is much larger for the manufacturing sector than for the non-manufacturing sector. These figures imply that the relative size of foreign-owned firms to domestically owned firms in the manufacturing sector tends to be larger than that in the non-manufacturing sector.

[10]In Fig. 11.1, the number of foreign-owned firms in the service sector is only slightly larger than that in the manufacturing sector. In fact, however, both in Japan and other developed countries, foreign entry is more prominent in the service sector (see, e.g., *Directory of Foreign-owned Firms in Japan* published by Toyo Keizai Shimposha). Relatively small foreign-owned firms, which are likely to be firms in the service sector, are not included in our dataset. Moreover, in the case of several service sectors, such as transportation, telecommunication, financial intermediation, insurance, and real estate, most of the firms are not included in the BSJBSA. The BSJBSA only includes firms in these sectors if they have an establishment in a sector administrated by METI. Refer to Ito and Fukao (2005) for more comprehensive statistics on foreign-owned firms in Japan.

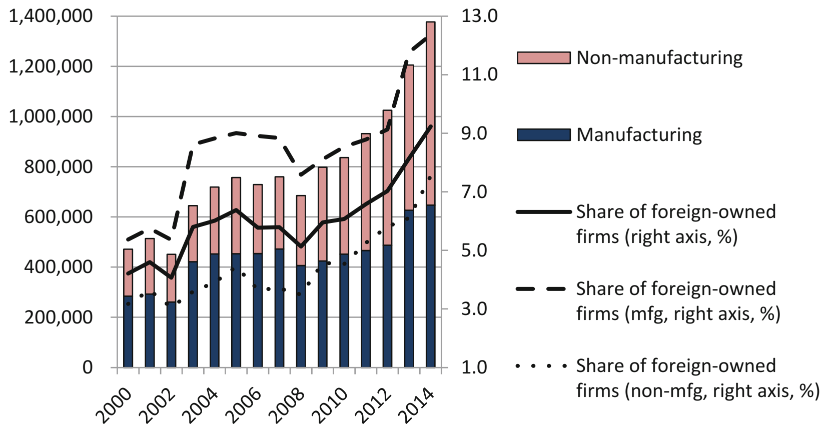

Fig. 11.2 Number of workers employed by foreign-owned firms in Japan. Notes: The figures include only firms with at least 50 employees or 30 million paid-up capital (Source: Compiled by the author using the figures taken from METI's reports of *Basic Survey of Japanese Business Structure and Activities*)

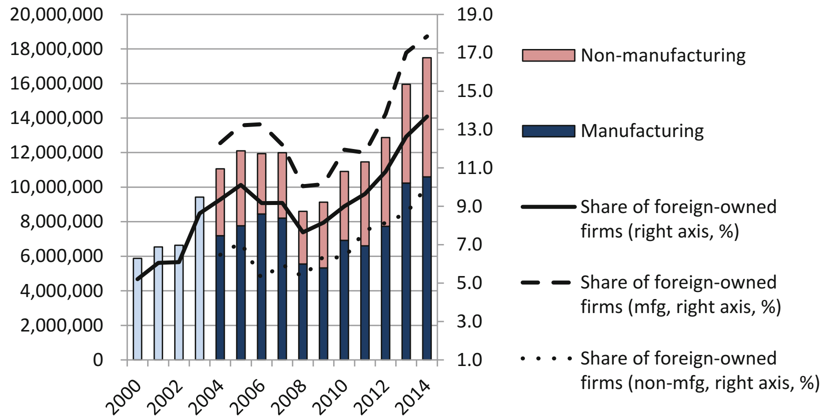

Fig. 11.3 Value added by foreign-owned firms in Japan. Notes: The figures include only firms with at least 50 employees or 30 million paid-up capital. The breakdown by sector is not available before 2004. The unit of the left axis is million yen (Source: Compiled by the author using the figures taken from METI's reports of *Basic Survey of Japanese Business Structure and Activities*)

The trend for foreign-owned firms' share in total employment increased until 2005, decreased after that, but it has increased again since 2008, which is similar to the trend in the number of foreign-owned firms.

Figure 11.3 shows the value added by foreign-owned firms and the share of foreign-owned firms in total value added. Similar to the trends in Figs. 11.1 and 11.2, although the value-added share of foreign-owned firms decreased from 2005 to 2008, it has increased again since 2008. The foreign-owned firm share nearly tripled from 5.2% in 2000 to 13.7% in 2014 in all industries. The value-added share of foreign-owned firms is much larger at 13.7% of total value added in all industries than the corresponding employment share of foreign-owned firms as of 2014. The sectoral breakdown also shows a similar trend, suggesting that foreign firms tend to have higher value added per employee, that is, higher labor productivity.

Thus, although the trends in the share of foreign-owned firms show somewhat different patterns across sectors and, depending on the indicator chosen particularly in terms of value added, the presence of foreign-owned firms increased during the period 2000–2014. These observations imply that foreign-owned firms tend to have higher labor productivity and a higher growth rate of labor productivity than domestically owned firms.

These conclusions are consistent with empirical studies on a variety of countries, which show that foreign-owned firms tend to outperform domestic firms. For Japan, studies that provide evidence of this effect include Fukao et al. (2005) and Kimura and Kiyota (2007). In addition, although not shown here to conserve space, the data used in the empirical analysis in the following sections in this chapter show that foreign-owned firms also outperform domestic firms in a range of other performance measures such as TFP, firm size, wages, and profitability.[11]

11.3 Empirical Methodology

11.3.1 Data

The data used for the following empirical analysis were firm-level panel data underlying the BSJBSA. The firm-level data in the Japanese manufacturing, mining, and commerce sectors and several other service sectors for 2000–2007 were available for this study.[12] Observations for firms for which data on sales, number of employees, total wages, tangible fixed assets, depreciation, or intermediate inputs were not positive, or were missing for at least 1 year, were dropped from the

[11]The results can be obtained from the author upon request.

[12]The survey contains detailed information on firm-level business activities such as the three-digit industries in which the firm operates, its number of employees, sales, purchases, exports and imports, R&D and patents, the number of domestic and overseas subsidiaries, and various other financial data such as costs, profits, investment, and assets. Although the survey also includes non-manufacturing firms for information on exports and imports, the firms are required to provide the amount of trade in goods only. The survey does not cover international transactions in services. The firm-level data of the BSJBSA were obtained through the Trade and Investment Facilitation Division, Trade and Economic Cooperation Bureau, Ministry of Economy, Trade and Industry (METI). However, the views expressed in this chapter are solely those of the author and do not represent those of the METI.

dataset for the analysis. After screening, the unbalanced panel dataset contained approximately 24,000 firms, half of which were service sector firms.[13]

Utilizing the firm-level panel data, two types of productivity measures were constructed: labor productivity and TFP. Because information on working hours at the firm level were not available, labor productivity was calculated as real value added per employee. Real value added was calculated as real output minus real intermediate input using industry-level price deflators taken from the JIP Database 2009. TFP for each firm was calculated based on the production function estimated using the semi-parametric estimation technique suggested by Levinsohn and Petrin (2003).[14]

11.3.2 Empirical Model

There are several main channels for spillover effects including demonstration/imitation effects or spillovers through backward and forward linkages.

The baseline specification for the relationship between inward FDI and the productivity growth of domestically owned firms is as follows:

$$\begin{aligned}\Delta PROD_{ijt} = {} & \beta_0 + \beta_1 \Delta\ FRPROD_{jt} + \beta_2 GAP_{ijt-1} + \beta_3 FDI\ share_{jt-1} \\ & + \beta_4 \Delta MKT\ share_{ijt} + \mu_i + \gamma_j + \eta_t + \varepsilon_{ijt}\end{aligned} \tag{11.1}$$

where i indexes domestically owned firms, j indexes industries, and t indexes years. The dependent variable (*PROD*) is the productivity of domestically owned firms. *FDIshare* denotes the foreign presence in the industry proxied by the employment share of foreign-owned firms.[15] Consistent with most existing studies on the spillover effects of foreign entry, the coefficient on the *FDIshare* variable, β_3, is used as an indicator of the existence and magnitude of spillover effects. Following Haskel et al. (2007), changes in market share (*ΔMKTshare*) are included to measure changes in competitive pressure. As argued, for example, by Aitken and Harrison (1999), competition with foreign-owned firms may reduce the market shares of domestically owned firms and force them to operate on a less efficient scale resulting in increases in their average costs and lower productivity. *MKTshare* is measured as a firm's sales as a proportion of the industry's total sales. Because the market share variable is also affected by technological differences between industries and may not be a good indicator of market power, the difference variable (*ΔMKTshare*) is used for the analysis.

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[13]The industry classification and number of observations by industry are shown in Tables 11.5 and 11.6 in the Appendix, respectively.

[14]For details of the definition and data source for each variable for the TFP calculation, see the Appendix.

[15]To calculate *FDIshare*, a firm's total number of employees is counted as foreign if the sum of the share held by foreigners is 33.4% or more. The variable *FDIshare* is calculated as the total number of workers employed by foreign-owned firms divided by the total number of employees in the industry.

This specification does not consider heterogeneity in the correlation between inward FDI and the productivity growth of domestically owned firms suggested by Aghion et al. (2009). However, following neo-Schumpeterian models of endogenous growth (e.g., Acemoglu et al. 2006), technological distance from the frontier firms in the industry (*GAP*) is included. The idea is that firms lagging behind the technological frontier can improve productivity by adopting advanced technologies available in the market. Thus, firms' productivity growth depends on both the ability to catch up with frontier firms and the ability of frontier firms to innovate. Therefore, as a proxy for the innovative ability of frontier firms, the productivity growth of frontier firms ($\Delta FRPROD$) is also considered.

Frontier firms are defined as those firms whose productivity level is among the top 5% in each industry and each year.[16] The productivity of frontier firms is calculated as the average productivity of frontier firms, and the technological distance from the frontier (*GAP*) is measured as the frontier's productivity level minus a firm's productivity level (*FRPROD* – *PROD*).[17] Both $\Delta FRPROD$ and *GAP* are expected to take a positive coefficient. Both TFP and labor productivity are used for the productivity variables *PROD* and *FRPROD*, and the productivity measures are in logarithm. μ_i, γ_j, and η_t are fixed effects for firms, industries, and years, respectively. ε_{ijt} is the error term. Firm-fixed effects (μ_i) are included to capture unobserved firm heterogeneity related to factors such as firm location, size, the subindustry of operation, managers' characteristics, and firm age.

11.4 Estimation Results

11.4.1 Baseline Results

Table 11.1 shows the estimation results of the baseline specification (1). For the baseline estimation, the 1-year difference between the productivity and market share variables is used.[18] To consider endogeneity, the *FDIshare* and *GAP* variables are lagged by 1 year. The results of the TFP specification are presented in columns (i) to

[16]The frontier firms include some foreign-owned firms. If the 33.4% foreign ownership ratio is applied, approximately 8% of the frontier firms are foreign owned, while if the majority of foreign ownership definition is applied, approximately 5% of the frontier firms are foreign owned. The frontier productivity growth indicates the growth potential of each industry and it seems reasonable to include foreign-owned firms among the frontier firms. However, the variable *FPROD* proxies the productivity growth rate of foreign-owned firms when the frontier firms consist largely of foreign-owned firms. Estimation using the *FPROD* variable calculated excluding foreign-owned firms produces almost the same results as when using the *FPROD* variable calculated including foreign-owned firms.

[17]For frontier firms, the technological distance from the frontier (*GAP*) is set to zero.

[18]The observations of which industry classification differs between year $t-1$ and year t are dropped from the estimations.

Table 11.1 Baseline estimation results

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
	TFP growth (from $t-1$ to t)			Labor productivity growth (from $t-1$ to t)		
	All	Mfg.	Services	All	Mfg.	Services
$\Delta FRPROD_{jt}$	0.503***	0.560***	0.445***	0.504***	0.628***	0.432***
	(0.010)	(0.017)	(0.013)	(0.010)	(0.017)	(0.012)
GAP_{ijt-1}	0.673***	0.645***	0.726***	0.698***	0.663***	0.754***
	(0.009)	(0.013)	(0.011)	(0.008)	(0.013)	(0.010)
$FDIshare_{jt-1}$	−0.503***	−0.379***	−0.621***	−0.348***	−0.187**	−0.344***
	(0.056)	(0.074)	(0.071)	(0.057)	(0.074)	(0.073)
$\Delta MKTshare_{ijt}$	6.023***	11.153***	3.481***	3.390***	9.577***	2.165***
	(0.894)	(1.917)	(0.714)	(0.845)	(1.865)	(0.636)
Industry effects	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	128,845	63,554	65,291	129,149	63,554	65,291
F statistic	109.0	102.0	117.7	121.4	110.4	139.8
R-squared	0.343	0.335	0.366	0.349	0.339	0.375

Source: Extracted from Ito (2012), Table 4.1
Note: Heteroscedasticity-robust standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level respectively

(iii) while the results of the labor productivity specification are presented in columns (iv) to (vi). The results based on the whole sample are shown in columns (i) and (iv), the results for the manufacturing firms' sample are shown in columns (ii) and (v), and the results for the services firms' sample are shown in columns (iii) and (vi).

The results in Table 11.1 show that the coefficient of *FDIshare* is negative and statistically significant in all the cases, suggesting that the presence of foreign firms has negative spillover effects on domestic firms' productivity growth in the same sector. Moreover, the results show that the negative effect tends to be larger for the service sector than for the manufacturing sector.

For other explanatory variables, $\Delta FRPROD$ and GAP have a positive coefficient as expected, implying that productivity growth of frontier firms and the catch-up toward frontier firms are important. The positive coefficient of GAP suggests that firms lagging behind the technological frontier are more likely to attempt to improve productivity and that catch-up mechanisms, such as "growth through competition, competition through growth" (Odagiri 1994), are effective for productivity improvement.

11.4.2 Heterogeneity of the Effects of FDI

Previous studies (e.g., Damijan et al. 2013) indicated that the magnitude and/or direction of the spillover effects that domestically owned firms receive from foreign-owned firms are likely to depend on firm-specific characteristics. To consider this heterogeneity in the correlation between inward FDI and the productivity growth of domestically owned firms, the baseline specification is modified as follows:

<Modified specification 1>

$$\begin{aligned}\Delta PROD_{ijt} = {} & \beta_0 + \beta_1 \Delta FRPROD_{jt} + \beta_2 GAP_{ijt-1} + \beta_3 FDI\ share_{jt-1} \\ & + \beta_4 \Delta MKT\ share_{ijt} + \beta_5\ CATCH_{ijt} \cdot FDI\ share_{jt-1} + \beta_6\ CATCH_{ijt} \\ & + \mu_i + \gamma_j + \eta_t + \varepsilon_{ijt}\end{aligned} \tag{11.2}$$

<Modified specification 2>

$$\begin{aligned}\Delta PROD_{ijt} = {} & \beta_0 + \beta_1 \Delta FRPROD_{jt} + \beta_2 GAP_{ijt-1} + \beta_3 FDI\ share_{jt-1} \\ & + \beta_4 \Delta MKT\ share_{ijt} + \beta_5 GAP_{ijt-1} \cdot FDI\ share_{jt-1} + \mu_i + \gamma_j + \eta_t + \varepsilon_{ijt}\end{aligned} \tag{11.3}$$

The variable *CATCH* is a dummy variable that takes 1 for catch-up firms and 0 otherwise. Catch-up firms are defined as firms that reduced the gap to the frontier during the preceding year.[19] That is, firms that reduced the distance to the frontier from year $t - 1$ to year t are defined as catch-up firms in year t. The modified specification 1 (Eq. 11.2) is estimated to examine whether catch-up firms enjoy positive spillovers. On the other hand, Aghion et al. (2009) argued that the threat from frontier entrants leads incumbents in sectors that are initially close to the technology frontier to innovate more, and this triggers productivity growth. In sectors close to the frontier, incumbent firms know that they can escape and survive entry by innovating successfully and, thus, they react with more intensive innovation activities. However, in sectors further from the frontier, the entry threat reduces the expected rents from conducting R&D for incumbent firms because incumbents cannot win against an entrant with frontier technology. Therefore, the FDI spillover effect is heterogeneous across sectors and firms depending on the distance from the technology frontier.

To incorporate Aghion et al.'s (2009) argument, the modified specification 2 (Eq. 11.3) includes an interaction term of the *GAP* and *FDIshare* variables. However, in contrast with Aghion et al. (2009), who test for heterogeneity across industries and consider the distance to the world technological frontier by industry, assuming that US industries represent the world technological frontier, I consider each firm's technological distance to the national frontier in each industry (*GAP*) instead of

[19]The definition of catch-up firms here follows Arnold et al. (2008).

the industry-level technological distance to the world frontier. In addition to data constraints, the reason is that I focus on the heterogeneity of FDI-spillover effects across firms within an industry. Based on Aghion et al. (2009), firms closer to the national frontier are expected to be more actively engaged in innovative activities and, thus, more likely to enjoy positive FDI spillovers than firms further from the frontier.

Table 11.2 shows the fixed-effect estimation results of the modified specifications 1 and 2 using TFP as a productivity measure.[20] The interaction term of the catch-up firm dummy and the inward FDI share has a significantly positive coefficient in columns (i) to (iii). However, the sum of the estimated coefficients of the stand-alone inward FDI share variable and its interaction with the catch-up firm dummy is still negative, suggesting that catch-up firms receive smaller negative spillovers compared to other firms. Even catch-up firms do not receive positive spillovers from foreign-owned firms in the same industry. On the other hand, columns (iv) to (vi) show that the coefficients of the inward FDI share are positive and the coefficients of its interaction term with the technological distance variable are negative. These results imply that firms closer to the technological frontier are more likely to enjoy positive FDI spillovers while firms further away from the technological frontier are more likely to receive negative FDI spillovers, which is consistent with the results obtained by Aghion et al. (2009).

For other explanatory variables, both the variable for frontier productivity growth ($\Delta FRPROD$) and the variable for technological distance from the frontier (GAP) have a positive and significant coefficient, as expected. The market share variable ($\Delta MKTshare$) also has a positive and significant coefficient, suggesting a positive correlation between market share growth and productivity growth.[21]

11.4.3 Robustness Checks

Estimating the relationship between foreign entry and the productivity of domestic firms raises important econometric factors concerning the possible endogeneity of FDI and the direction of causality. That is, although a considerable number of studies

[20] I obtained similar results when using labor productivity as a productivity measure.

[21] Supplementary analysis of extensions of the models above that include various measures of industry-level competition, such as the Herfindahl index (calculated by industry using the firm-level dataset), the import penetration ratio (calculated using the JIP Database 2009), and regulation weights (taken from the JIP Database), show that the Herfindahl index tends to be negatively correlated with firm productivity, suggesting that competition promotes productivity growth. However, the import penetration ratio is negatively associated with firm productivity growth while the regulation weight is positively associated with firm productivity growth, suggesting that competition restrains productivity growth. Although it is difficult to obtain a conclusive result regarding market competition effects on firm productivity, the estimated coefficients on the FDI variable are mostly consistent.

Table 11.2 FDI spillovers and catch-up firms

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
	All	Mfg.	Services	All	Mfg.	Services
$\Delta FRPROD_{jt}$	0.820***	0.822***	0.821***	0.499***	0.553***	0.446***
	(0.010)	(0.016)	(0.013)	(0.010)	(0.016)	(0.013)
GAP_{ijt-1}	0.486***	0.454***	0.545***	0.701***	0.678***	0.745***
	(0.010)	(0.014)	(0.014)	(0.009)	(0.014)	(0.012)
$FDI\ share_{jt-1}$	−0.486***	−0.319***	−0.762***	0.295***	0.354***	0.161
	(0.053)	(0.069)	(0.073)	(0.108)	(0.130)	(0.174)
$CATCH_{ijt-1}{}^{*}FDI\ share_{jt-1}$	0.284***	0.204***	0.445***			
	(0.036)	(0.043)	(0.065)			
$CATCH_{ijt-1}$	0.259***	0.279***	0.233***			
	(0.003)	(0.004)	(0.003)			
$GAP_{ijt-1}{}^{*}FDI\ share_{jt-1}$				−0.436***	−0.378***	−0.493***
				(0.065)	(0.074)	(0.112)
$\Delta MKTshare_{ijt}$	5.340***	8.946***	3.738***	5.977***	11.056***	3.494***
	(0.742)	(1.459)	(0.658)	(0.896)	(1.891)	(0.724)
Observations	128,845	63,554	65,291	128,845	63,554	65,291
F statistic	537.4	590.1	395.6	114.1	105.2	116
R-squared	0.49	0.496	0.491	0.346	0.338	0.367

Source: Extracted from Ito (2012), Table 4.2
Notes: Firm-fixed effects are controlled for. Year and industry dummies are included. Heteroscedasticity-robust standard errors are in parentheses with ***, **, and * indicating significance at the 1%, 5%, and 10% level respectively
Dependent variable: TFP growth (from $t-1$ to t)

have found a significant correlation between firm productivity and foreign entry, changes in the presence of foreign firms may be endogenous to shocks to firm productivity. Moreover, it is often difficult to determine the direction of causality between the presence of foreign firms and productivity. That is, foreign firms may be attracted to industries with high productivity growth. Alternatively, foreign firms may enter industries with low productivity growth to reap greater gains from their competitive advantages. Several previous empirical studies address these issues, for example, by employing an instrumental variable (IV) regression approach (e.g., Haskel et al. 2007; Aghion et al. 2009; Vahter 2011) and/or by employing longer time lags (e.g., Haskel et al. 2007). Because suitable instruments are not readily available, I use longer time lags to check the robustness of the results.[22]

[22]Possible candidates for an instrument may include inward FDI in the US or indicators of regulation. However, there are several difficulties in employing these variables as instruments. For example, inward FDI in the US is not highly correlated with inward FDI in Japan, implying that the inward FDI in the US may not work well as an instrument. In addition, although an instrumental variable should be correlated with foreign entry but not with the productivity of domestic firms, it is difficult to find a proxy for regulations that only affect foreign entry and

Table 11.3 Estimation results (3-year lagged)

(a) Estimation results for Eq. (11.1) using the 3-year lagged variables						
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
	TFP growth (from $t-3$ to t)			Labor productivity growth (from $t-3$ to t)		
	All	Mfg.	Services	All	Mfg.	Services
$FDI\ share_{jt-3}$	-0.512^{***}	-0.207^{**}	-0.896^{***}	-0.201^{***}	0.101	-0.399^{***}
	−0.069	−0.092	−0.095	−0.069	−0.091	−0.098
(b) Estimation results for Eq. (11.1) using the 3-year lagged variables						
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
	All	Mfg.	Services	All	Mfg.	Services
$FDI\ share_{jt-3}$	-0.640^{***}	-0.343^{***}	-1.226^{***}	-0.696^{***}	-0.306^{*}	-1.135^{***}
	−0.067	−0.088	−0.105	−0.158	−0.184	−0.225
$CATCH_{ijt-3}{}^{*}FDI\ share_{jt-3}$	0.656^{***}	0.539^{***}	0.951^{***}			
	−0.059	−0.069	−0.105			
$GAP_{ijt-3}{}^{*}FDI\ share_{jt-3}$				0.107	0.054	0.156
				−0.103	−0.117	−0.139

Source: Extracted from Ito (2012), Table 4.3
Note: Firm-fixed effects are controlled for. Year and industry dummies are included. Heteroscedasticity-robust standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level respectively
Dependent variable: $\ln TFP_{ijt} - \ln TFP_{ijt-3}$

In the baseline estimation and the modified estimations presented above, 1-year lagged values of the variables representing foreign presence are used instead of contemporaneous values to address the endogeneity issue. However, for robustness checks, the same models (Eqs. 11.1, 11.2, and 11.3) using a longer time lag are estimated to consider the possibility that foreign presence may be correlated with productivity shocks in the near future. Moreover, longer lags may be more appropriate if spillovers take time to materialize. The baseline results when taking 3-year differences in productivity and using 3-year lagged values for foreign presence are presented in Table 11.3. The modified specifications are also estimated with 3-year differences and lagged values, and the results are shown in Panel (b) of Table 11.3. To conserve space, the estimated coefficients of the inward FDI variable and its interaction terms only are shown in the table.[23]

The results in Table 11.3 are similar to those in Table 11.1, confirming that FDI spillover effects are negative once firm-fixed effects are controlled for. Columns (i) to (iii) in Panel (b) of Table 11.3 show that the estimated coefficients of the inward FDI variable and its interaction term with the catch-up firm dummy are significantly

do not affect productivity of domestic firms. Nevertheless, although employing an IV approach presents considerable difficulties, doing so in the future would be worthwhile.

[23]Panel (b) of Table 11.3 shows only the estimation results using TFP as a productivity measure. I obtained similar results when using labor productivity as a productivity measure.

negative and significantly positive, respectively. Although the estimated signs are consistent with those in columns (i) to (iii) in Table 11.2, the results in columns (i) to (iii) in Panel (b) of Table 11.3 suggest that catch-up firms enjoy positive FDI spillovers except in the case of the service sector (the sum of coefficients of the stand-alone inward FDI variable and its interaction with the catch-up firm dummy is positive in columns (i) and (ii)).

On the other hand, for technological distance and FDI effects, the results in Table 11.3 are not consistent with those in Table 11.2. Columns (iv) to (vi) in Panel (b) of Table 11.3 show that the estimated coefficients of the stand-alone inward FDI variable are negative while the coefficients of its interaction term with the technological distance variable are not statistically significant. In columns (iv) to (vi) in Panel (b) of Table 11.3, the overall effects of foreign presence are still negative.

Finally, as another robustness check, I examine whether the results depend on how foreign-owned firms are defined because this is not straightforward. In the analyses so far, foreign-owned firms were defined as firms with 33.4% or more foreign ownership following the official Japanese government definition and, therefore, firms in which foreign portfolio investment exceeds this threshold are included as foreign-owned firms.[24] To exclude such cases, Eqs. (11.1) to (11.2), (11.3) are estimated using a new *FDIshare* variable, which is calculated based on the majority ownership definition (50% or more foreign ownership).[25] Although the results using the 1-year lag variables are largely consistent with those in Tables 11.1 and 11.2, the results using the 3-year lag variables suggest positive spillover effects as shown in Table 11.4. Panel (b) of Table 11.4 also suggests that catch-up firms are likely to enjoy positive spillovers from majority-owned foreign firms in the same industry in the long run. In fact, Merlevede et al. (2014) suggest that local firms are likely to experience a positive effect from majority foreign-owned firms' presence for longer while foreign entry initially negatively affects local competitors' productivity. Although further investigations on the differential effects of foreign entry over time are required, the results in Table 11.4 are broadly consistent with the findings by Merlevede et al. (2014).

[24]Note that, in Japan (as in many other countries), a substantial share of the stocks issued by listed firms is owned by foreign institutional investors in the form of portfolio investments.

[25]Definitions of foreign-owned firms in official statistics vary across countries. For example, in the US, foreign-owned firms are defined as firms with 10% or more ownership by a single foreigner or foreign firm while, in Japan, foreign-owned firms are defined as firms with 33.4% or more ownership by one or more foreigners. In some countries, firms are considered foreign-owned with any foreign ownership share or with ownership shares of at least 5% or 10%. However, the majority ownership definition is employed worldwide.

Table 11.4 Estimation results (3-year lagged, majority-owned foreign firms)

(a) Estimation results for Eq. (11.1) using the 3-year lagged variables						
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
	TFP growth (from $t-3$ to t)			Labor productivity growth (from $t-3$ to t)		
	All	Mfg.	Services	All	Mfg.	Services
$FDI\ share_{jt-3}$	0.338***	0.680***	0.029	0.614***	0.707***	0.402***
	−0.114	−0.197	−0.127	−0.117	−0.193	−0.138
(b) Estimation results for Eq. (11.1) using the 3-year lagged variables						
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
	All	Mfg.	Services	All	Mfg.	Services
$FDI\ share_{jt-3}$	−0.08	0.243	−0.272**	0.459***	0.679***	0.801***
	−0.112	−0.18	−0.137	−0.126	−0.196	−0.148
$CATCH_{ijt-3}{}^{*}FDI\ share_{jt-3}$	0.642***	0.944***	0.547***			
	−0.105	−0.188	−0.122			
$GAP_{ijt-3}{}^{*}FDI\ share_{jt-3}$				−0.172***	−0.046	−0.594***
				−0.059	−0.068	−0.072

Source: Extracted from Ito (2012), Appendix Table 4
Note: Firm-fixed effects are controlled for. Year and industry dummies are included. Heteroscedasticity-robust standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level respectively
Dependent variable: $\ln TFP_{ijt} - \ln TFP_{ijt-3}$

11.4.4 Further Discussion and Interpretation of the Results

The analysis in this chapter suggests that FDI spillover effects on the productivity growth of domestically owned firms are negative in most cases. Negative FDI spillovers are possible when the presence of foreign-owned firms causes significant losses in the market shares of domestically owned firms and prevents the latter from operating on an efficient scale. The analysis here, however, indicates that FDI spillovers are negative even after controlling for changes in market shares. Possible explanations include the following. First, an increase in the presence of foreign-owned firms may increase demand for highly skilled workers and reduce the ability of domestically owned firms to attract highly skilled workers. Thus, the quality of labor at domestically owned firms may decline, and their productivity growth may deteriorate. Second, competition with foreign-owned firms may promote product diversification and/or product switching in domestically owned firms. Firms must often adjust their production inputs according to product switching, which is likely to lower productivity growth in domestically owned firms at least in the short run. Third, domestically owned firms may react to greater competition with excessive levels of investment to retain their market share, resulting in lower productivity. The results suggest that negative FDI spillover effects are particularly large in the case of service sector firms. If firms facing greater competition increase investment in, for example, information and communications technology (ICT) and job training for workers to improve the quality of services, their productivity level should, in theory, also improve. However, such efforts possibly result in excess quality and lower productivity. Moreover, it is difficult to measure service quality and to calculate productivity reflecting quality changes.[26]

While the results suggest that the overall spillover effects of inward FDI are negative, the negative effect tends to be smaller for firms with high productivity growth. In a longer period (3-year time lag), firms with high productivity growth are likely to experience positive spillover effects from inward FDI. This suggests that in the long run, the presence of foreign competitors may be favorable for such firms and help them to further improve their productivity. Moreover, some of the estimation results indicate that foreign entry may accelerate productivity growth for firms lagging behind the technological frontier in the long run, suggesting that learning effects from advanced foreign-owned firms do exist. If foreign entry accelerates productivity catch-up, then it is likely to contribute to long-run economic growth by affecting firm dynamics. However, it should be noted that the overall effect of inward FDI is still negative, and it is thus necessary to examine what factors contribute to positive FDI spillovers.

Finally, although foreign entry does not have a positive effect on domestically owned firms' productivity growth, it may nevertheless affect their behavior. Vahter (2011), analyzing Estonian firm-level data employing a specification à la Aghion et al. (2009), concluded that although FDI entry does not have a significant short-term effect on productivity growth, it is positively associated with process innovation in domestically owned firms. For Japanese firms, Todo (2006) found a positive association between the R&D stock of foreign-owned firms and the productivity of domestically owned firms while there was no such association for capital stock of foreign-owned firms, which implies that foreign-owned firms' knowledge spills over through their R&D activities. These results indicate that FDI spillovers are closely associated with knowledge flows to domestically owned firms, and positive FDI spillovers may be seen explicitly by focusing on knowledge flows instead of foreign penetration in terms of employment or sales. Although knowledge flows from foreign-owned to domestically owned firms are an interesting subject for future research, defining knowledge flows is difficult for the service sector.

11.5 Conclusion

This chapter examined the FDI spillover effects on the productivity growth of domestic firms using a large-scale Japanese firm-level dataset that includes a number of service sector firms. The analysis was motivated by the fact that although FDI in the service sector is a potentially important channel of international technology

[26]For a more detailed discussion on the complexity of measuring productivity in services, see, for example, Hartwig (2008) and Inklaar et al. (2008).

diffusion—particularly given that services are often difficult to trade—there is a lack of empirical research on the effects of such FDI. However, such research is essential for a better understanding of FDI spillovers and the formulation of economic and industrial policies.

The analysis found no strong evidence of positive FDI spillover effects on the productivity growth of domestically owned firms. In fact, the results suggest that the presence of foreign-owned firms in the same industry tends to be negatively associated with the productivity growth of domestically owned firms both in the manufacturing and service sectors. However, the magnitude of the negative effect is larger in the case of the service sector, implying that FDI spillover effects are heterogeneous across sectors and depend on the characteristics of sectors. Various possible sources for the heterogeneity were discussed, and these sources deserve further scrutiny in future research.

While the results suggest that the overall spillover effects of FDI are negative, the negative effects tend to be smaller for firms with high productivity growth. In the long run, productivity growth of such high-growth firms and the share of foreign-owned firms are positively correlated. This finding implies that the spillover effects of inward FDI differ across firms, and that policymakers should take such heterogeneous effects into account when they devise inward FDI promotion policies for domestic productivity improvement. For example, deregulation or policy supports for firms with high productivity potential may be effective by encouraging them to compete with foreign-owned firms with advanced technology and know-how. On the other hand, although the results are not sufficiently robust, firms lagging behind the technological frontier are more likely to see an improvement in productivity through learning from foreign-owned firms. The results suggest that to raise industry or macro-level productivity growth, a policy scheme to encourage less-productive firms to improve their productivity should be introduced along with the promotion of inward FDI. These results imply that foreign entry possibly contributes to long-run economic growth by affecting firm dynamics. However, the overall effect of inward FDI is still negative, and further investigation on the factors that lead to positive FDI spillovers is desirable.

Finally, this chapter focuses on FDI spillover within the same industry, and examining the role of inter-industry linkages is beyond the scope of this study. However, previous studies such as Javorcik (2004), Javorcik and Spatareanu (2011), and Barrios et al. (2011) suggested that inter-industry transaction relationships among firms are important channels of technology diffusion. In fact, Iwasaki (2013) found a positive FDI spillover effect through forward inter-industry linkages in the case of Japanese manufacturing firms: the presence of foreign-owned firms in upstream industries tends to have a positive impact on productivity of domestic firms in downstream industries. This is an interesting finding and deserves further investigation, particularly for the service sector. The service sector has a higher value-added-to-output ratio than the manufacturing sector and uses less intermediate inputs than the manufacturing sector, suggesting that it has fewer inter-industry transaction relationships.[27] Moreover, a large part of total demand in the service sector is final demand while in the manufacturing sector it is intermediate demand.[28] These relatively limited forward and backward linkages with other firms may prevent service sector firms from absorbing advanced technology or know-how from foreign-owned firms. Given various data constraints for services firms,[29] rigorous analysis of spillover effects through inter-industry linkages is not straightforward. However, further investigation focusing on service firms would be worthwhile.

Appendix: Variable Construction and Data Sources

Output Except for the commerce sector, gross output is defined as firms' total sales. For the commerce sector, gross output is measured as sales minus expenses for purchased materials. Gross output is deflated by the output deflator taken from the JIP Database 2009 for years 2000–2006. For 2007, the output deflator was extrapolated using the growth rate of various price indexes from 2006 to 2007 published by the Bank of Japan. The output price index was used for manufacturing industries, and the corporate service price index was used for service industries.

Intermediate Inputs For the commerce sector, intermediate inputs are calculated as (Cost of sales + Operating costs) − (Wages + Depreciation costs + Expenses for purchased materials). The intermediate inputs of other sectors are defined as (Cost of sales + Operating costs) − (Wages + Depreciation costs). Intermediate inputs are deflated by the intermediate input deflator taken from the JIP Database 2009 for the years 2000–2006. For 2007, the intermediate input deflator was extrapolated using the growth rate of various price indexes from 2006 to 2007 published by the Bank of Japan. The input price index was used for manufacturing industries. For service industries, the intermediate input deflator for 2007 was calculated using the output deflator and the 2006 JIP Input-Output Table.

Labor Input Labor input is calculated as each firm's total number of workers multiplied by the sector's working hours taken from the JIP Database 2009 for the years 2000–2006. For 2007, the data on working hours by sector are extrapolated

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[27]Based on the firm-level panel data used in this study, the value-added-to-output ratio is 28% for manufacturing firms, while it is 46% for services firms. The industry-level data from the 2005 Input-Output Tables show similar figures. At the aggregated level, the gross value-added-to-domestic-output ratio is approximately 30% for the manufacturing sector and approximately 60% for the service sector.

[28]For example, according to the 2005 Input-Output Tables, the share of final demand in total demand is 44% for the manufacturing sector while the corresponding figure for the service sector is 58%.

[29]For example, as mentioned above, BSJBSA only covers firms in sectors administrated by METI and does not cover firms in many other service sectors.

Table 11.5 List of industries

	JIP2006
1–48 All industries	1–108
1–30 Manufacturing	8–59
1 Food products and beverages	8–13
2 Textiles	15
3 Lumber and wood products	16, 17
4 Pulp, paper, and paper products	18–19
5 Printing	20
6 Chemicals and chemical fibers	23–27
7 Paint, coating, and grease	28
8 Pharmaceutical products	29
9 Miscellaneous chemical products	28
10 Petroleum and coal products	30, 31
11 Plastic products	58
12 Rubber products	22
13 Ceramic, stone and clay products	32–35
14 Iron and steel	36, 37
15 Non-ferrous metals	38, 39
16 Fabricated metal products	40, 41
17 Metal processing machinery	42
18 Special industry machinery	43
19 Office and service industry machines	45
20 Miscellaneous machinery	44
21 Electrical machinery and apparatus	46
22 Household electric appliances	47
23 Communication equipment	49
24 Computer and electronic equipment	48, 50
25 Electronic parts and devices	51, 52
26 Miscellaneous electrical machinery	53
27 Motor vehicles and parts	54, 55
28 Other transportation equipment	56
29 Precision machinery	57
30 Miscellaneous mfg. industries	21, 59
33–48 Services	60–107
33 Construction	60
34 Electricity, gas, and water supply	62,63,64
35 Transport and storage	74, 77
36 Telecommunications and broadcasting	78,79,90
37 Wholesale trade	67
3701 General merchandise	
3702 Textile products	
3703 Apparel accessories and notions	

(continued)

Table 11.5 (continued)

	JIP2006
3704 Agricultural, animal and poultry farm and aquatic products	
3705 Food and beverages	
3706 Building materials	
3707 Chemicals and related products	
3708 Minerals and metals	
3709 General machinery and equipment	
3710 Motor vehicles	
3711 Electrical machinery	
3712 Miscellaneous machinery and equipment	
3713 Fixtures and house furnishings	
3714 Drugs and toiletries	
3715 Other products	
38 Retail trade	68
3801 General merchandise	
3802 Dry goods, apparel, and apparel accessories	
3803 Food and beverages	
3804 Motor vehicles and bicycles	
3805 Furniture, fixture, and household utensil	
3806 Appliance stores	
3807 Drugs and toiletry stores	
3808 Fuel stores	
3809 Stores, n.e.c.	
39 Financial intermediation and real estate	69, 71
40 Advertising	85
41 Rental of office equipment and goods	86
42 Other business services	87, 88
43 Entertainment	89
44 Information services	91, 92, 93
4401 Information services and internet-based services	91
4402 Computer programming	91
4403 Motion pictures	92, 93
45 Eating and drinking places	94
46 Accommodation	95
47 Personal services	96, 97
48 Services, n.e.c.	66, 80, 81, 82, 84
31 Agriculture, hunting, forestry, and fishing	1, 2, 5, 6
32 Mining and quarrying	7

Table 11.6 Number of observations by industry and year

									(Number of firms)
		2000	2001	2002	2003	2004	2005	2006	2007	2000–07 average
1–48	All industries	23,324	23,803	23,308	22,607	23,995	23,549	23,703	24,738	23,628
1–30	Manufacturing	11,478	11,478	11,225	10,815	11,502	11,315	11,161	11,661	11,329
33–48	Services	11,782	12,258	12,024	11,738	12,447	12,185	12,494	13,031	12,245
33	Construction	348	430	416	372	401	369	390	320	381
34	Electricity, gas, and water supply	103	101	103	105	113	109	111	121	108
35	Transport and storage	57	116	123	127	139	110	129	104	113
36	Telecommunications and broadcasting	12	22	29	51	58	61	76	57	46
37	Wholesale trade	5268	5163	5006	4816	4961	4844	4714	4849	4953
38	Retail trade	2906	3014	2882	2783	2959	2940	2874	2995	2919
39	Financial intermediation and real estate	114	129	124	123	129	131	124	129	125
40	Advertising	136	137	134	136	161	155	169	188	152
41	Rental of office equipment and goods	230	230	250	262	275	285	297	291	265
42	Other business services	415	531	559	626	700	750	729	814	641
43	Entertainment	428	387	355	303	300	279	315	347	339
44	Information services	1276	1360	1392	1376	1543	1478	1467	1620	1439
45	Eating and drinking places	324	394	404	402	439	406	415	472	407
46	Accommodation	23	46	47	49	49	55	54	52	47
47	Personal services	124	168	148	161	162	149	449	484	231
48	Services, n.e.c.	18	30	52	46	58	64	181	188	80
31	Agriculture, hunting, forestry, and fishing	8	13	16	16	12	16	15	13	14
32	Mining and quarrying	56	54	43	38	34	33	33	33	41

using the growth rate of working hours from 2006 to 2007 taken from the *Monthly Labor Survey* published by Ministry of Health, Labor and Welfare.

Capital Stock For capital stock, the only data available are the nominal book values of tangible fixed assets. Using these data, the net capital stock of firm i in industry j in constant 2000 prices is calculated as follows:

$$K_{it} = BV_{it} * \left(INK_{jt}/IBV_{jt}\right)$$

where BV_{it} represents the book value of firm i's tangible fixed assets in year t, INK_{jt} stands for the net capital stock of industry j in constant 2000 prices, and IBV_{jt} denotes the book value of industry j's capital. INK_{jt} is calculated as follows. First, the data on the book value of tangible fixed assets in 1975 from the Financial Statements Statistics of Corporations published by Ministry of Finance were taken as a benchmark. Then, the book value of year 1975 was converted into the real value in constant 2000 prices using the investment deflator taken from the JIP Database 2009. Second, the net capital stock of industry j, INK_{jt}, for succeeding years was calculated using the perpetual inventory method. The sectoral depreciation rate used was taken from the JIP Database 2009.

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Chapter 12
The Stagnation of Growth Momentum in Japan and Asian NIEs: From the Perspective of Foreign Direct Investment

Hsiao-Chien Tsui

Abstract Previous studies on home country effects have mainly focused on foreign direct investment (FDI) from large developed economies to other countries. However, today's super recipient is a relatively larger economy than its investors, and many of these investors are not classified as "developed economies." This article uses panel data from 1993 to 2014 to examine the effects of FDI outflows on a home country's growth and employment. The empirical results for Japan and Asian NIEs (source countries) and China (recipient country) show that FDI outflows to China lead to decreases in the relative income between the source country and China and to increases in the source country's unemployment rate. In addition, I find that FDI outflows to China decrease the exports-to-GDP ratio only for small source countries (Taiwan and Korea), even though higher investment in China raises the ratio of their exports-to-China to China's total imports.

Keywords Capital outflows • Exports • Foreign direct investment • Home country effects • Unemployment

12.1 Introduction

China implemented a policy of economic openness in the late 1970s. Although the systems related to a so-called socialist market economy had been established, there were still serious problems regarding implementation, such as inadequate funds and outdated technologies. Therefore, to solve the problem of inadequate funds, China adopted a series of policies for promoting foreign investment in order to accelerate industrialization and earn more foreign exchange through the exports of

H.-C. Tsui (✉)
Department of Economics, Chung Cheng University, 168 University Road, Ming-Hsiung, Chia-Yi 62102, Taiwan
e-mail: ecdhct@ccu.edu.tw

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foreign-funded enterprises.[1] For this reason, 10% of foreign direct investment (FDI) across the world has flowed into China since the 1990s, increasing from 40.319 billion US dollars in 1999 to 135.6 billion US dollars in 2015, showing continual and stable growth. Correspondingly, numerous studies on the relationship between FDI and the economic development of China were undertaken. Some of these have analyzed the factors responsible for the difference in the amount of FDI for China as compared to other countries (Cheng and Kwan 2000; Coughlin and Segev 2000; Hsiao and Gastañaga 2001; Sun et al. 2002), while other studies focus on the causal relationship between FDI and the economic development of China (Lall and Narula 2004; Liu 2011; Liu et al. 2002; Wei 2000).

While most of these articles argue that FDI has had positive effects on the economic development in China, only a few have studied the impacts of FDI in China on the countries from which the investment originated. According to the data (shown in the next section), in Asia, Hong Kong ranked first in terms of cumulative investment in China from 1979 to 2015, followed by Japan, Taiwan, Singapore and Korea. Except for Japan, the remaining four Asian newly industrialized economies (NIEs) are highly dependent on exports; moreover, their export-oriented mode of economic development has contributed to remarkable economic growth. However, different articles present varied views on the relationship between FDI and exports. For instance, Markusen and Venables (1998) point out a substitution relationship between FDI and exports, which means that more FDI leads to fewer exports. But Helpman (1984) believes that FDI and exports are supplementary to each other, which means that more FDI brings more exports.

As the relationship between FDI and trade is extremely complicated, no conclusion has been drawn on the relationship between the two to date. According to the study by Seo and Suh (2006) on the influence of Korea's labor-intensive industries on the ASEAN, although FDI leads to some increase in exports because of the host country's demand for product components in the short term, exports decrease in the long run because of the technological advancement of the host country. Lim and Moon (2001) believe that if production with foreign investment is done in less-developed countries, the host country will be unable to provide all the intermediate materials or equipment necessary for production, and transnational enterprises will need to import intermediate raw materials and equipment for production slated for

[1]For instance, China issued the *Law of the People's Republic of China on Chinese-Foreign Equity Joint Ventures*, *Law of the People's Republic of China on Foreign-Capital Enterprises* and the *Law of the People's Republic of China on Chinese-Foreign Equity Joint Ventures* in 1979, 1986 and 1988, respectively. All three laws are basic laws for attracting foreign investment. Additionally, the *Income Tax Law of the People's Republic of China for Foreign Enterprises*, passed in 1991, stipulates the rules for the income taxation of joint ventures, solely owned enterprises and cooperative enterprises. With foreign investment, China aimed to solve the problem of inadequate domestic funds, earn foreign exchange through export expansion, introduce international technologies, promote industrial improvement and overcome the bottlenecks in transportation, energy and raw materials.

the home country. Therefore, foreign investment would have positive effects on the exports of the home country if production is done in less-developed countries.

Most studies on capital drain concentrate on the FDI from developed countries (or economic powers), such as the American and Japanese FDI, to other countries. Theoretical models, such as Gao's (2005) significant work, provide a North-South model by which to derive endogenous FDI from the core country to the peripheral country and its growth. That study found no direct causal relationship between FDI and growth. An empirical study on industrialized countries by van Pottelsberghe de la Potterie and Lichtenberg (2001) shows that FDI transfers technology in one direction: a country's productivity is increased if it invests in foreign countries with intensive R&D.

For this reason, this chapter introduces a theoretical model which uses the FDI data of Japan, Taiwan and Korea in China from 1993 to 2015 to explore the relative differences in economic scale between the investment recipient and the investor countries and to determine the influence of FDI on the investor countries.[2] With the current economic rise of China, Japan, Taiwan and Korea, all fear that overdependence on China will result in the so-called magnet effect. This study has found that if a small economically advanced country invests its capital in a large less-developed country, the gap in salaries between the two countries starts to narrow. In other words, FDI has a negative effect on salaries in the investor country. The findings of this study should prove of some value for Asian countries working to improve their FDI policies.

12.2 The Asian Economy

Undeniably, any discussion on the Asian economy must start with China, a super recipient in the world. According to the *World Economic Outlook 2015* of the IMF, China's GDP based on PPP grew 21.4 times from 1980 to 2013, while the global GDP cumulative growth was 2.3 times during the same period. China's per capita GDP was only 193 US dollars in 1980, equivalent to the global average of 7.7%. However, China's per capita GDP increased to 6810 US dollars in 2013, a rise to the global average of 64.9%. It is well known that technology, human capital, funds and basic infrastructure are the keys to the economic advancement of less-developed countries. Foreign investors not only fulfill the need for funds, but they also transmit new technology through their production processes and management. FDI has definitely contributed to China's rapid development.[3]

[2]The theoretical model proposed by Lee et al. (2009).

[3]Many studies confirm the contribution of FDI in promoting China's growth. See Zhang (2001), Tseng and Zebregs (2002), Dayal-Gulati and Husain (2002) and Baharumshah and Thanoon (2006).

Table 12.1 China's foreign capital inflows by Japan and Asian NIEs

Asian economies	Realized amount (100 million US dollars)			
	1979–2005	2006–2010	2011–2015	1979–2015
Japan	533.75	201.99	283.32	1019.06
Korea	311.04	161.05	166.86	638.95
Taiwan	417.57	190.73	277.46	885.76
Hong Kong	2,595.22	2,104.40	4,050.12	8,749.74
Singapore	277.44	194.23	330.94	802.61
Total	4,135.02	2,852.39	5,108.70	12,096.11
Total (all econ.)	6,545.06	4,259.52	5,911.43	16,716.01
Percentage (%)	63.18	66.97	86.42	72.36
Total (Asian NIEs)	3,601.27	2,650.40	4,825.38	11,077.05
Percentage (%)	55.02	62.22	81.63	66.27

Source: Foreign Investment Administration, Ministry of Commerce, P.R.C., FDI Statistics

The *China Foreign Economic Statistical Yearbook* documents information on the origin of foreign capital. As shown in Table 12.1, the top five Asian investors of FDI stock accumulated to 2015 (sequentially from most to least) are Hong Kong, Japan, Taiwan, Singapore and Korea. Asian NIEs contribute up to 66% of the inward capital in China, with Hong Kong alone providing 52%. If we calculate the FDI inflows to China in relation to the home country's GDP ratio for an individual economy, the statistics are even more impressive. Since 1990, the average ratio is slightly more than 0.1% for Japan, 0.5% for Korea, 1% for Taiwan, 2.5% for Singapore and 11% for Hong Kong. It is surprising that Asian NIEs invest so much more abroad than Japan does.

12.2.1 Asian NIEs: Small but Rich Source Countries

After the fast economic growth of the past 40 years, rich Asian NIEs now have sufficient wealth to invest abroad. The "economic miracle" of Asian NIEs is attested by their economic growth rates. Table 12.2 presents Asian NIEs' 5-year average economic growth rates, as compared to that of Japan. Obviously, the growth performance of the benchmark country, the USA, pales beside the Asian economies in the past half century, while the leader of flying geese, Japan, has given way to Asian NIEs since the 1970s. The other noticeable common feature in Table 12.2 is the decrease in the growth rate of Asian economies in the mid-1980s when China opened its markets.

Concurrent with their high economic growth, the Asian NIEs' economic miracle is distinguished by low levels of unemployment and national income equality. Table 12.3 presents the unemployment rates of the Asian NIEs, Japan and the

Table 12.2 The USA, Japan and Asian NIEs' economic growth rates (%)

	Japan	Korea	Taiwan	Hong Kong	Singapore	US
1951–1955	6.69	2.25[a]	6.03[b]	–	–	2.91
1956–1960	7.03	0.42	3.05	–	–	0.44
1961–1965	8.26	3.12	6.44	10.96	1.57	3.62
1966–1970	10.49	7.88	7.14	5.14	8.61	2.33
1971–1975	3.12	5.73	6.92	4.47	6.51	1.83
1976–1980	3.35	5.82	8.33	9.04	6.83	2.65
1981–1985	2.36	6.35	5.23	4.21	2.41	2.45
1986–1990	4.43	9.15	8.08	6.85	5.97	2.16
1991–1995	1.12	6.72	6.11	3.72	5.54	1.52
1996–2000	0.95	3.65	4.80	1.11	2.95	3.25
2001–2005	0.69	4.25	4.07	3.81	3.77	1.21
2006–2010	0.36	3.59	4.38	3.35	3.27	0.46
2011–2015	0.79	2.47	2.53	2.11	2.19	2.42
Average	3.22	5.21	5.32	4.79	4.04	1.65

Source: RGDPL in Penn World Table 6.2, WDI Database Archives (beta) and National Statistics, R.O.C. (Taiwan)
Note: Statistics are five-year average of growth rates of constant price GDP per capita
[a] 1954–1955
[b] 1952–1955

Table 12.3 Japan and Asian NIEs' unemployment rates (%)

	Japan	Korea	Taiwan	Hong Kong	Singapore	US
1966–1970	1.10[a]	4.65[a]	2.21	–	6.00[b]	4.10[a]
1971–1975	1.44	4.24	1.68	9.10[c]	4.50	5.98
1976–1980	2.06	3.98	1.55	3.76	3.68	6.66
1981–1985	2.50	4.16	2.31	2.66	3.16	8.26
1986–1990	2.50	2.88	1.91	2.68	3.48	5.92
1991–1995	2.58	2.38	1.56	2.54	2.26	6.58
1996–2000	4.06	4.42	2.78	3.98	3.04	4.60
2001–2005	4.96	3.66	4.66	4.82	4.44	5.44
2006–2010	4.38	3.44	4.60	4.30	3.44	6.78
2011–2015	3.32	3.38	4.11	3.86	2.70	7.14
Average	2.89	3.72	2.74	4.19	3.67	6.15

Source: International Labour Organization (Japan, Hong Kong, Korea, Singapore and the US), Directorate General of Budget, Accounting and Statistics, Executive Yuan, R.O.C. (Taiwan)
Note: Statistics are five-year average of unemployment rates
[a] 1969–1970
[b] 1970
[c] 1975

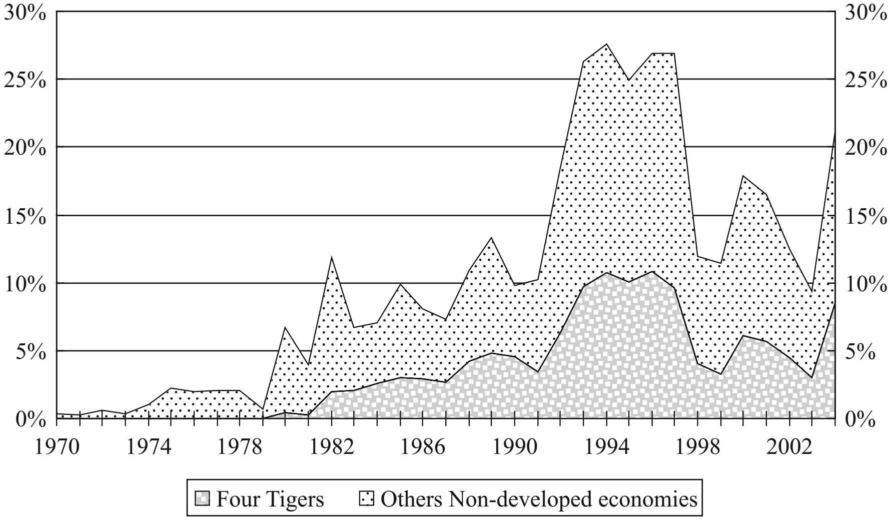

Fig. 12.1 Capital outflows shares of the Asian NIEs and other non-developed economies. Notes: The United Nations includes Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Gibraltar, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Malta, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, the UK, and the USA as developed economies. This article defines all economies not included in the developed countries group, but included in developing countries group and South-East Europe and CIS group in the United Nations classification, as non-developed economies (Source: Preliminary data are from UNCTAD, FDI Database on-line)

USA as a benchmark. It shows the Asian economies' unemployment rates to be significantly lower than that of the USA, even though the latter's rate is much less than those of European industrialized countries. However, as with the eventual turnaround of income growth for the five Asian economies, there has been a trend of increasing unemployment rates in these economies since the mid-1980s.

Figure 12.1 shows the FDI outflows relative to the world for Asian NIEs and other developing countries. From this figure, we can see that capital outflows mainly come from developed countries. Non-developed economies contributed roughly 10% of FDI outflows in the 1980s, which rose to 20% before falling back significantly in the 1990s. Of some 150 non-developed countries, Asian NIEs alone have provided more than 40% of FDI outflows since 1990. An analysis of the data finds that Hong Kong is the number one economy for capital outflows, followed by Singapore, Taiwan and Korea.

Since Asian NIEs are relatively small economies, the amounts of their FDI outflows are remarkable. Table 12.4 presents the 5-year averages of their per capita FDI outflows and their FDI outflows compared to GDP ratios. The amount of Asian NIEs' per capita FDI outflow from highest to lowest is Hong Kong, Singapore, Taiwan and Korea, which is consistent with the importance of their financial service

Table 12.4 Per capita FDI outflows and outward FDI/GDP of Japan and Asian NIEs (5-year average)

		Japan	Korea	Taiwan	Hong Kong	Singapore
1980– 1984	US$ %	36.30 0.36	2.07 0.11	2.46 0.09	67.62 1.14	41.82 0.70
1985–1989		202.14 0.94	17.19 0.56	119.54 1.78	356.23 3.80	113.34 1.34
1990–1994		214.44 0.73	34.20 0.46	140.78 1.52	1761.33 9.13	654.36 3.91
1995–1999		190.29 0.53	94.39 1.02	187.67 1.45	3,535.30 14.20	1,885.32 7.86
2000–2004		256.56 0.75	77.28 0.71	266.44 1.96	3,940.89 14.28	2,233.49 10.28
2005–2009		585.20 1.59	336.66 1.61	355.04 2.04	6,999.22 23.58	4,220.65 12.02
2012–2014		843.25 2.03	02.23 2.38	553.98 2.61	13,669.65 37.44	5,367.73 10.37
Average		332.60 0.99	170.34 0.95	232.84 1.60	4,362.57 15.10	2,083.47 6.49

Source: Preliminary data are from UNCTAD, FDI Database on-line

for China. The statistics in Table 12.4 also show that Hong Kong spends more than 10% of its output on outward FDI, Singapore close to 10%, Taiwan 1.5% and Korea less than 1% in FDI outflows.[4] In fact, most Asian NIE FDI flows into China.

12.2.2 *Make the Most from China or by China?*

As we look to the future of the world's economies, no one should ignore China's contribution. Figure 12.2 shows China's share of the world's total trade. The dramatic increase of China in the world commodity market signals its growing importance. Poor economies cannot afford large R&D expenditures on original inventions and innovations; instead, technological progress and economic growth are achieved through the diffusion and transfer of technology. In its strictest form, the gravity equation says that trade between two countries is proportional to the product of their outputs, and inversely related to the distance between them. Undeniably, the rise of China's competitiveness in manufacturing products presents

[4]In addition, the FDI outflows/GDP ratios are three to four times higher in Hong Kong than in Canada, and about two times higher in Singapore than in Canada. Taiwan's FDI outflow/GDP ratio remains at Canada's 1990 average level. Thus far, Korea's FDI outflow/GDP ratio is still below 1%.

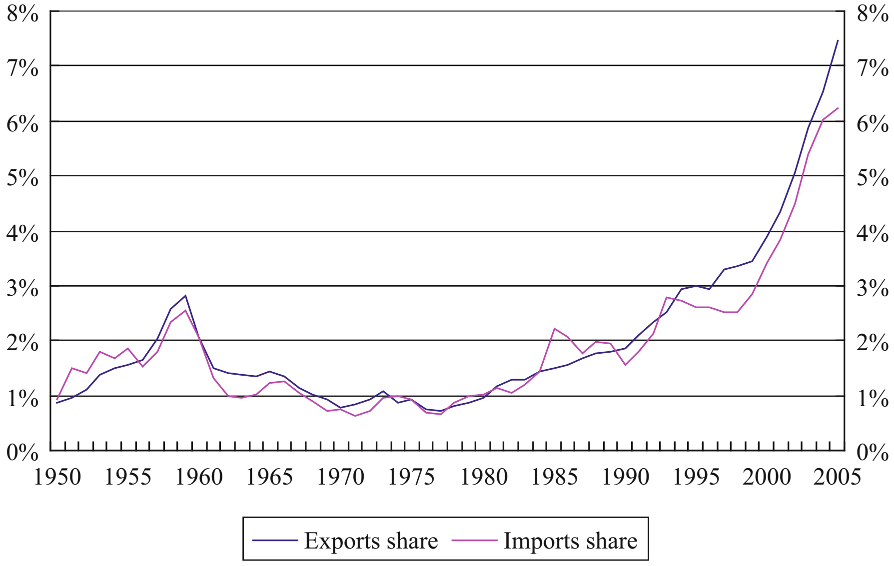

Fig. 12.2 China's shares of the world's total trade (Source: IMF, International Financial Statistics)

a challenge to all other countries, whereas the expanding Chinese market is an opportunity for them; their future success will undoubtedly depend on how well they respond to the challenge and take advantage of that opportunity.

The Asian economies' overwhelming outward FDI to China has attracted much attention. Hsiao and Hsiao (2004) suggest that there are some qualitative unobservable variables, such as cultural similarity and ethnicity, economic policy, political factors, potential crises, etc., which play prominent roles in determining FDI to China. Conceivably, cultural similarity and ethnicity have a positive effect on FDI inflows from Hong Kong and Taiwan and to a lesser extent from Korea and Japan. In addition, favorable economic policies and political measures encourage FDI inflows. Detractive factors, such as massive corruption, huge national debt, fragile banking systems, etc., have negative effects on FDI inflows. Hsiao and Hsiao (2004) found that, according to their panel data regression, Hong Kong, Taiwan, Korea and Japan, in that order, have smaller negative fixed effects than the USA does because the USA, and to a lesser degree Japan, is unable to take full advantage of cultural similarity and ethnicity.

In contrast with China's dramatic growth, growth in Korea, Singapore and Taiwan was slower in the 1990s than in the 1980s. Partly due to structural changes in these countries' economies, the average growth rate of relative per-capita GDP of Asian NIEs compared to China has declined since the beginning of the 1980s. The relative GDP per capita in terms of current PPP for these economies and Japan, as displayed in Fig. 12.3, shows the procurement by China. It can be seen that Asian NIEs' per capita GDP measures continued to increase relative to China's

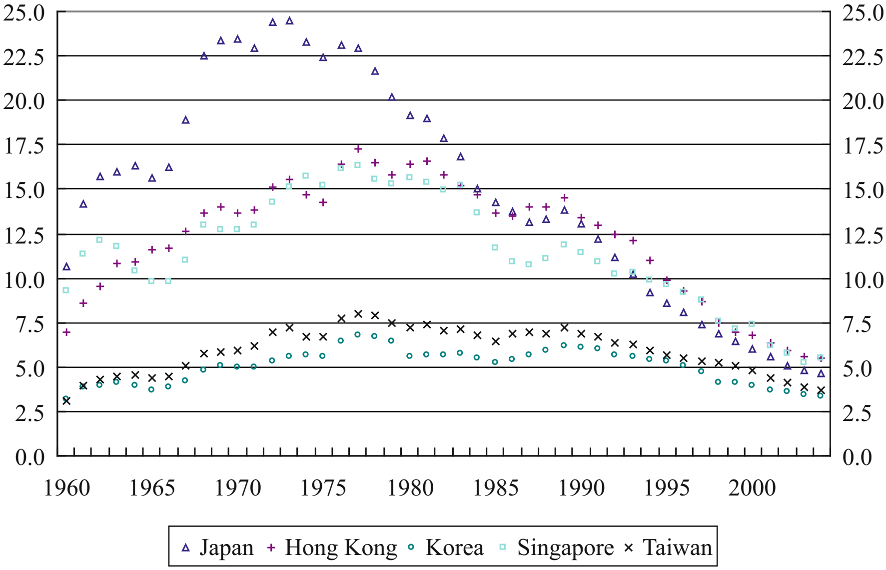

Fig. 12.3 China's procurement effect on Japan and Asian NIEs-the relative GDP of Japan and Asian NIEs to China (Source: Penn World Table 6.2. The relative GDP means the real GDP per capita (CGDP) of a target economy divided by that of China)

until the late 1970s, decreased before the beginning of the 1980s and reached their historic lowest points at the end of the statistics. The decreasing trend of the relative GDP of Japan to China came earlier than those of Asian NIEs, which may be due to the slowdown in technological progress in the mid-1970s in Japan. The GDP ratio dropped from 24.5 times (in 1973) to 4.6 times for Japan, 17.3 (in 1977) to 5.5 for Hong Kong, 16.3 (in 1977) to 5.5 times for Singapore, 8 (in 1977) to 3.7 for Taiwan and 6.8 times (in 1977) to 3.5 for Korea. Interestingly, this swing and China's marketization occurred simultaneously.[5]

12.3 The Model

Unlike the traditional economic model that focuses on FDIs from developed and/or large economies, this article uses an economic model to describe the evolution of domestic employment in a small economy which invests in a large economy, as well as the income disparity between the small economy and its big recipient. Herein, the small economy is relatively small compared to the larger one, and its output production and labor hiring in the large economy have no direct effects on the larger

[5]For the same period, Canada's relative GDP to the USA stayed between 0.7 and 0.9. In 2004, the ratio was 0.8, back to the 1960s level, and roughly equal to the average of the sample.

economy's market prices. Since the aim here is to investigate the small economy's home country effects of FDI outflow on the larger economy, the premise is that there is no relationship between the foreign factor prices and the FDI inflow from the domestic economy. A detailed description of this model can be found in my other article, Lee et al. (2009). However, for the ease of readers, the model is described briefly below.

Assume a Cobb-Douglas production technology with capital stock and labor being its two input factors, and an externality of capital accumulation for the representative firms as:

$$Y_t^i = A_t^i\left(K_t^i\right)^{\alpha}\left(\overline{K}_t^i N_t^i\right)^{1-\alpha}, \qquad i = d,\ f, \tag{12.1}$$

where term Y_t^i denotes products of the representative firm in country i; K_t^i and N_t^i are firm's capital input and labor input in production, respectively; A_t^i is the stationary technological parameter in the production function; $\overline{K}_t^i$ is the average capacity augmenting labor productivity; and d and f refer to a domestic country and a foreign one, respectively.

The Ak-type setup has several advantages: first, the production function admits sustainable economic growth and allows us to easily derive the growth rate; second, it allows a simple assumption on parameters to capture different growth rates; and third, it simplifies the derivation of optimal employment and the change in economic disparity between a capital recipient country and the home country. The parameter of technology level A_t^i is assumed to be stationary and with a constant mean, which, compared to a domestic country, is higher in an advanced country and lower in a less-developed country. Assume further that once a less-developed economy invests in, or gets investment from, a more developed economy, its technology gradually increases to a higher level, as in the more developed economy, through knowledge spillover and imitation. The influence of FDI flowing through technology transfers can be interpreted as indirect effects on human capital, but direct effects on physical capital. On the contrary, investment in or from a less-developed economy does not change the technological level of the home economy.

In the case of a foreign country being "advanced," $f = a$, and in the case of it being "less developed," $f = l$. Assume that the technological level (A_t^i) is sufficiently distinct, so that the interest rate and wage are highest to lowest, respectively, in the advanced country, domestic country and the less-developed one before their openness to the foreign capital market.[6] The ranking of the factor prices means $r_0^a > r_0^d > r_0^l$ and $w_0^a > w_0^d > w_0^l$, in which interest rate $r_0^i = \alpha A_0^i\left(N_0^i\right)^{1-\alpha}$ and wage rate $w_0^i = (1-\alpha)A_0^i K_0^i\left(N_0^i\right)^{-\alpha}$ with $i = a,\ d,$ and l.

[6]Note that the marginal productivity of input factors depends not only on A, but also on factor inputs and parameters. Here I simply assume that the difference between domestic inputs/parameters and foreign inputs/parameters is relatively insignificant.

Upon being open to the foreign capital market, domestic firms can invest either in a more advanced or in a less-developed country and earn profit from its production as:

$$A_t^d\left(k_t^f\right)^{\alpha}\left(\overline{K}_t^f n_t^f\right)^{1-\alpha} - w_t^f n_t^f, \qquad f = a \ \text{or} \quad l, \tag{12.2}$$

where n_t^f and k_t^f denote the home firm's own capital input and local labor input in production abroad. Note that the profit function comes from the assumptions that labor is immobile across borders, the factor share is the same for a domestic firm and a foreign firm in one economy and know-how is (at least temporarily) private. The first and third assumptions appear to be relatively natural, while the second is made for factoring in the restrictions faced by FDI firms. Re-define K_t^d as the capital stock located in the domestic country. Assume that, given the initial stock of capital, the domestic representative firm chooses N_t^d, n_t^f, K_t^d and k_t^f to maximize its total profits (from foreign and domestic production).

The first order condition for n_t^f reflects the marginal productivity of labor of the FDI firms being equal to its cost in the invested economy, which in turn is equal to the marginal productivity of labor of local firms in the recipient country. Thus, the relationship is easy to derive:

$$n_t^f = \overline{N}_t^f\left(\frac{A_t^d}{A_t^f}\right)^{1/\alpha}\left(\frac{k_t^f}{\overline{K}_t^f}\right), \tag{12.3}$$

where $\overline{N}_t^f$ is the equilibrium labor employed by the foreign representative firm.

In the case where the foreign country is a less-developed country ($f = l$), because of the higher technology level of the domestic country, FDI firms tend to hire more labor than typical local firms, and/or if both FDI firms and local firms hire the same amount of labor, to earn maximum profit, FDI firms can install less capital stock than local firms. Conversely, in the case where the foreign country is more advanced ($f = a$), FDI firms tend to hire less labor than local firms do, and/or if both FDI firms and local firms hire the same amount of labor, FDI firms must install more capital stock than local firms do to earn maximum profit. Since individual firms take technology levels as exogenous variables, immediate profits obtained with lower factor costs become their main concern. From this view, it is much easier for firms to invest and produce in a less-developed foreign country than in a more advanced one, even though we know that direct investment in a more advanced economy is helpful for the long-term development of the home country.

The first order condition for optimal distribution of capital stock shows that to maximize total profits, the marginal productivity of capital across national borders must be equal. Together with the optimal n_t^f in Eq. (12.3), I have the optimal labor demand in the domestic economy presented as:

$$N_t^d = \overline{N}_t^f\left(\frac{A_t^d}{A_t^f}\right)^{1/\alpha}. \tag{12.4}$$

One important implication in Eq. (12.4) is that there is a positive relationship between the ratio of domestic to foreign technology and domestic employment. If there is a "cost down" investment policy and firms choose to invest in the less-developed large country, domestic prosperity, in terms of high employment, high marginal productivity of capital and high investment, spikes in the beginning of capital outflows, but drops as the recipient country's technology level increases and the technology gap between the two countries narrows. Conversely, if the firm's policy is to invest in an advanced, large country, domestic employment and marginal productivity of capital gradually rise as the domestic country's technology level increases and the technology gap between the two countries narrows.

Since the GDP growth rate depends positively on the marginal productivity of capital stock, $\alpha A_t^i \left(N_t^i\right)^{1-\alpha}$, the domestic rate is, in turn, dependent upon $\alpha \left(A_t^d\right)^{1/\alpha} \left(\overline{N}_t^f\right)^{1-\alpha} \left(A_t^f\right)^{-(1-\alpha)/\alpha}$ and the foreign rate on $\alpha A_t^f \left(\overline{N}_t^f\right)^{1-\alpha}$. This shows that FDI to a more advanced country decreases the gap in income through stimulating domestic economic growth, while FDI to a less-developed country decreases the gap in income through suppressing domestic economic growth and increasing foreign economic growth.

12.4 Empirical Results

12.4.1 Effects of FDI Outflows

First, this chapter examines the effects of FDI outflows on the home country's growth and employment using panel data. The panel data analysis concentrates on an analysis of China's major investors in Asia: Hong Kong, Korea, Singapore, Taiwan and Japan, the purpose being to determine the influence of investment in China by these five economies based on their relative income (compared to China's), unemployment rate and exports. Note that, relative to the Chinese economy, Hong Kong, Korea, Singapore and Taiwan are small economies, while Japan is a large one. According to the theory, a small and more developed country investing in a large and less-developed country will experience decreases in both employment as well as income disparity (compared to the recipient country), as the less-developed recipient country gains the higher technology of production through FDI inflows. In addition, examining whether or not FDI outflows substitute for exports from the home country is useful in predicting its effect on domestic industries (Kim and Kang 1996; Lim and Moon 2001; Lipsey et al. 2000; Liu and Huang 2005). Hence, in the discussion on the empirical results, I explore the effects on the home country's exports, as well as employment and income disparity.

This article employs the fixed effects model of panel data analysis using balanced panel data from 1993 to 2014. There are two econometric procedures for dealing with the panel data: the fixed effects model and the random effects model. The choice between the two models depends on whether the individual-specific and time-specific effects are independent of the explanatory variables; the Hausman test is a simple procedure to check for this independence condition. The results of the Hausman test for the relative income, unemployment rate and export ratio models are 57.28, 29.44 and 22.98, respectively; this shows that the independence hypothesis is to be rejected for these models. In other words, the fixed effects model is efficient compared to the random effects model.

In this article, the fixed effects model has three other regressors. The first regressor is the one-period lagged dependent variable used to capture the persistent characteristic of the time series. The second regressor is the one-period lagged FDI variable. The third is a product of a dummy variable and the second regressor. The dummy variable is 1 for Japan and 0 for Asian NIEs. Whether FDI's effects depend on the size of the source country can be shown through the significance of the third regressor. I use the GDP share of FDI outflows to China in the source country (FDI/Y) to measure the depth of investment in China. The data of FDI in China are derived from the *China Statistical Yearbook* and a web site.[7] Nominal GDP data come from *IFS* of the IMF. The first independent variable is the relative income compared to China (rGDP); it is measured as the per capita output on the PPP valuation of the source country's GDP divided by that of China. The data source is the *World Economic Outlook* (WEO) of the IMF. The second independent variable is the unemployment rate (U), obtained from the Directorate General of Budget, Accounting and Statistics, Executive Yuan, R.O.C. for Taiwan and the International Labour Organization for others. The third is the exports-to-GDP ratio (X/Y) from the *IFS* of the IMF.

The second to fourth columns of Table 12.5 present the estimated results from the fixed effects model for the per capita relative income and unemployment rate for each regression. I find that the coefficients for the lagged dependent variables are significantly high, as expected. I also find that a higher FDI outflow to China (FDI/Y) leads the source country's per capita income (rGDP) to be relatively lower, but raises its unemployment rate (U). Note that the increase in unemployment and decrease in relative income are both significant, but the export ratio is not. As my theory implies, small but more advanced countries investing in a large but less-developed country experience decreased employment as well as income disparity. In addition, the product of the large country's dummy and lagged FDI ratio is significantly positive for the exports ratio regression, indicating a different outward FDI effect for large source countries. In view of the exports effect, I consider the effects of outward FDI on the exports of export-led countries in the next subsection.

[7]The web site is www.fdi.gov.cn/common. There were a variety of regulations on outward FDI to China by the governments of Taiwan, Korea and Singapore before the 1980s and the early 1990s. The official FDI data toward China might thus be underestimated by the three governments, and inward FDI from China might be relatively reliable. An unavoidable underestimation arises from all the investors indirectly investing through a "tax haven." Another data flaw between Hong Kong's and Taiwan's FDI to China is that a lot of Taiwanese firms use nominal firms in Hong Kong to invest in China, but the actual data are unavailable.

Table 12.5 Panel data regression of *FDI/Y*

Dep.	Relative income (*rGDP*)	Unemployment rate (*U*)	Exports ratio (*X*/*Y*)
Slope			
Dep.$_{(t-1)}$	0.823 (49.712)	0.888 (10.069)	1.221 (12.566)
$(FDI/Y)_{t-1}$	−5.288 (−3.081)	10.066 (1.937)	0.850 (0.433)
$(FDI/Y)_{t-1}$ × Dummy	−86.881 (−0.906)	327.409 (1.560)	4.914 (2.429)
Fixed effects			
Japan	−0.111	−0.021	0.009
Korea	−0.035	0.267	0.006
Taiwan	0.104	0.060	−0.008
Hong Kong	0.298	−0.646	0.002
Singapore	0.009	0.090	−0.007
Adjusted R^2	0.941	0.806	0.963

Note: Panel regression includes a common constant. Statistics in parentheses are *t* statistics, which is corrected by white cross-section standard errors

12.4.2 Effects of Home Country's Exports for FDI Outflows to China

Liu et al. (2001) examined the causal relationship between inward FDI and trade in China and found that the growth of China's imports causes its FDI to grow; the FDI growth then causes its exports to grow and the growth in exports, in turn, causes its imports to grow. My purpose, on the other hand, is to determine the effects of outward FDI on the exports of export-led countries. Specifically, I investigate the effects of outward FDI to China on the exports of Hong Kong, Korea, Singapore and Taiwan, their economic growth being closely related to exports. This article employs the fixed effects model of panel data analysis to discover the influence of investment in China by Asian NIEs, with Japan as comparison, on a variety of export measures. To investigate the outward FDI effects, I construct another FDI measure: the ratio of China's FDI inflows from the individual source country to China's total FDI inflows (FDI/CHINA).

The second to fourth columns of Table 12.6 show the estimated results from the fixed effects model for the ratio of the source country's exports to China to the total imports in China (X_c/CHINA), the ratio of the source country's exports to China to its total exports (X_c/X) and its exports-to-GDP ratio (X/Y) for each regression.[8] The results of Table 12.6 reveal that a higher FDI-to-China ratio (FDI/CHINA) leads the exports-to-China ratio (X_c/CHINA) to rise significantly, but there is an additional counter effect for large countries. Overall, a large country's FDI-to-China ratio has no effect on its exports-to-China ratio. That is to say, for Hong Kong, Korea,

[8]Total exports and export-to-China data for Hong Kong, Korea, Singapore and Japan are from the IMF, Direction of Trade Statistics (DOT). Taiwan's data are from Cross-Strait Economic Statistics Monthly, Mainland Affairs Council, R.O.C.

Table 12.6 Panel data regression of *FDI/CHINA*

Dep.	Exports to China/China's total imports $\left(\frac{X_c}{CHINA}\right)$	Exports to China/exports to the world $\left(\frac{X_c}{X}\right)$	Exports ratio $\left(\frac{X}{Y}\right)$
Slope			
Dep.$_{(t-1)}$	0.819 (14.703)	1.710 (26.571)	0.783 (11.666)
$(FDI/CHINA)_{t-1}$	0.319 (4.930)	0.064 (1.833)	−0.957 (−1.943)
$(FDI/CHINA)_{t-1}$ × Dummy	−0.363 (−3.114)	−0.105 (−1.661)	0.229 (2.577)
Fixed effects			
Japan	0.044	0.019	−0.045
Korea	0.016	0.007	−0.037
Taiwan	−0.022	0.023	−0.044
Hong Kong	−0.038	−0.057	0.099
Singapore	−0.003	0.009	0.026
Adjusted R^2	0.947	0.970	0.929

Note: Panel regression includes a common constant. Statistics in parentheses are *t* statistics, which is corrected by white cross-section standard errors

Singapore and Taiwan, exports to China accompany their FDI outflows to China, but exports from Japan to China are independent of their investments in China. The regression result from the ratio of exports to China to total exports (X_c/X) provides weak evidence. The effect of the FDI-to-China ratio on the exports-to-China ratio is positive but insignificant for a small source country, and negative but insignificant for a large source country. Higher FDI outflow to China might increase the importance of a small source country's exports to the Chinese market. The last interesting finding is from the regression for the exports ratio (X/Y). It is found that a higher FDI-to-China ratio leads the export share of the source country to decrease significantly, while there is an additional significant counter effect for a large country. Overall, a large country's FDI-to-China ratio has no effect on its export share. This means for Korea, Taiwan, Hong Kong, and Singapore, higher FDI outflows to China harm their exports to the world market, but similar exports from Japan are independent of their investments in China.

12.5 Conclusion

In 1993, China became the second largest attractor of foreign investment in the world, following the USA. Although this position has been taken by India and the ASEAN in recent years, the amount of China's foreign investment in 2015 remained as high as 135.6 billion US dollars; in this regard, China remains at the top among the developing countries. However, China's ability to attract foreign investment led to the negative growth of the FDI of neighboring countries in 2015, including Japan, Taiwan and Korea. Whether the sizeable investments of these countries in China will reduce their exports and jobs, and affect their economic systems remains unclear. Therefore, this chapter uses empirical information to show the effects of the FDI of small economies in China on the production and employment of the investor countries.

First, this article offers a theoretical model of endogenous growth to analyze the relationship between FDI outflow and output. According to the model, if a small economically advanced country invests in a large but less-developed country, the production of the FDI recipient will improve, but the employment of the investor country will decline; moreover, the income gap between the two will narrow. To confirm the findings based on the model, the fixed effect model of panel data was adopted in the empirical analysis to explore the effects of the investments of Japan (large economy), Taiwan and Korea (small economies) in China on the investor countries. According to the results, the FDI in China reduces the relative income between the investor countries and China and increases the unemployment rate of the investor countries. Also, it is found that the FDI in China reduced the export proportion of small economies; as Korea and Taiwan are export-oriented, they continue to face the negative effects caused by the FDI in China.

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