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Industrial Location and Vitalization of Regional Economy

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Preface

The economy of many regions of the world have undergone significant changes due to the globalization that has been progressed since the latter half of the 20th century. In the first half of the 20th century, agglomeration economy exerted great power, the manufacturing industries that had an overwhelming influence on the world economy were attracted to the regions with good production conditions, and these regions were blessed with affluent economies. This situation of regional economy was enormously transformed by the innovation of IT and ICT in the second half of the 20th century. The globalized economy increased the firms' activity on a global scale, and the economic activity in general also expanded significantly. This spatial expansion of the economic activity increased the scale of firms' production and caused major changes in the world production organization: The enormous expansion of the firms' activity caused competition among the firms on a global scale, especially competition for cost reduction was intensified. This competition led to the fragmentation of production processes, and the fragmented processes were dispersed all over the world. And such a series of movements also changed the overall management function of the firms, and along with this, the firms' strategy of factory location also changed significantly. As a result, the industrial and economic environment of each region of the world have changed significantly. The changes in the economic environment have been occurring simultaneously in both developed and developing countries. It can be said that each region of the world is now under pressure to respond to the new economic environment.

This book is designed against the background of such economy of many regions of the world that have undergone significant changes due to the globalization that has been progressed since the latter half of the 20th century. The primary aim of the book is to provide useful knowledge and insights in planning strategies that regions placed in a changing economic environment should take for new economic development. The basic outline of this book is organized as follows.

This book is composed of 10 chapters. And it is arranged into four sections according to the contents of chapters. First, the book deals with the economic effects of government policies, regulation and corporate tax. These are primary factors that greatly affect regional economy and always have an important influence on regional vitalization. The first chapter inquires effects of the regulatory policy of restricting large-scale firms to protect traditional small firms in the local market. It is clarified in this chapter that as small firms tend to enter excessively when there is spatial competition, the market share regulation on the dominant firm prevents efficient outcome unless small firms are eliminated. In most regional retail markets in Japan, small ordinary stores are far from total elimination, so a restriction on the expansion of large-scale stores is not needed (**A. Torii**). The second chapter takes up corporate tax. The national government devises a tax system and formulates subsidy policies for regional vitalization. This chapter analyzes the effect of Japanese corporate tax policy on regional economic development by estimating its impact on firms' decisions on factory location. It provides meaningful insights for policy makers by analyzing the Japanese corporate tax system. It is clarified that the effect of corporate taxation on regional economic development is negative at the national level. On the other hand, the public service of highway infrastructure has a significantly positive impact on manufacturing employment within Japan's three major metropolitan areas (**M. Shinohara**).

Secondly, this book takes up two location factors, labor and agglomeration economy. These factors continue to be important location factors in the economic society where the global economy is expanding. Thus, labor employment is considered. The third chapter examines 'Verdoorn's Law', i.e., the relation between employment and output growth across the NUTS-3 regions of the European Union. And in this chapter an explanation is provided as to how this law sets up a process of cumulative causation. The empirical results provide considerable support to the validity of 'Verdoorn's Law' (**A. Stilianos**). The fourth chapter considers firms' human resource management. This chapter considers how firms can utilize human resource management through cooperative behavior across a region. It is shown that the management may improve not only the efficiency of production for the local firm but also the level of residents' well-being. In addition, the chapter also demonstrates how a sustainable region, which has the optimal economies of scale and scope under partnerships with neighboring areas, can be organized (**D. Nakamura**). Then, agglomeration economy is dealt with in the fifth chapter. As is well known, agglomeration economies played a crucial role in factory location in the 20th century. Although the agglomeration system has been altered by the progress of the globalized economy and the role of the agglomeration has changed significantly, the locational impact of the agglomeration economy itself has been maintained. It is important even in the present time to clarify its effects on production. The power of the agglomeration economies is examined through the Chinese case study **(N. Wang)**.

Thirdly, the book deals with some regions in the world where the measures to revitalize the regional economy have been implemented. It takes up three cases that show typical phenomena in regional economic vitalization. They are the cases shown in Sweden, China, and the Philippines. The first case is a Swedish one. In Northern Sweden, initially, the economic actors that are factories for production of batteries and fossil-free steel have been established. Now, the area faces a phase of new industrialization, the green "reindustrialisation" has the potential to change the relatively slow growth in the region. The sixth chapter analyses the economic background and forces behind the stagnation and indicates that legislation, policy and narratives at the national and European level are other obstacles for growth (**L. Westin**). Then, the Chinese case is taken up in the seventh chapter. The economic stagnation in Northeast China shows sharp contrast with the rapid economic growth of China as a whole. Revitalization of Northeast China is one of the important practices in regional development. The chapter suggests the following strategies based on considerations of the local economy; building up the complementary relationship among the three provinces in that area based on their characters and designing “hub-and-spoke” for different industries in detail are better choices. In addition, it proposes a strategy that the government should make decisions from the demand-side perspective subject to demographic change, decarbonization and the trend of the fourth industrial revolution driven by cutting-edge technologies and digital transformation (**H. Gao and Y. Taniguchi**). And then, the case of the Philippines is dealt with.

In the Philippines some places are able to benefit from the economic expansion and increasing urbanization, while others are left behind. To better understand the problem of widening spatial disparity and craft policies would make urbanization more inclusive, it is vital to look at how cities are organized and how that affects socio-economic conditions. The eighth chapter analyses the structure of the city system within the provinces in the Philippines. And it shows that provinces with a city system, where cities are geographically adjacent to one another and where the population is concentrated, typically have superior socioeconomic conditions, while provinces with city system in which both population and cities are relatively dispersed, tend to have inferior socio-economic condition. This chapter outlines appropriate policy recommendations (**A. Dumayas**).

Finally, the last section of the book is assigned to two fundamental studies on the relations between industrial location and regional economy. The study in the ninth chapter deals with the relation between education and economic growth. Industrial locations are often determined based on regional labor cost disparities. This study selects Indonesia, the Philippines, and India among Asian developing countries and examines the determinants of urban–rural disparities in per capita consumption expenditure in these three countries, with a focus on education, using the Blinder–Oaxaca decomposition method. It is shown in this study that in Indonesia, the Philippines, and India, differences in educational endowments appear to have been a key determinant of urban–rural disparity accounting for considerable amount of the urban–rural expenditure gap. In addition, differences in job sectors also contribute to the expenditure gap, albeit to a lesser extent (**M. Hayashi**). The last chapter elucidates that the characteristics of the regional economy decisively depend on the location of region using the concept of connection economy. It is shown that the prefectures in Japan are arranged with regularity according to the strength of the connection economy. The prefectures that largely enjoy the connection economies have large economic activities and factory scales in their territories becomes smaller. However, the prefectures with low connection economies have larger factory scales to enjoy more place-based economies. Agglomeration economy continues to have a significant impact on the composition of production activity in each region. This study supports the fundamental view that the industry that should be attracted for regional vitalization should be determined according to the regional characteristics (**T. Ishikawa**).

The globalized economy has significantly changed the regional economic organization formed in the 20th century. Each region in the world is in a different economic environment than before. They need to reorganize their economic activities for new development. This book provides some clues for economic revitalization for regions in times of change.

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Contents

Chapter 1
The Effect of Regulation on a Dominant Firm to Protect Fringe Firms in a Local Market

Akio Torii

Abstract A model of competition between a large-scale dominant firm and fringe firms is analyzed to examine the effect of market share regulation on the dominant firm to protect the small firms. One feature of the model is that the dominant firm and the small firms provide close but different services to consumers. Because business stealing effects are possible for both the dominant firm's and small firms' entries, the effect on social welfare is generally indefinite. When small firms face the danger of extinction because of the expansion of the dominant firm, it is demonstrated that the effect is evaluated solely by the excessiveness of the number of small firms. As small firms tend to enter excessively when there is spatial competition, the market share regulation on the dominant firm prevents efficient outcome unless small firms are eliminated. In most regional retail markets in Japan, small ordinary stores are far from total elimination, so a restriction on the expansion of large-scale stores is not needed.

1.1 Introduction: Competition Between Dominant Firm and Fringe Firms

In this paper, I would like to argue on a type of spatial competition between a dominant firm and numerous small firms—a model of partial monopoly. Textbook models of partial monopoly have analyzed strategies of a dominant firm under the asymmetric distribution of firm size in a market of a homogeneous good. In these models, the asymmetries are from the disadvantages of the cost condition or the restricted capacity of fringe firms. The asymmetry considered here is not based on differences in such cost conditions in manufacturing the homogeneous good. I discuss the competition between a market with numerous small firms and a large-scale firm, where they supply a close substitute. Thus, I analyze a competition with outside goods in Salop (1979) explicitly.

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When a new product is introduced, it may create quite a new market, but mostly, the product finds its niche close to the incumbent goods. If a new product gains its share successfully by getting consumers' acceptance of the new dimensions of innovative quality or service not provided by old products, the newcomer gains a substantial market share in the market consisting of numerous small incumbents. Then, a quasi-partial monopoly develops. This is the situation I argue here. These innovations can be seen everywhere, especially in service industries, where substantial shares are occupied by firms who have achieved standardization of service traded such as e-commerce bookstore platforms. It is obvious that a brick-and-mortar bookstore on a street corner would provide consumers with very close but different services. Often, conflicts occur between the large-scale newcomer and the small incumbents. The small incumbents are inclined to pursue political compromise and achieve a regulation on the share of the new product. Conflicts in this composition are often observed in the transition of regional economies, especially when large-scale innovative retailers enter regional markets previously supplied by small-scale retailers. A typical example is conflicts between large retail chain stores (e.g., general merchandising stores) and small ordinary stores that were regulated by a previous Large Store Law in Japan. The law had been enacted to restrict the activity of large stores and had effectively deterred them from entering local retail markets, at least throughout the last decades of the twentieth century.

Unlike the anti-competitive feature of the regulation, the effect of the share of the dominant firm on social welfare in the regional economy of the regulation is not so clear. First, consumers may suffer from the elimination of small firms in the competitive fringe due to the increasing share of the dominant firm. If the goods or services are heterogeneous, consumer surplus depends not only on the equilibrium price but also on the share of competitive fringe because the smaller firms provide consumers a type of product diversity or quality that is different from what the newcomer provides. This is different from the markets considered in standard models of a partial monopoly with a perfectly homogeneous good. When the goods are homogeneous, the effect of regulation can be reckoned by the outcome of price and quantity supplied at the new equilibrium. Consumer surplus does not depend on who supplies the goods. This problem has been analyzed in the context of price leadership.[1]

Second, there seems to be no obvious conclusion on whether the share of the dominant firm is excessive from the perspective of social welfare or not. If smaller firms provide consumers with an indispensable type of service or quality, there should be an optimal sharing of the market between the dominant firm and the fringe firms. The dominant firm may tend to increase its market excessively, driving out smaller firms, whereas too many smaller firms caused by free entry may lead to excessive diversity, as opined by Mankiw and Whinston (1986), Economides (1989), and Suzumura et al. (1988), leading to an insufficient share of the dominant firm. Thus, when the goods are heterogeneous, two possibilities of partial excessiveness of entry must be evaluated—an excessive share of the dominant firm and an excessive number of small

[1] Schenzler et al. (1992).

firms. Here, I use the word partial excessiveness as follows. The share of the dominant firm is excessive if (if and only if) the marginal decrease of the share improves the social welfare derived from maintaining the number of smaller firms and vice versa. As the two markets, one for the dominant firm and the other for smaller firms, are segmented, these partial excessivenesses can be analyzed by keeping the other market as outside goods. Therefore, this paper treats the market for outside goods explicitly.

In general, as both markets tend to allow excess entry through the business stealing effect described by Mankiw and Whinston (1986), whether restrictions on the share of the dominant firm may improve or deteriorate social welfare is indefinite. However, I argue that, at least, when the small firms face a threat to be expelled entirely, the optimality is solely dependent on the excessiveness of the number of small firms. If the number of small firms is excessive, the share of the dominant firm will be insufficient irrespective of the condition of the market of the dominant firm and vice versa. Moreover, if the equilibrium of the market of small stores is determined by free entry, the tendency of excess entry caused by the business stealing effect will make the share of the dominant firm too little for social optimality. If this occurs, the regulation should be discarded.

A similar problem has been analyzed in the study of Nishimura (1994), where one market is shared by competitive large-scale firms equipped with standardized mass-production technologies and smaller local firms. He demonstrated that consumers tend to prefer excessive mass-produced goods when there is no externality in the consumption of mass-produced goods. This paper is different from his in the analysis of two segmented markets, as it does not specify it so definitely, at least, in the general proposition and is not dependent on the assumption of competition among large-scale firms.

In Sect. 1.2, a general model of quasi-partial monopoly is constructed and the effect of a regulation that restricts the share of the dominant firm is analyzed. I try to analyze the problem by not depending on a specific spatial competition model as far as possible. The results of the spatial competition models are dependent on how the models are constructed, the linear demand function, the quadratic trip cost function, and so on. In Sect. 1.3, I apply the model to investigate the effect of the regulation of the previous Large Store Law in Japan. In Sect. 1.4, implications and some discussions are provided.

1.2 A Model Analysis of a Partially Monopolized Market

The two definitions of excessiveness facilitate the following discussions. There are segmented markets—Markets 1 and 2. Consider a function $W(N^1, N^2)$, which the social planner wants to maximize. N^1 and N^2 are some conditions of the markets or the number of firms in Markets 1 and 2, respectively. N^1 is *partially excessive (insufficient)* iff

$$\frac{\partial W}{\partial N^1} < 0\,(> 0),$$

and N^1 is *totally excessive (insufficient)* iff

$$\frac{dW}{dN^1} = \frac{\partial W}{\partial N^1} + \frac{\partial W}{\partial N^2}\frac{dN^2}{dN^1} < 0\,(> 0).$$

Note that they are both local concepts.

For the convenience of explanation, I construct a model in a spatial competition context. Consider a market where two types of services, L and S, are supplied to consumers who are distributed in a segmented liner city. The two services substitute each other. Ordinary consumers buy both, although if one thinks a type of service is too expensive, the individual will buy only one type. These services can be completely compensated for each other. The first type of service (L) is served by a single corporation; the firm is geographically monopolist or effectively differentiated, so there is no alternate supplier of service L for consumers. Service L is characterized by a quality index q. Every consumer who buys service L can enjoy the same quality. Therefore, service L is a standardized service.

The second type of service (S) is served by small firms. Why should they be small? It is because they survive by relying on the local convenience of their service. To compete with service L, these small firms offer services that need intensive user-specific information, so marginal cost increases rapidly, and the optimal firm size is small. Even if there is only one firm that supplies the service, the firm can meet only a fraction of the market. Unlike service L, service S cannot be described by a single quality index because consumers have different valuations of the type of service offered or the location-specific benefit. Thus, the firms have to survive by offering more accessible and convenient services that are difficult to standardize. The firms compete against each other through the price and the horizontal quality of the good. Therefore, I assume spatial competition in service S.

The whole market of services L and S appears as a partial monopoly. The monopolistic firm is dominant because it has an established brand name or reputation. Other firms have no national brand name, but nearby consumers know the quality and service supplied well. I assume the marginal costs of these suppliers are zero. The fixed cost is $F(\cdot)$ $(F' > 0)$ for the firm supplying service L and F^s for all firms supplying service S. I specify the gross consumer benefit of these goods as $U(N, q)$, where N is the number of small firms, and I assume the function is differentiable, and the differential coefficients are positive for the following two arguments: consumers benefit from the diversity among small firms (N) and the quality of the service of the dominant firm (q). Consumers' taste or the locations of firms in horizontal quality space is symmetric for service S and all firms supply the same amount, so no argument is made about the respective quantity supplied by small firms in function U. Thus, the social surplus on which I argue the optimality is as follows:

$$W(N, q) \equiv U(N, q) - NF^s - F(q).$$

Smaller firms can enter their market freely, whereas a new entrant achieves a nonnegative profit. I neglect the discreetness of the entry condition and assume N to be a continuous real number. I denote the number of firms at the free entry equilibrium by N^e. Then, $R(N^e, q) = F^s$, where $R(N, q)$ is the revenue function of smaller firms. I assume twice differentiability of R by N and q, and the revenue decreases as the total number of small firms increases ($R_N \leq 0$) and decreases as the quality level of the dominant firm increases ($R_q < 0$), where the subscripts denote partial derivatives throughout this paper. Then, N^e is a non-increasing function of q. Function R is determined by how smaller firms compete with each other, which I avoid specifying to make the conclusions as general as possible.

Using this revenue function, I specify the situation of the quasi-partial monopoly described above, defining the fringe firm as follows:

Assumption *Fringe Firm in Quasi Partial Monopoly.*

For any value of q, there exists N^*, such that

$$R\left(N^2, q\right) < R\left(N^1, q\right) < R\left(N^*, q\right) \text{ if } \mathrm{N}^* < N^1 < N^2,$$

$$R(N, q) = R\left(N^*, q\right) \text{ if } \; N \leq N^*,$$

$$\left.\frac{\partial R}{\partial N}\right|_{N=N^*} = 0.$$

This definition is depicted in Fig. 1.1. The condition sets the largest size of small firms as follows: even if its neighboring small suppliers or competitors disappear, the firm cannot supply to a larger number of customers. In the conventional spatial competition model, this upper bound of revenue can be naturally introduced by the maximum supplying area constrained by trip costs and the reservation price set by outside goods. In that situation, N^* corresponds to the maximum number of firms at which they can set the monopoly price. At the border, the reservation price is the same as the trip cost of a consumer, so the demand level is zero. This satiated number of firms N^* is dependent on q. The example is demonstrated in the later part. Without this condition, the market turns into an oligopoly as N becomes smaller. When F^s or q is sufficiently small, the free entry equilibrium N^e should be sufficiently large such that $N^e(q) > N^*$. In these conditions, the entry of a new small firm reduces the profits of all small firms through the business stealing effect.

The last part of the assumption may need some explanation to make the model more specific. The assumption of the existence of the upper bound for small firms' revenue implies that if the market for small firms is segmented to N^* submarkets, they can set a monopoly price (p^M) without impinging on their neighbors. The firm avoids setting a lower price to increase its territory, supplying $Q(p^M; N^*, q)$, which is the demand at price p^M under N^* and q. Therefore, it is natural to assume that even when the number of firms increases to $N^* + \epsilon$, they can earn at least $(p^M + \delta) Q(p^M + \delta; N^* + \epsilon, q)$, where δ is the price increase that prevents the firm from

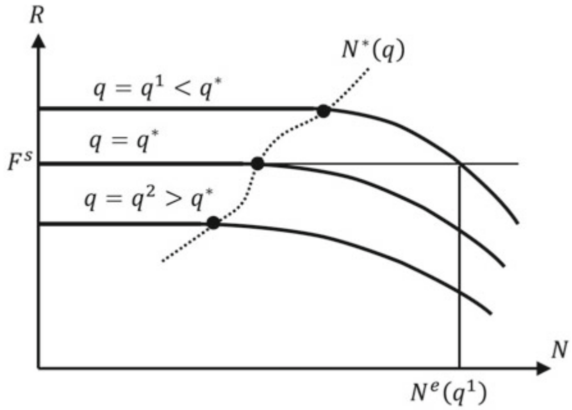

Fig. 1.1 Definition of fringe firms

impinging on its neighbors' territories. A small increase in the number of small firms requires smaller territory sizes for each of them. Then, the price needs to increase to narrow down the size of territories. Thus, I define $\Delta(\epsilon)$ as the minimum price increase under which small firms would not impinge on their neighbors' territories, then $\lim_{\epsilon\to 0}\Delta(\epsilon) = 0$. If this is not accepted, the assumption of the existence of the upper bound for small firms' revenue should also be questioned. Thus, there are kinked equilibria in the neighborhood of monopoly equilibria (see Salop, 1979). Expanding $(p^M + \Delta(\epsilon))Q(p^M + \Delta(\epsilon); N^* + \epsilon, q)$, we derive the following:

$$R(N^* + \epsilon, q) \geq (p^M + \Delta(\epsilon))Q(p^M + \Delta(\epsilon); N^* + \epsilon, q)$$

$$= \big(p^M + \Delta(\epsilon)\big)Q\big(p^M + \Delta(\epsilon); N^*, q\big)$$

$$\geq p^M Q\big(p^M; N^*, q\big) + \Delta(\epsilon)\big(Q(p^M); N^*, q) + p^M Q_P(p^M; N^*, q)\big) + o\big(\Delta^2(\epsilon)\big)$$

$$= R(N^*, q) + o(\Delta^2(\epsilon))$$

where the partial differential coefficient of Q by P is denoted as Q_P. Note that $Q(p^M) + p^M Q_p(p^M) = 0$, $Q(p^M + \Delta; N^* + \epsilon, q) = Q(p^M + \Delta; N^*, q)$ as $\epsilon > 0$. Then, so far as $\Delta(\epsilon)/\epsilon$ does not diverge to infinity, the last part of the assumption is equal to assume kinked equilibria around the neighborhood of the monopoly equilibria, which I think is general. As the monopoly equilibrium is a special case of kinked equilibria, the derivative should smoothly be continuous at this point.

Now, the social surplus can be written as $w(q) \equiv W(N^e(q), q)$, which is a function of the value of q that the social planner should pay attention. The derivative of w,

$$w'(q) = \frac{\partial W}{\partial q} + \frac{\partial W}{\partial N^e} \cdot \frac{dN^e}{dq} = \left(\frac{\partial U}{\partial q} - F^{'}(q)\right) + \left(\left(\frac{\partial U}{\partial N}\bigg|_{N=N^e} - F^s\right) \cdot \frac{dN^e}{dq}\right)$$

comprises consumers' direct benefit from improvement in the quality of service L minus the incremental fixed cost (inside the first parenthesis) and the loss from the decreased diversity provided by small firms plus the saved fixed cost of small firms (the second parenthesis). The first term represents the partial excessiveness of the side of the dominant firm, and the second term represents the partial excessiveness of the side of the small firms. We have to evaluate the two excessivenesses, which make the evaluation of the optimality of q very complicated. Nevertheless, the sign of w' can be determined by only one partial excessiveness of the share of small firms when they face a catastrophe.

First, the catastrophic point is defined by the value of $q = q^*$ such that $R(N^*, q^*) = F^s$. When $q > q^*$,

$$\max_N R(N, q) = R(N^*(q), q) < R(N^*(q), q^*) < R(N^*(q^*), q^*) = F^s,$$

then no small firm can survive. When $q = q^*$, $N^e(q^*) = N^*$ because $R(N^*, q^*) = F^s$. When $q < q^*$,

$$R(N^*(q), q) = R(1, q) > R(1, q^*) = R(N^*(q^*), q^*) = F^s,$$

then $N^e(q) > N^*$, and firms enter the market beyond the satiated number of small firms. Thus, I call the market of small firms face a catastrophic point in the market when $q = q^*$.

Note that when $q < q^*$ the definition of $N^e(q)$ implies $R(N^e(q), q) = F^s$. To investigate the relation between q and the number of small firms at the free entry equilibrium, differentiating this relation by q gives:

$$R_N \frac{dN^e(q)}{dq} + R_q = 0.$$

Evaluating this relation at $(N, q) = (N^e(q^*), q^*)$ leads to:

$$\lim_{\substack{N \to N^{*+} \\ (q \to q^{*-})}} \frac{dN^e(q)}{dq} = -\infty \text{ because } \frac{\partial R}{\partial N}\bigg|_{N=N^e(q^*)} \to 0^- \text{ and } \frac{\partial R}{\partial q}\bigg|_{q=q^*} < 0.$$

Therefore, in the decomposition of differential w' the absolute value of $\frac{\partial W}{\partial N^e} \cdot \frac{dN^e}{dq}$ overwhelms the value of $\frac{\partial W}{\partial q}$, and the sign of w' is determined solely by the sign of $\frac{\partial W}{\partial N^e}$. This term represents the partial excessiveness of the number of small firms.

Then, I propose the following proposition:

Proposition Under the situation of the quasi-partial monopoly described above, when the small firms face a catastrophe that makes the dominant firm expel them entirely from the market, the optimality of the share of the dominant firm can be determined only by the partial excessiveness of the number of small firms, which is the difference between the incremental consumer benefit from the small firms and their cost. We can neglect the partial excessiveness of the side of the dominant firm.

When $q > q^*$, the outcome in the market is beyond the scope of this model. The price and quality of the service should change discontinuously at the point $q = q^*$, and the social surplus function should also jump at this point. Therefore, I refrain from analyzing the global optimality of the share of the dominant firm. However, at least, in the neighborhood of the catastrophic point, the sign of $w'(q)$ should be the same as that of the catastrophic point.

1.3 A Model Analysis of Competition Between Large-Scale Stores and Ordinary Small Stores

In this section, the model that is presented as general as possible in Sect. 1.2 is reformulated as a specific model to discuss the effect of a regulation. The general model has been constructed somewhat ambiguous to make it applicable to many purposes. Therefore, the discussion in this section may help with the recognition of the model. If the general model is accepted, the result in this section can be directly obtained without detailed discussions, making it redundant.

Although the Large Retail Store Law in Japan requires entrants to only notify the Ministry of International Trade and Industry (MITI) at that time[2] or local governments, the law had effectively deterred entrances of large-scale retail stores since its legislation in 1974 until May 1990 when a modification was issued. In 1979, the statute was amended to expand coverage, and in 1981 and 1982, MITI issued guidance on self-restraint and repression, respectively. The upraise of notifications in 1979 led to rushed applications before the revision of the law. In the change of total floor area and the number of establishments of those stores, the effects of these restraints are reflected in lags.[3]

It is reported that legal procedures took three or four years and often more than six years. This slowness of negotiation periods discouraged entrances of large-scale stores. The main cause of this slowness was knotty negotiation in the Local Commercial Activities Adjustment Board, which comprised representatives of local retailers, consumers, scholars, and experienced persons. The board plays a role in the adjustment of the store's floor space, components items, and opening hours and schedules. It is not hard to consider how difficult it was to coordinate conflicting interests on

[2] MITI was reorganized into Ministry of Economy, Trade and Industry (METI) in 2001.

[3] Large Store Law was replaced in 2000 by Large-scale Store Location Law. The new law regulates location, layout, and operational method of the facilities of large-scale stores. The role of regulating store openings has receded.

such boards. Even if this uphill task passes through, the entrant suffers frustration in the resulting conditions.

This regulation policy on the opening of large-scale stores in Japanese regional retail markets is aimed to protect small and medium size ordinary retailers. This purpose is clearly stated in the preamble of the law. Therefore, the issue is not only in large-scale stores but also in small and medium size retailers. The restrictions of large-scale retail stores are related to the efficiency of small retail stores. If small retail stores are really inefficient, the regulation of entry of a large-scale store would simply mean protection of smaller ones because they are small. However, the problem is not so clear as its appearance. Large-scale retail stores and smaller ones supply different types of services to consumers. Whereas large-scale stores supply wider assortments, cheaper prices, and an opportunity for one-stop shopping, smaller stores offer convenience in location, information and recommendation of items sold, and assistance in selecting and gathering products.

Therefore, if the entrance of large-scale retail stores leads to a decrease in the number of small ordinary stores, it deprives consumers of the opportunity to get the services that small ordinary stores provide. We do not see this problem as competition between large- and small-scale enterprises in homogeneous markets such as manufacturing industries, rather we consider the problem as competition between markets that supply very close substitutes. To analyze the optimal composition of large-scale stores and small ordinary stores, we compare the effects on distributors' and consumers' costs.

I assume that consumers pay attention to the type of services supplied by different types of stores even if the item sold is physically the same. In models of spatial competition, consumers often compare the sum of mill price and trip cost and select one store that offers the minimum total cost. There is no viewpoint that consumers buy from several stores, making the best mix of the services provided. This is because those models are not constructed to analyze a retail market but to analyze competition among manufacturing firms in a horizontal quality space.

Empirically, when determining where to buy, the price level is not so critical, but other factors, such as parking lot spaces and width of assortments, are.[4] Services that are not supplied by retailers should be compensated for by consumers themselves. For example, if assortments are not enough, they have to make a trip to another store to seek more suitable goods. Therefore, consumers have the opportunity to minimize their shopping costs by shopping from different types of stores, as they offer different compositions of services.

Here, I consider a market for a convenience good. The commodity is a necessity, and the elasticity of demand is zero, so we have to consider only the distribution cost for social optimality. When a consumer buys the good, he/she needs distribution services in several dimensions. The quality of the service provided by a large-scale

[4] *Gravitation Law in Retail* assumes that consumers incur trip costs in determining where to shop. However, where to shop is determined probabilistically, and the probability is inversely associated with trip costs. Theories explaining these conducts assume that consumers maximize a class of utility function. It is parallel to minimizing the total shopping cost for a given amount of service.

store (q) comprises the average nearness from the consumer, the width of assortment, chances of one-stop shopping, and so on. These services help consumers to save on their shopping costs. However, small stores provide other benefits, especially convenience in store locations (x), which are far nearer than the location of the large store. The distribution service and its cost incurred by consumers depend on q and x. I assume that consumers are located on a circle of radius $r/(2\pi)$ with uniform unit density. When there are N small stores, they are located in the same distance r/N, which is denoted as D. x is the shorter distance for a consumer to reach small stores. Given the prices of both type of stores, p^L for the large-scale store and p^s for small stores, as well as q and x, consumers will choose an optimal combination of shopping.[5] It is assumed that the large-scale store is located at the center of the circle, and q is the inverse of the radius of the circle.[6]

When q is quite small, which is likely in the retail market of fresh groceries, the total demand for goods from ordinary small stores becomes inelastic because most of the demand is already directed to them, and the ratio is expected to be stable. If the excessive entry theorem is valid in this market of smaller stores, D is smaller, and p is higher than the optimal values that minimize the total distribution costs. Thus, the number of small stores is partially excessive, and q is totally insufficient. Conversely, if q is quite large and the ratio of the demand for goods from ordinary small stores is so small that no store survives, the system may suffer higher social distribution costs as consumers are deprived of their chances to optimize the ratio. Thus, we can conjecture that at some level of q, the total distribution cost is minimized.

The strategy of setting q by large-scale stores has not been considered. Depending on the function of the fixed cost $F(q)$ of the large-scale store and its conjecture about reactions of small stores (q), the service quality or the share of the large-scale store is chosen at some level. The problem is the relationship between the optimal level and the chosen level of q.[7] To make the problem complicated, at some level of q, all

[5] Specifically, assuming there are two dimensions in distribution services,(v^1, v^2), Type L supplier supplies (v^{1L}, v^{2L}) with price p^L, and Type s supplier supplies (v^{1s}, v^{2s}) with price p^s. For example, the simplest form of these two dimensions is (width of assortment, convenience of the location of the store). The large store offer $(q, -x^L)$, whereas small stores offer $(q^s, -x)$, where $q^s \ll q$ and $x \ll x^L$. The total distribution service required to buy a good is (v^{1T}, v^{2T}), which costs a consumer $C(v^{1T} - tv^{1L} - (1-t)v^{1s}, v^{2T} - tv^{2L} - (1-t)v^{2s})$, where t is the ratio the consumer buys from small stores. Then, the total consumer cost, which is the sum of the price and service cost, is $tp^s + (1-t)p^L + C$, whose derivative is $p^s - p^L + C_1 \cdot (v^{1s} - v^{1L}) + C_2 \cdot (v^{2s} - v^{2L})$, where the suffixes of C represent partial derivatives. If the components of (v^{1s}, v^{2s}) and (v^{1L}, v^{2L}) are quite different and C_{11} and C_{22} is sufficiently large, as expected in retail markets, the total cost can be maximized internally at $0 < t < 1$.

[6] We can regard the quality of the large-scale store as the average distance from consumers. Consider a broader market with several large-scale stores and scattered small stores, if a new large-scale store enters the market, the average distance from consumers to large-scale stores decreases, which improves the convenience of large-scale stores. Therefore, the share of the large-scale stores would increase. In this story, q is positively associated with the number of large-scale stores, and the share of the large-scale stores is an increasing function of q. Furthermore, the radius of the circle would shrink as new large-scale stores enter the market.

[7] If we consider q as the number of large-scale stores, as described in Footnote 6, q is not chosen but determined by some entry mechanism of them.

the small stores are expelled. Thus, the relationship of these three levels of q—the optimal, chosen, and catastrophic points—should be considered.

Depending on the value of q, the intervals of small stores at free entry equilibrium are determined by $D(q) \equiv r/N^e(q)$. The maximization problem of social surplus equals the minimization of the total distribution cost because zero elasticity of demand is assumed. The total distribution cost of consumers on the circle is as follows:

$$DC(q) = F(q) + \frac{r}{D(q)} F^s + r \cdot TC(q, D(q))$$

where $DC(q)$ denotes the total distribution cost, and $TC(q, D(q))$ is the total trip cost incurred by consumers per unit length of arc; $TC_q < 0$, and $TC_D > 0$.[8] Then, we get:

$$\frac{d}{dq} DC(q) = \left(\frac{dF(q)}{dq} + TC_q(q, D(q)) \right) + r \left(-\frac{F_s}{\{D(q)\}^2} + TC_D(q, D(q)) \right) \frac{dD(q)}{dq} \quad (1.1)$$

The first term represents the partial excessiveness of the share of the large-scale store, and the second term represents the partial excessiveness of the share of small stores. Generally, we cannot evaluate the total value of Eq. (1.1), but we have to consider only the second term, that is, the partial excessiveness of the share of smaller firms at the catastrophic point where the elimination of all small stores is imminent.

The revenue function of a small store is as follows:

$$\tilde{R}(p^s; N, q, p^L) = 2 \int_0^{\frac{r}{2N}} t(q, x, p^s, p^L) p^s dx$$

where t is the ratio of the demand directed to small stores, and I assume that $t_q < 0$. p^s is determined by q and competition between small stores. Regarding the competitive outcome of p^s, I assume that the revenue function has an upper bound, so when $p^s = p^m$, it is maximized for any positive and bounded value of q and p^L. To put it precisely:

Assumption of the limited elasticity of substitution

For any value of $(\infty, \infty) > (q, p^L) > (0, 0)$, there exists p^m such that $p^m = \text{argmax}_{p^s} \; \tilde{R}(p^s; 1, q, p^L)$ and $t(q, r/2, p^m, p^L) = 0$.

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[8] If we assume the situation described in Footnote 6, we have to consider the total distribution cost from unit arc as follows:

$$DC(q) = \frac{F(q)}{r} + \frac{F_s}{D(q)} + TC(q, D(q)).$$

We have to redefine $F(q)$ as $F(q)/r$, which is the fixed cost of the large-scale store for a unit supplying area. Then, the following analysis is valid for this story setting r as 1.

When a monopolistic small firm sets the monopolistic price (p^m), there exist boundaries such that $t = 0$ in the circle. This assumes that r should be sufficiently large. Given q and p^L, at some distance x from the store, the ratio of $p^m + \gamma(x)$ to p^L exceeds the maximum elasticity of substitution, where $\gamma(\cdot)$ represents the cost of the consumers' trip. If the elasticity of substitution between two types of services becomes infinite when t approaches zero or if the trip cost is trivial, this condition is not satisfied. The services are thus substituted close enough to be completely compensated for each other. I denote the minimum distance x as $x^m(q, p^L)$, then $t(q, x^m(q, p^L), p^m, p^L) = 0$.

Even when the number of small stores is small, this assumption is still valid—no demand is directed to small stores at the boundaries of the supplying areas of two adjacent small stores. I denote $N^m(q, p^L) \equiv r/(2x^m(q, p^L))$, then $t(q, r/(2N^m), p^m, p^L) = 0$. Hereafter, $x^m(q, p^L)$ and $N^m(q, p^L)$ are simply expressed as x^m and N^m, respectively. N^m is the maximum number of small firms, and they can keep a supplying area with $2x^m$ length. When the number of firms is not more than N^m, the distance from the most inconvenient consumer to the nearby small store exceeds x^m. As $t(q, x^m, p^m, p^L) = 0$, no revenue is expected from the area ($x > x^m$), so the total revenue remains at the same level:

$$\tilde{R}(p^m; N < N^m, q, p^L) = \tilde{R}(p^m; N^m, q, p^L).$$

The state of monopoly is not altered. They can act as a monopolist in their supplying area.

When N exceedsN^m, the revenue should be a non-increasing function of$N$, at least in the neighborhood ofN^m. Given q and p^L at some n such that $n > N^m$, suppose the small firms get the revenue higher than the revenue of a monopolist at the pricep^{sn}. If so, whether $t(q, r/(2n), p^s, p^L) = 0$ or$t(q, r/(2n), p^s, p^L) > 0$, a monopolist can earn a profit that is greater than $\tilde{R}(p^m; N^m, q, p^L)$ setting the pricep^{sn}, a contradiction. Note that we do not know whether the price level increases or decreases with the number of firms, so the result above is not self-evident. In the context of spatial competition, prices that are higher than the monopoly price can result depending on the assumption of the conjectures of reaction functions.[9]

When the competition between the large-scale store and small firms is specified, the number of small firms and the revenue of a monopolist are determined by q. I denote the number of small firms as $\overline{N}^m(q) \equiv N^m(q, \overline{p}^L(q))$ and the maximum revenue of the monopolist as $\overline{R}(q) \equiv \tilde{R}(\overline{p}^m(q); N^m(q, \overline{p}^L(q)), q, \overline{p}^L(q))$, where $\overline{p}^m(q)$ and $\overline{p}^L(q)$ are p^m and p^L, respectively resulted from the specified competition. When q increases from a very low level $\tilde{R}_p(p) = 0$ by maximization and $\tilde{R}_N = 0$ by:

$$\left.\frac{\partial R}{\partial N}\right|_{N=N^m} = -\frac{r}{2(N^m)^2} t(q, \frac{r}{N^m}, p^m, p^L)p^m = 0,$$

[9] See Greenhut et al. (1976).

so,

$$\frac{d\overline{R}}{dq} = \widetilde{R}_p \frac{d\overline{p}^m}{dq} + \widetilde{R}_N \left(\frac{\partial N^m}{\partial q} + \frac{\partial N^m}{\partial p^L} \frac{d\overline{p}^L}{dq} \right) + \widetilde{R}_q + \widetilde{R}_{p^L} \frac{d\overline{p}^L}{dq} = \widetilde{R}_q + \widetilde{R}_{p^L} \frac{d\overline{p}^L}{dq}.$$

At some value of q, $\overline{R}(q)$ coincides with F^s. If q increases beyond the value, small firms would suddenly disappear from the market because the maximum value of the revenue is under F^s. This is the catastrophic point in the market for small firms. Therefore, at the catastrophic point, $q = q^*$, it is assumed that

$$\overline{R}(q^*) = F^s \quad \text{and} \quad \left.\frac{d\overline{R}}{dq}\right|_{q=q^*} = \widetilde{R}_q + \widetilde{R}_{p^L} \frac{d\overline{p}^L}{dq} < 0.$$

I use q^* as defined in Sect. 1.2. From the revenue function, it is straightforward that, at least, in the neighborhood of the catastrophic point, the assumption of the limited elasticity of substitution is sufficient for the condition of the fringe firms in partial monopoly defined in Sect. 1.2. N^* corresponds to N^m.

Consider the neighborhood of the catastrophic point. When the given value of q falls in the region $q < q^*$, the number of small firms at free entry equilibrium $N^e(q)$ is determined to satisfy the condition $\widetilde{R}(\overline{p}^s(q); N^e, q, \overline{p}^L(q)) = F^s$. Differentiating the equation at the catastrophic point, $(q, N^e) = (q^*, N^*)$, the following is derived:

$$\left\{ \widetilde{R}_{p^s}\Big|_{p^s=p^m} \left.\frac{d\overline{p}^s}{dq}\right|_{q=q^*} + \left.\left(\widetilde{R}_q + \widetilde{R}_{p^L} \frac{d\overline{p}^L}{dq} \right)\right|_{q=q^*} \right\} dq + \tilde{R}_N\Big|_{N=N^*} dN^e = 0.$$

Note that $\overline{R}(q^*) = \widetilde{R}(\overline{p}^s(q^*); N^m(q^*), q^*, \overline{p}^L(q^*)) = F^s$, then $N^e(q^*) = N^m(q^*)$. Therefore, $\widetilde{R}_N\big|_{N=N^e(q^*)} = \widetilde{R}_N\big|_{N=N^*(q^*)} = 0$. Because $\widetilde{R}_{p^s}\big|_{p^s=p^m} = 0$ by maximization of small firms, the inside of the parenthesis of the first term is $\left.\left(\widetilde{R}_q + \widetilde{R}_{p^L} \frac{d\overline{p}^L}{dq} \right)\right|_{q=q^*}$, which is negative. Moreover, when $N < N^m$, $\widetilde{R}_N = -r/(2N^2)t(q, r/N, p^m, p^L) < 0$. Therefore, as q increases to the catastrophic point, $q \to q^{*-}$,

$$\lim_{q' \to q^{*-}} \left.\frac{dN^e(q)}{dq}\right|_{q=q'} = \infty.$$

Then,

$$\lim_{q' \to q^{*-}} \left.\frac{dD(q)}{dq}\right|_{q=q'} = -\frac{r}{(N^e(q))^2} \left.\frac{dN^e(q)}{dq}\right|_{q=q'} = -\infty.$$

Intuitively, as consumers at the border do not buy from small firms, $t(x^m/2) = 0$, and the small firms behave like a monopolist, although there are N^m small firms. They ignore the existence of their neighbors, and the revenue function does not depend on the number of other firms. Thus, reducing the number of small firms will not improve their revenue, and all the small firms will suddenly disappear from the market.

Therefore, in Eq. (1.1), the absolute value of the second term is overwhelming, and the sign of derivative of the total distribution cost $\frac{d}{dq}DC(q)$ is determined by whether the number of small firms is partially excessive or not, $-F^s/(D^2) + TC_D$. A positive value of the second term indicates that the amount supplied by ordinary small stores could have been distributed cheaper by a larger number of stores and vice versa.

1.4 Implications

If it is assumed that the same amount of goods could be distributed by a smaller number of small stores, the inside of the parenthesis of the second term of Eq. (1.1) is negative, and the value of Eq. (1.1) is negative at the neighborhood of the catastrophic point. As the share of the large-scale store is increasing, the total distribution cost is still decreasing.[10]

Figure 1.2 depicts how the number of small-scale grocery stores decreases as the regional retail activity declines. The data are from the *Census of Commerce in 2014* area mesh statistics. All the area in Japan was divided into meshes of 1 km each, and the number of stores, retail and wholesale sales, and sales floor space were surveyed. In the figure, the x-axis represents the number of retail workers in each of the 6,658 10 km mesh areas, which is expected to proxy the magnitude of regional retail activities, and the y-axis represents the number of grocery specialty stores in the same areas as the proxy for the activities of ordinary small stores.[11] The figure depicts that there are many areas where the relationship between retail activities and the number of small firms looks almost proportional. This is because, in many rural areas, inhabitable lands are very limited, surrounded by mountainous terrain. The population is concentrated in a small area; thus, population density is high. Therefore, retail activities and the number of small stores are proportional—both are determined by the ratio of inhabitable lands in these areas. This property causes a large variance on the y-axis—the number of small stores. Nevertheless, it is obvious

[10] Torii (1993) demonstrated that if only the distribution cost is considered, under free entry and elastic demand, the number of stores will be excessive whether the type of competition is Zero Conjectural Variation or Lösch as the same amount of goods can be distributed by smaller number of stores. This implies that the inside of the parenthesis of the second term of Eq. (1.1) is negative.

[11] I aggregated the number of stores to 10 km mesh because 1 km mesh is too small as an area to consider the competition between retail stores, especially those in rural areas. I surveyed 65,710 1 km mesh areas, finding that 21,552 areas have only one store. The reason I used the number of retail workers in the areas and did not use the retail sales as the proxy for retail activities is that in many areas, the sales data are kept confidential because of the small number of stores. Grocery specialty stores are those who sell 50% or more of their sales in food product, except for grocery supermarkets, chain convenience stores, and department stores.

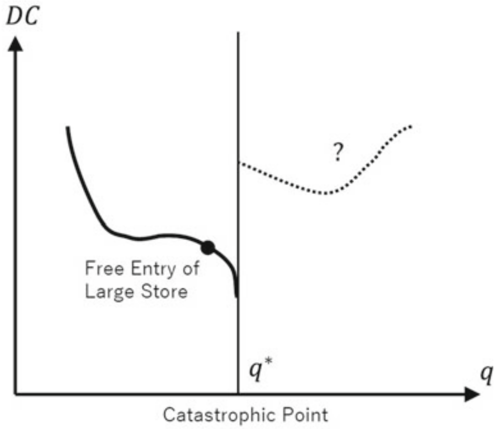
that in many areas, small stores face the danger of elimination. When the number of workers in their 10 km mesh decreases to less than 100, grocery specialty stores face extinction. Note that both axes are on the logarithmic scale. If these crises are caused by expansions of large-scale stores nearby, the possible effect on the total increasing distribution cost should be considered. However, in most areas in Japan, there are spaces for large-scale stores, contributing to efficient retail distribution costs.

The full shape of the DC function, that is, the total distribution cost, cannot be known unless the trip cost function or pricing strategies are specified. Therefore, there may be several local optimal points that minimize DC. However, at least in the neighborhood of the catastrophic point, the increased share of large-scale stores decreases the total distribution cost (See Fig. 1.3). If large-scale stores stop increasing their share before they reach the catastrophic point because they have reached the optimal, this free entry equilibrium of large-scale stores does not mean an excess entry of large stores unless there are several minimizing points in the DC function. If this occurs, there is no need for market share regulation of large-scale stores. The share of the large store is still insufficient at the free entry equilibrium.

If large-scale stores enter beyond the catastrophic point, then the situation is beyond the ability of this model. In such a case, the competition among large-scale stores has to be explicitly considered. The total distribution cost may be discontinuous at this point. However, it is at least valid that unless the entrance of large-scale stores eliminates all the ordinary small stores, entries occur only when it decreases the total distribution cost. Then two conditions are necessary for sound rationality of the market share regulation. The total distribution cost jumps up at the catastrophic

Fig. 1.2 Relationship between regional retail activity and number of small firms in mesh statistics in Japan

Fig. 1.3 Possible effect of expansion of a large-scale store in regional retail market



point, and new entry or an increase in the share of the large store is still observed at the catastrophic point.

The catastrophic point is located at a high value of q when the demand density is high and the fixed costs of small stores are small, as expected of the Japanese retail market. There is only a limited probability that small firms would face extinction. Thus, the analysis of this study reveals that there is no economic reason to restrict the entrance of large-scale stores unless we find the rationalization to protect small stores because they are small.

A more specific model that assumes the conduct of consumers and the pricing strategy of large-scale stores is analyzed by Torii (1990). In the model, consumers select a combination of where to buy from to minimize their total shopping cost. Using that model, the proposition stated above is examined explicitly.

The level of actual restrictions is far before the free-entry equilibrium of large-scale stores. The presence of rents caused by the restriction reported by Hosono (1987) can be used to ascertain this phenomenon. The author also identifies the existence of rents in large-scale stores in 1979—the same year the restriction was tightened. Therefore, this tendency was expected to become stronger after that year.

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Chapter 2
Corporate Taxation and Regional Economic Development in Japan: A Panel Analysis of Prefectural-Level Data

Masahiro Shinohara

Abstract Japan's Business Location Promotion Law was enacted with the aim of revitalizing regional economies through decentralized industrial growth. This paper analyzes the effect of corporate tax policy—modeling tax burden as the marginal effective tax rate (METR) at the prefectural level—on regional economic development by estimating its impact on firms' decisions about where to locate new facilities. The key findings can be summarized as follows: (1) The effect of corporate taxation on regional economic development—modeled as employment in the manufacturing sector—is significantly negative at the national level. However, when the country is split into two categories—Japan's three major metropolitan areas versus all other prefectures ("provincial regions")—the effect is not statistically significant in either category. (2) Several independent variables unrelated to tax burden also influence regional economic development. Notably, market characteristics—modeled as population size—has a significantly positive effect both at the national level and separately within each regional category. The nationwide model indicates that the effect of market characteristics is considerably larger than that of corporate taxation. (3) The public service of highway infrastructure has a significantly positive impact on manufacturing employment within Japan's three major metropolitan areas.

2.1 Introduction

Japan's industrial location policies have reached an inflection point, influenced by economic and social changes in the twenty-first century, such as globalization, population decline, and decentralization. Their emphasis "has shifted from the decentralization of industrial and other functions to focusing on the independence of regional economies, the creation of new internationally competitive industries, and industrial

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agglomeration."[1] Japan's manufacturing sector was singled out for support in the Business Location Promotion Law enacted in 2007[2]: by encouraging firms to locate new facilities in ways that take advantage of regional characteristics and strengths, it aimed to revitalize local economies through the creation of advanced industrial clusters. Since 2017, this Law has been partially amended and joined by the Regional Future Investment Promotion Law.[3] This piece of legislation was also intended to promote regional economic development, but with a much broader scope, targeting regional economic advancement projects by companies in a wide range of sectors beyond manufacturing.

Both pieces of legislation provide financial support towards these goals in the form of tax incentives. For example, companies can claim special depreciation or tax credits on corporate income tax, as well as reductions or exemptions for fixed property tax and real estate acquisition tax. In addition, when local governments reduce or exempt companies' property tax (municipal) or real estate acquisition tax (prefectural) under the terms of the laws, they are eligible to receive subsidies from the national government (funded by the "local allocation tax") for a specified period to help compensate for the resulting revenue shortfall.

Such tax incentives and allocations to local governments are certainly ambitious, and their effectiveness in advancing their stated goals deserves close attention; however, quantifying such effects can prove challenging. This study utilizes an econometric model to examine the effect of corporate tax policy on regional economic development in Japan via its impact on industrial location decision making since the enactment of the Business Location Promotion Law. Location decisions shall be framed as choices between prefectures, rather than cities or towns. The chief focus shall be the manufacturing industry, with sector-specific employment adopted as an indicator of local economic development. This study is expected to contribute uniquely to the literature due to both the dearth of quantitative analyses of the effects of the Japanese tax system on regional economic development among previous works (see Sect. 2.1) and its methodology of estimating firms' marginal effective tax rates to represent tax burden.

The rest of the paper is organized as follows. Section 2.1 reviews previous analyses of the impacts of taxation on regional economic development. Section 2.2 details the methodology of our econometric model, the results of which are presented in Sect. 2.3.

[1] Matsubara and Kamakura (2020), p. 219.

[2] Act on Formation and Development of Regional Industrial Clusters through Promotion of Establishment of New Business Facilities.

[3] Act on Strengthening a Framework for Regional Growth and Development by Promoting Regional Economy Advancement Projects.

2.2 Literature Review

Numerous studies have analyzed the impacts of taxation on business location and regional economic development, among which survey research has been a particularly fertile and active subfield. In a pioneering literature review, one of the first to address the question of taxation and business location, Due (1961) presented several common conclusions of previous studies on the topic: (1) tax effects are not an important determinant of location decisions; (2) state/local taxes *are* an important factor to consider when deciding between locations within a metropolitan area; however, since they represent such a small percentage of total costs, their influence is negligible; and (3) the effect of regional differences in tax regimes on location decision making is minimal.[4]

Due's work served as inspiration for a series of successive surveys, including some focused on the results of published econometric models; notable examples include Oakland (1978), Wasylenko (1981, 1985, 1997), Newman and Sullivan (1988), Bartik (1991, 1992), and Hanson (2019). With the exception of Hanson (2019), each review focused on the impact of local taxes on business activity and regional economic development and can be categorized as comparing trends either within a specific region (urban areas), between different regions (states or urban areas), or in both respects. Each survey shall be briefly summarized in the paragraphs below, but broadly speaking, they commonly found (1) local tax burden to have a significantly negative impact on regional economic development and (2) tax differences within a given region to influence business location decisions to a greater extent than such differences between different regions. Despite their differences from Due (1961), by acknowledging that other factors have considerably larger effects than taxation, they essentially reached the same conclusion.

Examining several studies from the 1960s and 1970s focused on local taxes' impact on business location inside metropolitan areas, Oakland (1978) concluded that the field was still too immature to estimate the effects of taxation for several reasons: (1) the methods used in such analyses needed further refinement; (2) more empirical evidence derived from econometric model-based research needed to be collected; and (3) such models still needed to incorporate the behavior of local governments on the supply side, e.g., providing businesses with industrial land.

Reviewing the empirical analyses within metropolitan areas and between states conducted since Oakland (1978), Newman and Sullivan (1988) noted that while many of them expressed skepticism toward the conventional view that taxation's effects on business location decision-making are inconsequential, none ultimately reached solid conclusions in that respect.

Focusing exclusively on studies from the 1980s, Bartik (1991, 1992) noted that although researchers disagreed on the impact of local taxes on regional economic development, most had moved away from the traditional view that they had no significant effects at all. Second, these effects were more conspicuous within a given metropolitan area than between metropolitan areas or between states.

[4] See Due (1961), p. 171.

Following in Bartik's footsteps, Wasylenko (1997) classified previous econometric analyses by whether they examined the effects of taxation between different regions versus within a particular region.[5] Within each category, studies were further classified by the dependent variable chosen to represent regional economic development: macro indicators, such as income, employment, and investment, versus micro indicators, such as factory expansions, relocations, and births. In this framework, he identified large differences between regions unrelated to taxation, such as in market and cost characteristics; however, tax differentials were typically reduced by measures taken by local governments to close the gap with their neighbors. Thus, while the effects of taxation on economic activity were significant in a statistical sense, they were minor in terms of degree. Within a specific region, conversely, smaller differences in non-tax factors acted to amplify proportionally the effects of taxation on economic activity in this scenario. Similar conclusions were drawn in previous works by the same author (1981; 1985).

In a recent working paper, Hanson (2019) noted that in parallel with developments in the field of micro-econometrics, natural experiment approaches have become mainstream in econometric research since the era in which the econometric research covered by Wasylenko (1997) was conducted. His paper summarized and reviewed a host of studies on how regional economic development is influenced by taxation, separately examining each of the following: property taxes/incentives, spatially targeted and zone-based tax concessions, business-specific incentives (subsidies), and corporate income taxes. Hanson concluded by arguing that a policy shift away from property tax incentives and towards lower corporate income tax rates and measures to promote investment would be needed to steer regional economic development in the right direction.

The publications discussed above are representative of research trends outside of Japan. The paragraphs below shift focus to domestic research into taxation's relationship with regional economic development. Several econometric analyses of the determinants of industrial location have been conducted in Japan, including Gaku (2000), Ogawa and Ishida (2013, 2016), and Takao et al. (2018), but only a few have examined the impact of taxation. Gaku (2000) clarified the effects of the government's tax-financed regional policies on industrial location using dummy variables, representing whether or not a prefecture was designated as eligible under each of the three laws passed for that purpose (the Industrial Development in Underdeveloped Regions Promotion Law, New Industrial City Construction Promotion Law, and Industrial Relocation Promotion Law). Despite the insights yielded, his analysis did not extend to the effects of taxation. Fuzisawa (2012) showed that industrial location incentives (tax cuts, credits, subsidies, loans, etc.) are a determinant of corporate decision-making in this regard, modeling their effects using policy dummy variables at the municipal level. Nakata (2016) analyzed how pro forma standard taxation, a corporate enterprise tax introduced in 2004, changed company behaviors related

[5] In the Japanese context, an inter-region analysis would compare trends in different prefectures, while an intra-region analysis would compare trends between different municipalities within a specific prefecture.

to headquarters relocation. She found that the new system had made firms more sensitive to concerns about the effective corporate tax rate, which made them avoid regions with high rates as relocation destinations.

2.3 Methodology

2.3.1 Model

This study modeled the fixed effects of independent variables according to the following estimation equation:

$$Y_{it} = \beta_i X_{1it} + \cdots \beta_k X_{kit} + \alpha_i + \lambda_t + u_{it}$$

where Y_{it} is the value of the dependent variable for individual i at time t; X_{kit} is the value of the kth independent variable individual i at time t ($i = 1, \ldots, N$; $t = 1, \ldots, T$), α_i is an individual-specific constant term (fixed effect), λ_t is a time effect, and u_{it} is an error term.

The estimation period spanned 20 years in total, consisting of four yearlong periods separated by a five- or four-year[6] interval (2005, 2010, 2015, 2019). Endogeneity bias was addressed by implementing one period of lag, utilizing independent variable data from the year before the corresponding dependent variable data (2004, 2009, 2014, 2018). National census data were the only exception: while sampled at five-year intervals, data were only available for the years in which the census was conducted (2000, 2005, 2010, 2015). Elasticity values were calculated based on log-transformed variable data. Data from all 47 prefectures were analyzed in a nationwide model, as well as two region-specific models: an “metropolitan” regional model consisting of Japan’s three major metropolitan areas—Tokyo, Nagoya, Osaka, and neighboring prefectures[7]—and a “provincial” regional model covering all prefectures outside those three areas.

[6] The four-year interval was chosen (i.e., 2019 was selected instead of 2020) because at the time during which the study was performed, 2018 was the latest year for which real capital stock data were available needed to estimate the METR.

[7] In Japan, “the three major metropolitan areas” (*san-daitoshi-ken*) refers to the three largest metropolises in the country and their neighboring prefectures, which are heavily urbanized with interconnected economies, i.e., the Tokyo Metropolitan Area (Tokyo, Kanagawa, Saitama, Chiba, Ibaraki), the Nagoya Metropolitan Area (Aichi, Gifu, Mie), and the Osaka Metropolitan Area (Osaka, Hyogo, Kyoto, Nara, Wakayama). Government data collected since 2000 indicated that businesses are increasingly choosing to locate new factories in these three giant conurbations (2000: 27.2%, 2005: 34.3%, 2010: 37.3%, 2015: 40.0%, 2020: 42.6%; Survey of Factory Location Trends, METI).

2.3.2 Variable Selection

(1) Dependent variable

Regional economic development can be quantified using macro-indicators, such as income, employment, and investment, and/or micro-indicators, such as factory expansions, relocations, and births.[8] This paper adopted employment as the dependent variable, defining it as the number of workers employed in the manufacturing sector.

(2) Independent variables

To examine the impact of corporate taxation on regional economic development via its influence over industrial location decision-making, numerous relevant factors were considered as candidate explanatory variables. These regressors were chosen with reference to the results data of an annual business survey, in which respondents endorsed specific reasons for their business location decisions, as well as previous econometric analyses of business location and economic development.

(1) Business survey data

Conducted annually since 1962, the *Survey of Factory Location Trends* targets businesses in the manufacturing, electricity, gas, and heating industries that have acquired land of 1,000 m^2 or more for the purpose of constructing factories or research facilities. Roughly 1,300 businesses participate in the survey, and results are published separately by industry and prefecture. Businesses rate 18 factors by their importance in their decision criteria for locating in the prefecture(s) that they chose, categorizing them as "critical" or "secondary" reasons; any number of reasons can be selected.

The top 10 reasons endorsed by businesses for new factory location during the estimation period are ranked in Table 2.1. For scoring, a reason marked "critical (secondary)" is awarded 1.0 (0.5) points for each business endorsing it. These factors can be broadly classified under the price/availability of production inputs (land prices, access to human resources/labor force, ease of procuring raw materials, etc.), transportation infrastructure (highway access), agglomeration advantages (proximity to headquarters/other company-owned plants, site of the industrial park, proximity to affiliated companies), market access (proximity to markets), environment (few restrictions from the surrounding environment), and government support (sincerity/proactivity/responsiveness of local government, national/local government subsidies). Thus framed, the prices/availability of production inputs and agglomeration advantages clearly rank among the most important considerations for new factor location.

[8] See Wasylenko (1997), p. 39.

Table 2.1 Japanese survey data on factors influencing business decisions about new factory locations: reasons by rank (all industries)

Rank	2007	2011	2016	2021
1	Proximity to headquarters/other company-owned plants (270)	Proximity to headquarters/other company-owned plants (157)	Proximity to headquarters/other company-owned plants (203.5)	Proximity to headquarters/other company-owned plants (155.5)
2	Site of industrial park (216)	Site of industrial park (95)	Land prices (102)	Land prices (65)
3	Land prices (208)	Land prices (85)	Site of industrial park (96)	Site of industrial park (64)
4	Few restrictions from the surrounding environment (157.5)	Proximity to markets (77)	Access to human resources/labor force (76)	Proximity to affiliated companies (51.5)
5	Proximity to affiliated companies (142.5)	Proximity to affiliated companies (75)	Few restrictions from the surrounding environment (74.5)	Access to human resources/labor force (48.5)
6	Access to human resources/labor force (133.5)	Access to human resources/labor force (72)	Proximity to markets (71.5)	Proximity to markets (44.5)
7	Proximity to markets (110.5)	Few restrictions from the surrounding environment (70)	National/local government subsidies (71)	Highway access (41.5)
8	National/local government subsidies (105.5)	Ease of procuring raw materials, etc. (60)	Highway access (37.5)	Few restrictions from the surrounding environment (32.5)
9	Sincerity/proactivity/responsiveness of local government (98.5)	Sincerity/proactivity/responsiveness of local government (56)	Proximity to affiliated companies (62.5)	National/local government subsidies (31.5)
10	Ease of procuring raw materials, etc. (77.5)	National/local government subsidies (54.5)	Sincerity/proactivity/responsiveness of local government (51)	Ease of procuring raw materials, etc. (31)

Note Numbers in parentheses denote each reason's score
Source Prepared from data in *Survey of Factory Location Trends* (Ministry of Economy, Trade and Industry)

(2) Econometric model

The dependent and independent variables often used in past econometric models of economic development and business location are compiled in Table 2.2. The representative works shown include Plaut and Pluta (1983)'s study of industrial growth and Wasylenko (1997)'s review of econometric models of economic development. Wasylenko (1981) and Arauzo-Carod et al. (2009) surveyed a number of published econometric models of industrial location, specifically focusing on their selection of explanatory variables. Japanese studies of factory location are represented by Gaku (2000) and Ogawa and Ishida (2013, 2016).

The explanatory variables surveyed in Table 2.2 are re-organized in Table 2.3 according to different criteria.[9] They can be divided into non-fiscal and fiscal variables; the former can be subdivided into economic and non-economic factors. Economic factors consist of cost characteristics and market characteristics, based on the assumption that firms seek to maximize profits.

The following variables were regarded as cost characteristics: access to markets, prices and availability/productivity of production inputs, transportation infrastructure, agglomeration advantages (economic/industrial agglomeration), distance from headquarters, and information/travel costs.[10] Economic agglomeration can take two forms: economies of urbanization and economies of regional specialization. The former refers to "economic benefits that arise when a large number of stakeholders not exclusively within a particular sector or industry locate in the same area," while the latter refers to "economic benefits that arise when companies in the same sector or industry cluster in a particular area."[11] Since both economies of regional specialization and industrial agglomeration involve the effects of the concentration of the same industry, the two terms can be used interchangeably.

Different market characteristics have relevance to the suppliers of intermediate goods and those of final (consumer) goods. While demand for intermediate goods depends on the number of customers (i.e., local businesses) in need and their degrees of need, demand for the final goods is more dependent on demographic and socioeconomic factors (per capita income level, population size, and density, etc.). Both types of demand, however, are influenced by the numbers of competing suppliers.[12]

Non-economic factors include worker education level and living and business environments.[13] In the case of small firms, the personal preferences of management also influence location decisions.

Fiscal variables include taxation, public services, government incentives (tax cuts/credits, subsidies, loans), and environmental regulations.

[9] This categorization scheme was drawn exclusively from the works of Wasylenko (1981, 1997).

[10] It stands to reason that information and travel costs would consume a greater percentage of earnings for smaller enterprises, which may be one reason why small business owners may limit their options to familiar areas. See Wasylenko (1981), p. 160.

[11] See Fukazawa (2020), p. 43.

[12] See Wasylenko (1981), p. 157.

[13] Technology-intensive industries tend to locate preferentially in areas with higher population densities and higher levels of worker education. Arauzo-Carod et al. (2009), p. 703.

Table 2.2 Economic development and industrial location-related variables in past econometric modeling research

	Dependent variable	Independent variables	
		Non-fiscal	Fiscal
Plaut and Pluta (1983)	Industrial growth (percent changes in real value added, employment, real capital stock)	· Market access · Prices of production inputs (wages, land, raw materials, energy) · Availability/productivity of production inputs (unemployment rate, labor union activities, labor productivity) · Climate and living environment · Business environment	· Taxation · Public services
Wasylenko (1997)	Economic development (income, employment, investment, factory expansions, relocations, and births)	· Wages · Energy prices · Presence of labor unions/protection laws · Economic agglomeration · Market size (population size, per capita income level)	· Taxation · Public services
Wasylenko (1981)	Industrial location	· Market characteristics (per capita income, population size, etc.) · Cost characteristics (wages, equipment costs, land prices, transportation costs, economic agglomeration, energy prices, information/travel costs) · Personal preferences of business owners (climate, commute time, etc.)	· Taxation · Public services · Government incentives (tax cuts/credits, subsidies, loans)
Arauzo-Carod et al. (2009)	Industrial location	· Economic agglomeration · Transport infrastructures · Wages · Education level · Population density · Market characteristics · Personal preferences of business owners	· Taxation · Public services · Government incentives for new businesses · Environmental regulations

(continued)

Table 2.2 (continued)

	Dependent variable	Independent variables	
		Non-fiscal	Fiscal
Gaku (2000)	Industrial location (no. of manufacturing plants by prefecture)	· Wages · Land prices · Economic agglomeration · Industrial agglomeration	Government policies encouraging local plant location (dummy variable for policy-designated regions)
Ogawa and Ishida (2013, 2016)	Industrial location (no. of manufacturing plants by prefecture)	· Industrial agglomeration · Prices of production inputs (wages, land) · Factory worker availability; access to sophisticated technical professionals · Infrastructure · Distance from headquarters	–

Source Prepared by the author

Given the above, the following variables were incorporated into the models as independent variables. Four non-fiscal variables categorized as cost characteristics were incorporated: real wages, land prices (i.e., production inputs), and two types of agglomeration advantages. Economic agglomeration was modeled as employment density (number of employees per km^2); industrial agglomeration was modeled as establishment density (number of manufacturing sites per km^2). For market characteristics, population size was used due to its correlation with local demand. One non-economic factor was included—worker education level—which was modeled using the education expenditures of local government as a proxy variable.

Two kinds of fiscal variables were incorporated into the model: taxation (i.e., tax burden) and public services. Same as in Papke (1991), taxation was operationalized as the *marginal effective tax rate* (METR), an indicator of the extent to which real costs of capital are increased by tax burden. The METR was estimated according to Eq. (2.1) below, where *ucc* represents the real cost of capital under the tax system, and r denotes the real interest rate.[14] Equation (2.2) was used to calculate *ucc* (A: present discounted value of the preferential treatment of investments, ρ: discount rate, δ: economic depreciation rate, π: inflation rate). This formula also accounted for taxation on corporate income at rate τ (i.e., combined corporate income, inhabitant, and enterprise taxes), as well as excluding deductible corporate fixed asset taxes W_c from the corporate taxation base.

$$\text{METR} = \frac{ucc - r}{ucc} \tag{2.1}$$

[14] For detailed information on how the METR is defined, see Devereux (2003), p. 7.

Table 2.3 Independent variable classification

		Non-fiscal variables	Fiscal variables
Economic factors	Cost characteristics	· Market access · Production inputs: Prices (wages, land, energy, etc.) · Production inputs: Availability/productivity (workforce availability, presence of labor unions/protection laws, labor productivity) · Transport infrastructures · Agglomeration advantages (economic agglomeration, industrial agglomeration) · Distance from headquarters · Information costs · Travel costs	· Taxation · Public services · Government incentives (tax cuts/credits, subsidies, loans) · Environmental regulations
	Market characteristics	· Demand for intermediate goods; number of competing producers · Demand for final goods (per capita income level, population size, population density); number of competing producers	
Non-economic factors		· Worker education level · Environment (living environment) · Personal preferences of business owners (in the case of small firms)	

Source Prepared by the author

$$ucc = \frac{1}{1-\tau}\{(1-A)(\rho+\delta-\pi)+(1-\tau)W_c\}-\delta \tag{2.2}$$

τ is the effective corporate tax rate: the rate until 2007 was calculated using Eq. (2.3); the rate from 2008, when Japan introduced the special local corporation tax, and

Table 2.4 Tax rate for corporate taxation in Japan

	Corporate inhabitant tax (per corporate income tax basis)		Corporate enterprise tax		Corporate income tax (basic rate) (%)	Special local corporation tax (%)
	Standard tax rate	Higher rate than standard tax rate	Standard tax rate	Higher rate than standard tax rate		
2004	1 5%	46 (5.8%, 6%)	40 9.6%	7 (9.888%, 10.08%)	30	–
2009	1 5%	46 (5.8%, 6%)	39 5.3%	8 (5.588%, 5.78%)	30	4.3
2014	1 5%	46 (5.8%, 6%)	39 5.3%	8 (5.588%, 5.777%, 5.780%)	25.5	2.9
2018	1 3.2%	46 (4%, 4.2%)	39 6.7%	8 (6.988%, 7.169%, 7.18%)	23.2	2.9

Note (1) Numbers reflect the total number of organizations subject to the tax that year
(2) Percentages reflect official rates as of April 1st of the corresponding year
Source Prepared from data in *Handbook on Local Taxes* (Panel on Local Tax Affairs (eds.)) and *Trends in Corporate Tax Rates* (Ministry of Finance)

onwards was calculated using Eq. (2.4).[15] Rate and tariff schedules for each type of corporate tax are provided in Table 2.4. Corporations having capital stock of less than 100 million yen are not subject to pro forma standard taxation,[16] but are subject to the corporate enterprise tax at a higher rate than the standard tax rate, as well as the special local corporation tax. W_c is the effective rate for fixed property tax and was calculated using Eq. (2.5). The denominator term—gross nominal capital stock—is the nominally adjusted value of the indicator "real net capital stock by prefecture (excluding intellectual property products)" listed in the *R-JIP Database 2021* (Research Institute of Economy, Trade and Industry). The numerator term—the assessment value of corporate depreciable fixed assets—is the tax basis of the corporate depreciable assets listed in the *Statistical Report on Value of Fixed Assets* (Ministry of Internal Affairs and Communications).

[15] See Nakata (2016), p. 7.

[16] Since FY2004, ordinary corporations with capital exceeding 100 million yen are subject to pro forma standard taxation (a.k.a. "size-based corporate taxation"), which consists of a value-added levy (based on total remuneration plus net interest/rent expenses) and a capital levy (based on total capital stock, etc.), in addition to an income levy (based on corporate income). Roughly 1% of all corporate entities in Japan are subject to pro forma standard taxation.

$$\tau = \frac{Corporate\ Tax\ Rate \times (1 + Prefectural\ Inhabitant\ Tax\ Rate) + Corporate\ Enterprise\ Tax\ Rate}{1 + Corporate\ Enterprise\ Tax\ Rate} \tag{2.3}$$

$$\tau = \frac{\text{Corporate Tax Rate} \times (1 + \text{Prefectural Inhabitant Tax Rate}) + \text{Corporate Enterprise Tax Rate} \times (1 + \text{Special Local Corporate Tax Rate})}{1 + \text{Corporate Enterprise Tax Rate} \times (1 + \text{Special Local Corporate Tax Rate})} \tag{2.4}$$

$$W_c = \frac{Assessment\ Value\ of\ Corporate\ Depreciable\ Fixed\ Assets \times Fixed\ Property\ Tax\ Rate\ (1.4\%)}{Gross\ Nominal\ Capital\ Stock} \tag{2.5}$$

Discount rate ρ was derived as $\rho = (1 - \tau)i$, assuming that companies self-finance with debt at nominal interest rate i.[17]

One phenomenon that deserves special attention when examining the effects of taxes is how differences in the METR between regions are reflected in land prices. If one area has a higher (lower) METR than other areas, land prices there will fall (rise) in accordance with the expected future tax burden. In the case of complete capitalization, the effects of taxes are offset by change in land prices. Complete capitalization was not assumed in this analysis, but both taxation and land prices were included as explanatory variables.[18]

Public services act as a kind of synergistic production input, with high-quality services increasing production levels by lowering firms' costs while increasing the productivity of labor and other factors. It thus seems reasonable to assume that companies take local public services into account when selecting new factory locations. Furthermore, since public services are financed by tax revenues, their impacts must be considered alongside that of taxation to estimate the latter accurately. Even heavy tax burdens can benefit companies on balance if they gain value from the public services thus financed, a good example of why the effect of taxes on regional economic development is not always negative.[19]

In their reviews of previous studies examining the impact of local public services on business location and economic development, Bartik (1991) and Fisher (1997) showed that those related to transportation, public safety (police and fire), and education are most likely to have positive effects. Given their importance, three public service-related variables were included in the present analysis: public safety expenditures, highway infrastructure, and education expenditures. The second factor was operationalized as the number of kilometers of Japan's National Expressway within the prefecture ("real highway length" below). Public safety and education expenditures were considered jointly with spending at the municipal level and analyzed as a percentage of each prefecture's total annual expenditures.

The independent variables described in the paragraphs above were hypothesized to have contrary effects on factory location decisions. Since real wages, land prices, and

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[17] For details on how the present discounted value of the preferential treatment of investments A, discount rate ρ, and economic depreciation rate δ are estimated, see Iwata et al. (1987).

[18] If land price (LP) were not included in the regression model, the value of the coefficient for the METR (TAX) would reflect the net effect excluding capitalization.

[19] Gabe and Bell (2004) identified an important trade-off in fiscal policy in this regard: when municipalities seeking economic growth try to attract businesses by cutting taxes, public services suffer as a consequence, which dampens economic growth in turn.

tax burden act as costs from a business perspective, they were expected to have negative effects. Conversely, agglomeration advantages (both economic and industrial), market characteristics (which reflect demand), and public services were expected to have positive impacts.

2.4 Data

(1) Statistics used

Definitions of the variables used in the study model are presented in Table 2.5, along with the respective data sources.

Table 2.5 Variable definitions and data sources

Dependent variable		
Variable	Definition	Data source
Number of workers (WORKER)	No. of employees in manufacturing industry	*Statistical Survey on Corporate Performance and Business Establishment* (Statistics Bureau, Ministry of Internal Affairs and Communications) *Economic Census* (Statistics Bureau, Ministry of Internal Affairs and Communications)
Independent variables		
Non-fiscal	Definition	Data source
Real wages (RW)	Real wages in manufacturing industry	*Basic Survey on Wage Structure* (Ministry of Health, Labor and Welfare) *Social Indicators by Prefecture* (Statistics Bureau, Ministry of Internal Affairs and Communications)
Land prices (LP)	Average price of land (all categories)	*Survey of Factory Location Trends* (Ministry of Economy, Trade and Industry)
Economic agglomeration (EA)	Employment density (no. of employees per km^2)	*Statistical Survey on Corporate Performance and Business Establishment* (Statistics Bureau, Ministry of Internal Affairs and Communications) *Economic Census* (Statistics Bureau, Ministry of Internal Affairs and Communications) *Planimetric Reports by Prefectures and by Municipalities* data (Geospatial Information Authority of Japan)
Industrial agglomeration (IA)	Establishment density (no. of manufacturing sites per km^2)	*Statistical Survey on Corporate Performance and Business Establishment* (Statistics Bureau, Ministry of Internal Affairs and Communications) *Economic Census* (Statistics Bureau, Ministry of Internal Affairs and Communications) *Planimetric Reports by Prefectures and by Municipalities* data (Geospatial Information Authority of Japan)

(continued)

Table 2.5 (continued)

Dependent variable		
Variable	Definition	Data source
Market characteristics (MC)	Population size	*National Census* (Statistics Bureau, Ministry of Internal Affairs and Communications)
Fiscal	Definition	Data source
Taxation (TAX)	METR (marginal effective tax rate)	*Special Report on Survey of Corporate Performance* (Policy Research Institute, Ministry of Finance) *Statistical Report on Value of Fixed Assets* (Ministry of Internal Affairs and Communications) *Handbook on Local Taxes* (Panel on Local Tax Affairs (eds.)) *Trends in Corporate Tax Rates* (Ministry of Finance) *R-JIP Database 2021* (Research Institute of Economy, Trade and Industry) *Annual Report on National Accounts* (Economic and Social Research Institute, Cabinet Office) *Average Contractual Interest Rates on Bank Loans* (Bank of Japan)
Public services 1 (PS1)	Public safety expenditures (% of annual spending)	*Annual Report on Account Settlement by Prefecture* (Ministry of Internal Affairs and Communications) *Annual Report on Account Settlement by Municipality* (Ministry of Internal Affairs and Communications) *Annual Statistics on Local Public Finance* (Ministry of Internal Affairs and Communications)
Public services 2 (PS2)	Highway infrastructure (real highway length)	*Annual Report on Highway Statistics* (Ministry of Land, Infrastructure, Transport and Tourism)
Public services 3 (PS3)	Education expenditures (% of annual spending) –	*Annual Report on Account Settlement by Prefecture* (Ministry of Internal Affairs and Communications) *Annual Report on Account Settlement by Municipality* (Ministry of Internal Affairs and Communications) *Annual Statistics on Local Public Finance* (Ministry of Internal Affairs and Communications)

Source Prepared by the author

(2) Summary statistics and correlation matrices

Summary statistics and correlation matrices (after log-transformed) for the study variables are presented in Tables 2.6, 2.7, 2.8, and 2.9. The sample size was 188 (47 prefectures × 4 years) for all but two independent variables: real wages (RW) had a sample size of 180 due to missing data, while the METR (TAX) had a sample size of 187 because the rate was negative in one year of one prefecture and therefore could not be log-transformed. Coefficients presented in all correlation matrices were based on the log-transformed values for each variable.

Table 2.6 Summary statistics

	Sample size	Mean	S.D	Min	Max
WORKER (×10,000 people)	188	22.16	207,200	2.70	101.70
RW (×10,000 yen)	188	272.2	34.09	191.40	371.90
LP (yen/m^2)	180	17,752	16,359	843	93,742
EA	188	0.479	0.789	0.023	4.382
IA	188	0.027	0.053	0.001	0.315
MC (×10,000 people)	188	271.1	262.4	56.61	1374.0
TAX	187	0.990	0.204	−1.651	1.211
PS1 (%)	188	4.540	0.89	2.33	8.80
PS2 (km)	188	161.6	108.1	17.80	725.4
PS3 (%)	188	16.23	1.894	9.885	21.35

Note Numbers in parentheses indicate units
Source Prepared by the author

Table 2.7 Correlation matrix (nationwide)

	Worker	RW	LP	EA	IA	MC	TAX	PS1	PS2	PS3
Worker	1.000	0.722	0.539	0.560	0.717	0.891	−0.041	0.564	0.285	0.332
RW		1.000	0.540	0.489	0.746	0.608	−0.029	0.713	−0.047	0.425
LP			1.000	0.438	0.576	0.520	0.057	0.396	−0.089	0.288
EA				1.000	0.718	0.708	0.006	0.575	−0.199	−0.021
IA					1.000	0.675	−0.033	0.685	−0.274	0.375
MC						1.000	−0.007	0.591	0.175	0.243
TAX							1.000	−0.009	0.014	−0.033
PS1								1.000	−0.203	0.544
PS2									1.000	−0.060
PS3										1.000

Source Prepared by the author

2.5 Estimation Results

The estimation results of the proposed model are presented in Tables 2.10, 2.11, and 2.12. At the national level, the effect of the METR (TAX) on manufacturing sector employment (WORKER) was significantly negative in nearly all models tested.

The exception was Model 5, which included all independent variables, where it lost statistical significance. The correlation matrix for the national-level analysis (Table 2.7), however, suggested high collinearity between MC (market characteristics) and economic/industrial agglomeration (EA/IA). When EA and IA were removed, the negative effect of TAX regained statistical significance, as seen under Model 6.

Table 2.8 Correlation matrix (metropolitan)

	Worker	RW	LP	EA	IA	MC	TAX	PS1	PS2	PS3
Worker	1.000	0.576	0.520	0.636	0.804	0.927	0.066	0.496	0.393	0.098
RW		1.000	0.557	0.703	0.670	0.650	−0,047	0.620	−0.205	−0.250
LP			1.000	0.551	0.629	0.557	0.104	0.413	−0.141	−0.181
EA				1.000	0.918	0.794	0.080	0.690	−0.197	−0.460
IA					1.000	0.871	0.096	0.669	−0.058	−0.252
MC						1.000	0.128	0.654	0.182	−0.074
TAX							1.000	0.042	−0.080	−0.055
PS1								1.000	−0.200	−0.091
PS2									1.000	0.264
PS3										1.000

Source Prepared by the author

Table 2.9 Correlation matrix (provincial)

	Worker	RW	LP	EA	IA	MC	TAX	PS1	PS2	PS3
Worker	1.000	0.568	0.305	0.124	0.394	0.782	−0.026	0.223	0.622	0.202
RW		1.000	0.304	−0.167	0.581	0.281	0.181	0.507	0.265	0.423
LP			1.000	−0.005	0.300	0.238	0.232	0.053	0.098	0.201
EA				1.000	−0.125	0.433	−0.038	0.016	0.149	−0.096
IA					1.000	0.140	−0.053	0.364	−0.240	0.474
MC						1.000	−0.030	0.161	0.570	0.116
TAX							1.000	0.151	0.104	0.077
PS1								1.000	−0.002	0.663
PS2									1.000	−0.079
PS3										1.000

Source Prepared by the author

In contrast to TAX, market characteristics consistently had a significantly positive effect on manufacturing employment in every model in which it was included, and it reflected much larger elasticity in absolute terms (MC: 0.725 v. TAX: −0.014; Model 6).

In the case of Japan's three major metropolitan areas, same as in the national model, MC was highly inter-correlated with EA and IA (Table 2.8). When EA and IA were excluded, the impact of TAX was negative but not statistically significant (Model 12). The effects of MC and PS2 (real extension of expressway) were positive and statistically significant.

In the rest of Japan's prefectures ("provincial regions"), no such correlations with MC were visible for EA or IA (Table 2.9), so all nine independent variables were included in the final model (Model 17). Similar to that of metropolitan regions, the

Table 2.10 Effects of corporate tax environment on manufacturing employment (nationwide)

Dependent variable: WORKER						
Independent variable	(1) FE	(2) FE	(3) FE	(4) FE	(5) FE	(6) FE
TAX	−0.022*** (0.008)	−0.023*** (0.007)	−0.018** (0.007)	−0.011* (0.006)	−0.009 (0.007)	−0.014* (0.007)
RW		−0.027 (0.098)	−0.028 (0.097)	0.054 (0.079)	0.044 (0.078)	0.081 (0.071)
LP		0.002 (0.006)	0.002 (0.006)	−0.0002 (0.004)	−0.001 (0.005)	−0.001 (0.004)
EA			−0.008 (0.024)	−0.031 (0.022)	−0.037* (0.022)	
IA			0.088 (0.077)	0.086 (0.062)	0.088 (0.057)	
MC				0.797*** (0.204)	0.740*** (0.187)	0.725*** (0.208)
PS1					-0.115 (0.072)	−0.095 (0.073)
PS2					−0.005 (0.043)	−0.0008 (0.044)
PS3					0.110 (0.073)	0.102 (0.076)
Observations	187	180	180	180	180	180
Within R-squared	0.878	0.880	0.883	0.913	0.916	0.911
Time effects	Yes	Yes	Yes	Yes	Yes	Yes

Note (1) Clustered robust standard errors are given in parentheses under coefficients
(2) The individual coefficients are statistically significant at the *10%, **5%, and ***1% significance level
Source Prepared by the author

effect of TAX was negative but non-significant, while that of MC was positive and significant. In addition, the effect of real highway length (PS2) on industrial location was statistically significant, but opposite to the direction expected.

In summary, the findings above indicated that the METR had a significant negative effect on industrial location decisions at the national level, but lacked statistical significance when confined to only metropolitan or provincial regions within Japan. This discrepancy could be a consequence of the larger variation in the METR across all of Japan's prefectures (coefficient of variation: 55.975) than in either regional category (metropolitan: 11.333, provincial: 5.754). Therefore, it seems plausible that tax differences between Japan's three metropolitan areas and provincial regions did not significantly influence employment within either regional category.

Table 2.11 Effects of corporate tax environment on manufacturing employment (metropolitan)

Dependent variable: WORKER						
Independent variable	(7) FE	(8) FE	(9) FE	(10) FE	(11) FE	(12) FE
TAX	−0.029** (0.012)	−0.022* (0.011)	−0.003 (0.011)	−0.008 (0.010)	−0.004 (0.007)	−0.016 (0.010)
RW		0.294 (0.198)	0.452 (0.258)	0.410 (0.230)	0.229* (0.120)	0.091 (0.116)
LP		0.004 (0.014)	0.012 (0.014)	0.007 (0.016)	0.004 (0.016)	−0.001 (0.015)
EA			0.013 (0.049)	−0.007 (0.035)	0.076* (0.038)	
IA			0.416* (0.228)	0.432* (0.236)	0.147 (0.187)	
MC				0.294 (0.310)	0.624** (0.227)	0.798*** (0.234)
PS1					0.096 (0.069)	0.051 (0.117)
PS2					0.126** (0.057)	0.135*** (0.041)
PS3					0.445** (0.200)	0.306 (0.203)
Observations	52	49	49	49	49	49
Within R-squared	0.914	0.928	0.940	0.942	0.964	0.956
Time effects	Yes	Yes	Yes	Yes	Yes	Yes

Note (1) Clustered robust standard errors are given in parentheses under coefficients
(2) The individual coefficients are statistically significant at the *10%, **5%, and ***1% significance level
Source Prepared by the author

2.6 Conclusion

Japan's Business Location Promotion Law was enacted with the aim of revitalizing regional economies through decentralized industrial growth. This paper analyzed the effect of corporate tax policy—modeling tax burden as the METR at the prefectural level—on regional economic development by estimating its impact on firms' decisions about where to locate new facilities. The estimation models developed in the pages above revealed the following about these business trends in the last two decades:

(1) The effect of corporate taxation on regional economic development—modeled as employment in the manufacturing sector—is significantly negative at the

Table 2.12 Effects of corporate tax environment on manufacturing employment (provincial)

Dependent variable: WORKER					
Independent variable	(13) FE	(14) FE	(15) FE	(16) FE	(17) FE
TAX	−0.001 (0.366)	0.050 (0.348)	0.122 (0.300)	−0.172 (0.190)	−0.131 (0.180)
RW		−0.199 (0.135)	−0.187 (0.121)	−0.021 (0.087)	−0.026 (0.085)
LP		0.001 (0.007)	0.0009 (0.007)	0.0001 (0.004)	0.002 (0.005)
EA			−0.018 (0.035)	0.001 (0.021)	−0.002 (0.021)
IA			0.077 (0.072)	0.031 (0.044)	0.030 (0.035)
MC				1.266*** (0.176)	1.191*** (0.160)
PS1					−0.095 (0.060)
PS2					−0.083* (0.045)
PS3					0.061 (0.066)
Observations	135	131	131	131	131
Within R-squared	0.866	0.871	0.874	0.935	0.944
Time effects	Yes	Yes	Yes	Yes	Yes

Note (1) Clustered robust standard errors are given in parentheses under coefficients
(2) The individual coefficients are statistically significant at the *10%, **5%, and ***1% significance level
Source Prepared by the author

national level. However, when the country is split into two categories—Japan's three major metropolitan areas versus all other prefectures ("provincial regions")—the effect is not statistically significant in either category. This curious result may be explained by the smaller variation in the METR across prefectures within metropolitan regions and within provincial regions, compared with that of all prefectures in the country.

(2) Several independent variables unrelated to tax burden also influence regional economic development. Notably, market characteristics—modeled as population size—has a significantly positive effect both at the national level and separately within each regional category. The nationwide model indicated that the effect of market characteristics is considerably larger than that of corporate taxation.

(3) The public service of highway infrastructure (i.e., the real National Expressway length within a prefecture) has a significantly positive impact on manufacturing employment within Japan's three major metropolitan areas.

The results of the nationwide model reinforce those of previous studies reporting the differences in state and local tax burden to have negative, statistically significant, yet ultimately negligible effects on regional economic development. Several issues deserve future examination. First, since manufacturing is a highly diverse sector of the economy, it would be worthwhile to repeat the analysis separately for different industrial subsectors within it. Second, this study's focus on tax differences between different regions (prefectures) means that it did not cover how such differences may influence location decisions within a specific region, such as choosing from among municipalities within Japan's three major metropolitan areas.

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Chapter 3
Economies of Scale and Cumulative Causation

Stilianos Alexiadis

Abstract This paper examines 'Verddorn's Law', i.e. the relation between employment and output growth across the NUTS-3 regions of the European Union. Moreover, an explanation is provided as to how 'Verdoorn's Law' sets up a process of cumulative causation. Following the relevant literature, the empirical assessment is conducted using spatial econometric techniques. The empirical results provide considerable support to the validity of 'Verdoorn's Law'. A more detailed analysis suggests that differences in regional growth rates perpetuate a 'dualistic' situation Europe, with advanced regions growing at the expanse of less-developed regions.

Keywords Cumulative Causation · Scale Economies · Regional Growth

JEL R10

3.1 Introduction

A major concern for economists is to find an explanation for why growth rates differ between economies, whether the term 'economy' is applied to countries or geographical areas within them, that is to say regions. It is quite possible that differences in growth rates operate 'cumulatively', perpetuating a 'centre-periphery' situation; an idea proposed by Myrdal (1944, 1957), who postulated that a mechanism of *cumulative causation*, or 'backwash-effects' allows successful regions growing at the expense of less-successful regions. In seeking to provide an explanation for this phenomenon attention is often diverted to concepts such as *dynamic increasing returns*. Kaldor (1967) used the relation between the growth of manufacturing output

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and the growth of labour productivity, known as 'Verdoorn's Law', as an empirical approximation of increasing returns. In an explicit regional context, Kaldor (1970) rivets attention on 'Verdoorn's Law' in order to describe formally a process, through which once a region obtains a productivity advantage it grows at the 'expense' of the other regions. Initially successful regions exhibit higher growth rates while less-advanced regions find themselves in a position of relatively lower growth. It may be argued that such 'clusters' are caused by a mechanism that sustains initial differences across regions. Nevertheless, is it possible for this process to be reversed, or at least slowed down, in favour of the less-advanced regions? Kaldor (1970, p. 344) allows for such a possibility by stating that '[t]here are also important diseconomies resulting from excessive rates of growth in industrial activities in particular areas [...] and these at some stage should serve to offset the technological economies resulting from faster growth'. Increasing returns reach a critical limit after which results to lower growth. If this condition holds for advanced regions, then this may reverse the outcomes of cumulative causation. However, in the context of regional growth models, this remains a virtually unexploited mine of research.

'Verdoorn's Law' has been tested for the OECD (Romero & McCombie, 2016) and individual countries (e.g. Cornwall, 1976; McCombie, 1981; Australia, Metcalf & Hall, 1983) and for various regional contexts (e.g. for the USA states, Bernat, 1996; the UK regions, Hildreth, 1989a, 1989b, the regions of Japan, Casetti & Tanaka, 1992). Several studies (e.g., Fingelton & McCombie, 1998, Pons-Novell and Marshal, 1999) have looked at its applicability to extended regional contexts, such as the regions of European Union (hereafter EU). Nevertheless, few empirical studies examined the possibility of reversing the directionality of cumulative causation. This paper has two aims. A first aim is to extend and improve the empirical literature on 'Verdoorn's Law' using recent data from the EU regions while a second aim is to provide empirical evidence of the possibility of reversing the process of cumulative causation.

Following this introduction, this paper is divided into four sections. The context in which the paper's main question emerges, viz. that faster growth leads to an accelerating reinforcing circle is discussed in Sect. 3.2. An explanation is provided as to how 'Verdoorn's Law' sets up a process of cumulative causation. Section 3.3 discusses some issues relating to data use and manipulation. After outlining the estimation procedure, Sect. 3.4 discusses the econometric results. A final section summarises the econometric results and suggests an interesting policy conclusion.

3.2 Theoretical Foundations

'Verdoorn's Law' describes a statistical relationship between the growth of output and the growth of labour productivity. Kaldor (1966) in his Inaugural Lecture, held in Cambridge, used 'Verdoorn's Law' in order to provide an explanation for UK's slow growth rate.[1] He argued that industrial output in UK was constrained by the growth of labour supply and via 'Verdoorn's Law' industrial productivity grows at a slow rate. Subsequently, Kaldor (1970) offered an alternative view of 'Verdoorn's Law' as an indication of increasing returns to scale, when the expanding size of the local production fabric generates increasing productivity and a source of difference in regional growth rates.[2] Kaldor (1972) considers the presence of increasing returns as a direct challenge to the neoclassical equilibrium theory.[3] The central conceptual apparatus derives from an early model by Young (1928). Increasing returns are considered in *macro* sense as a function of the continual division of labour and more importantly operate in a cumulative way.[4] This argument has been admirably stated by Young (1928) and one can hardly do better than quote him in *extenso*: 'Modified, then, in the light of this broader conception of the market, Adam Smith's dictum amounts to the theorem that the division of labour depends in large part upon the division of labour. This is more than mere tautology. It means, if I read its significance rightly, that the counterforces which are continuously defeating the forces which make for economic equilibrium are more pervasive and more deeply rooted in the constitution of the modern economic system than we commonly realise. Not only new or adventitious elements, coming in from the outside, but elements which are permanently characteristics of the ways in which goods are produced make continuously for change. Every important advance in the organisation of production, regardless of whether it is based upon anything which, in a narrow or technical sense, would be called a new 'invention', or involves a fresh application of the fruits of scientific progress to industry, alters the conditions of industrial activity and initiates responses elsewhere in the industrial structure which in turn have a further unsettling effect. Thus change becomes progressive and propagates itself in a *cumulative way*.' (Young, 1928, p. 533) [emphasis added].

A simple conclusion follows from Young's model. Increasing returns can be considered as a primary force behind the process of cumulative causation. Despite its simplicity, its implications are quite deep. Moreover, several aspects of dynamic increasing returns refer to intangible concepts, such as organisational structure,

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[1] In his Inaugural Lecture Kaldor (1966) put forward three propositions or Growth Laws. For a more detailed analysis see Thirlwall (1983).

[2] Increasing returns to scale turn out to be essential for explaining the uneven geographical distribution of economic activity (Scotchmer and Thisse, 1992, call this the 'folk theorem of spatial economics').

[3] Nevertheless, Verdoorn (1959) argues that this relationship holds only as an asymptotic case of long-run equilibrium development.

[4] Beginning by arguing that there is a common intellectual basis between development economics and economic geography, these factors were 'rediscovered' by Krugman (1991, 1995). In the words of Krugman (1995): 'Both development economics and economic geography experienced a flowering after World War II, resting on the same basic insight: the division of labour is limited by the extent of the market, but the extent of the market is in turn affected by the division of labour. The circularity of this relationship means that countries may experience self-reinforcing industrialisation (or failure to industrialise), and that regions may experience self-reinforcing agglomeration' (p. 3).

managerial systems, history, agglomerations and so forth. In order to accommodate the theory with empirical observations, an exact specification of scale effects is essential. An empirical approximation is provided by the relation between output and productivity growth.

Verdoorn (1949) linked the empirically endorsed relationship between labour productivity and output to the *division of labour*.[5] More specifically, 'in fact one could have expected a priori to find a correlation between labour productivity and output, given that the division of labour only comes about through increases in the volume of production; therefore the expansion of production creates the possibility of further rationalisation which has the same effects as mechanisation' (p. 3). This proposition may be expressed in a more general form. In particular, 'Verdoorn's Law' considers the growth of labour productivity ($\dot{\rho}_{i,t}$) as a function of the growth of output ($\dot{q}_{i,t}$): $\dot{\rho}_{i,t} = f(\dot{q}_{i,t})$ with $f' > 0$ (Chatterji & Wickens, 1983). Empirical applications usually involve estimation of the following regression equation:

$$\dot{\rho}_{i,t} = a + b\dot{q}_{i,t} + u \tag{3.1}$$

where i denotes a region, a stands for the rate of autonomous productivity growth, b is the Verdoorn coefficient and u is a serially independent random error with zero and constant variance. Given that labour productivity is defined as $\dot{\rho}_{i,t} = \dot{q}_{i,t} - \dot{l}_{i,t}$, where $\dot{l}_{i,t}$ is the growth rate of labour force, then Eq. (3.1) can be written as

$$\dot{l}_{i,t} = a + \beta\dot{q}_{i,t} + u \tag{3.2}$$

According to McCombie and de Ridder (1984) Eq. (3.2) is preferable[6] since it avoids the spurious correlation inherent in (1) resulting from the definition of productivity growth as . Scale returns can be estimated as $\nu = 1/(1 - \beta)$.

Verdoorn (1949), from an analysis of international and sectoral industry data, observed the relative consistency of average value of the elasticity of productivity with respect to output at approximately 0.45. He concluded that '[t]his means that over the long period a change in the volume of production, say of about 10 per cent, tends to be associated with an average increase in labour productivity of 4.5%'. On these grounds b is expected to display a positive sign. Specifically, $0.41 \leq b \leq 0.57$, while $b = \dot{p}/\dot{q}$ sets the 'limits' for increasing returns (Hildreth, 1989a, 1989b). Indeed, a large body of quantitative studies[7] show that b takes a value about 0.5, implying that a one-percentage-point increase in output growth induces an increase in the growth of employment of half a percentage point and an equivalent increase in the growth of productivity.

Nearly a decade after Kaldor's Inaugural Lecture, Rowthorn (1975a, 1975b) in a stimulating paper, rekindled interest in 'Verdoorn's Law' by suggesting that is

[5] It might be argued that Verdoorn (1949) provides an algebraic formulation of Young's verbal model.

[6] This is an indispensable element of Kaldor's growth model (Molana and Vines, 1989).

[7] See McComie et al., (2002) for a more detailed review.

incorrectly specified. To be more precise, Rowthorn (1975a, 1975b) argues that output growth should be regressed on employment growth; thus $\dot{q}_{i,t} = a' + b'\dot{l}_{i,t} + u$. The primary question here is whether employment or productivity is endogenously or exogenously determined. Rowthorn (1975a, 1975b) criticised Kaldor's interpretation on the grounds that if manufacturing growth is constrained by a shortage of labour, then the growth rate of labour force must be treated as the independent variable. Kaldor (1966), indeed, attributed the slow growth rate of the United Kingdom to the restriction on the availability of labour from agriculture, but subsequently (1975) changed his mind arguing that the demand for exports constrains the growth rate, not the supply of labour.[8] There is a major debate that has centred on the correct specification of 'Verdoorn's Law' (e.g. McCombie, 1981; Rowthorn, 1979; Thirlwall, 1980a, 1980b). It is clear that Rowthorn's specification is just a simple production relation and perhaps, more importantly, has little to say about the cumulative nature of growth.

Scale economies appear in many forms. For example, economies producing a larger volume of output occur mainly in the direct use of capital and labour and in inputs (maintenance, overhead costs of various kinds) related to them. Moreover, external economies arise when the real cost of supplying a given set of demand is less with coordinated investment decisions than with individual decisions based on existing market information (Chenery, 1959). At the regional level scale effects are present, for example, when large-scale investment in a region causes a decrease in the cost of supplying the demand for the products of surrounding regions; a movement towards spatial equilibrium. While this argument makes sense, there are forces working in the opposite direction. 'Verdoorn's Law' portrays a mechanism by which output growth induces further growth in productivity due to dynamic increasing returns, reflected in productivity gains growth which, in turn, make the products of a region more competitive and subsequently increase its exports, leading to even higher rates of growth.[9] However, this occurs at the expense of regions unable to realise dynamic increasing returns. Dixon and Thirlwall (1975) construct a formal model of cumulative causation in which 'the Verdoorn coefficient gives rise to the possibility that once a region obtains a growth advantage, it will keep it' (p. 205). In this light, the Verdoorn coefficient is a sustaining factor in the *persistence* of regional growth differences *once* they have emerged. A high degree of concentration, for example, of the economic activities within a region creates substantial increasing returns, which give this region an *initial* growth advantage, viz. faster productivity growth, leading to even higher concentration in successful regions creating a 'circle'[10]; a direct challenge to the neoclassical model of general equilibrium, which relays on factor movements across regions. Indeed, although less-developed regions offer the

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[8] This holds not only internationally, but also even more so across regional economies. As Thirlwall (1980a) argues, regional problems are essentially, balance-of-payment problems.

[9] A similar process is implied by Fujita et al. (2001).

[10] This possibility is pointed out early by economic geographer. Abler et al. (1970), for example, argue that 'Spatial structure and spatial process are *circularly* causal. Structure is a determinant of the process as much as process is a determinant of structure.' (p. 60) [emphasis in the original].

advantage of low-wage labour, these benefits tend to be offset by the scale economies found in the industrialised regions (Dawkins, 2003). However, it is not yet clear if the effects of this circle can be slowed down or even reversed in favour of the less-developed regions.[11] McCombie (1988) pointed out the necessity for incorporating factors, like spatial agglomeration and negative external effects that *offset* the benefits of cumulative causation in 'central-successful' regions; a process that may be reinforced *deliberately* through regional policies. Surprisingly little attention has been devoted to this possibility, at least not in an explicit way.[12] Setterfield (1997), following Frankel (1955), outlines an approach that allows cumulative causation to occur at a slower 'pace'. In particular, regional growth is determined by a specific production 'technique', that a region implements, and it is very possible that this region in future will continue to grow due to that technique, viz. a '*lock-in*' in a specific growth-path. Some techniques lead to high growth paths while others to low growth paths for regions that implement them. However 'initially self-perpetuating high relative growth through cumulative causation may, therefore, endogenously create the conditions for a subsequent era of slow relative growth' (Setterfield, 1997, p. 372).

Assume that there is an estimate of ν amongst two distinctive time periods; if $\nu_t - \nu_{t-1} < 0$ then this can be considered as an indication that there are tendencies for cumulative causation to operate at a slower rate. This may take place if regions in 'low growth paths' shift their production structure towards implementation of more advanced techniques, i.e. a technological diffusion effect. Overconcentration of establishments in advanced regions can be conceived as a source of reversing the effects of cumulative causation, provided that it suppresses their growth rates. In conjunction with a movement of manufacturing establishments from advanced towards less-advanced regions, then cumulative causation is to be reversed or, at least, to operate in a slower pace. Reversing the process of cumulative causation requires that conditions in less-advanced regions should become similar to those of the advanced regions. Another way of stating the same thing is to say that differences in conditions across regions should diminish over time.

The process of regional growth is complex and depends upon the relative extent of mechanisms such as factor mobility, price flexibility and transfer of knowledge/technology (e.g. Martin, 1999; Martin & Sunley, 1998). Where such mechanisms exist they are likely to be enhanced, rather than reduced, by *spatial dependence*. Econometrically, any effects from spatial interaction are captured in the error-term (u) of Eq. (3.1), which is modelled as $u = s\boldsymbol{W}u + e = (\boldsymbol{I} - s\boldsymbol{W})^{-1}e$, where s is a scalar spatial-error coefficient, e is the new error-term, $\boldsymbol{I}$ is the identity-matrix and $\boldsymbol{W}$ is a spatial-weights matrix. This matrix can be constructed in several ways. A

[11] Such an outcome is implied by a new generation of growth models; those belonging to New Economic Geography (NEG). A more detailed treatment of NEG is encapsulated in Fujita et al. (2001), Gruber & Soci (2010), Ottaviano (2007) together with a critical assessment of these models. For a more detailed review see Fingleton (2007).

[12] There are though a few notable theoretical exemptions. Roberts (2002), for example, argues that increasing real wages in conjunction with labour shortages might result to a slow-down in the process of cumulative causation.

usual practice is to construct spatial weights as $w_{ij} = 1/d_{ij}$. Here, d_{ij} denotes the distance between two regions i and j, typically represented by the distance between the regions' main cities where the majority of economic activities are located. Thus, Eq. (3.2) can be written as follows:

$$\dot{l}_{i,t} = a + \beta \dot{q}_{i,t} + (I - sW)^{-1} e \tag{3.3}$$

According to Eq. (3.3), the effects of a random shock on the growth rate of a given region will disperse beyond that region's boundaries, impacting on the growth rates of surrounding regions through the spatial transformation $(\boldsymbol{I} - s\boldsymbol{W})^{-1}$.. Moreover, the diffusion of the impact is such as to spread beyond a region's immediate neighbours throughout all regions in the economy. In this way, each region is viewed not as an independent unit, but rather as a functional unit-member of a complex geographical system. After all this approach is in accordance with the first law of geography: 'Everything is related to everything else, but near things are more related than distant things' (Tobler, 1970).

An alternative way to include spatial dependence in econometric estimations is by a *spatial-lag* model. The idea of this model is really quite simple. According to this approach, the dependent variable is adjusted by a spatial matrix as an additional explanatory variable. More specifically,

$$\dot{l}_{i,t} = a + \beta \dot{q}_{i,t} + \lambda(W i_{i,t}) + u \tag{3.4}$$

One immediately obvious implication of applying spatial econometric techniques is the possibility of *circularity*. Firms want to locate where market potential is high, that is, near large markets. But markets will tend to be large where lots of firms locate. So, one is led naturally to a consideration of the possibility of self-reinforcing regional growth or decline (Krugman, 1995). Consequently, spatial econometric techniques provide an appropriate framework to examine 'Verdoorn's Law' and the process of cumulative causation.

3.3 Empirical Application

In this section, some points about the methods and the data employed in econometric estimations are discussed, followed by the presentation and a detailed account of the econometric results.

3.3.1 Estimation Methods and Data Description

The analysis refers to the period 1995–2018 and is divided into several shorter time spans, forming a 'panel-data' framework. In such a framework the main concern is the appropriate time-span lengths. Technically, it is feasible to use annual time spans, given that the available data-set provides yearly observations. However, given that the model's underlying hypothesis refers to the long-run, annual time spans seem rather inappropriate. Throughout this section, regular non-overlapping intervals of four years were used. In particular, the entire time period was divided into 6 non-overlapping sub-periods, 1995–1998, 1999–2002, 2003–2006, 2007–2010, 2011–2014 and 2015–2018. Using these sub-periods, the error term is less likely to be influenced by business cycle fluctuations and the residuals are less serially correlated, compared to a yearly data-set. Estimation of the spatial specifications is carried out by the Maximum-likelihood method (ML), as Ordinary Least Squares (OLS) may result in problems of bias.[13]

Empirical analysis is carried out using data for the regions of EU, obtained from EUROSTAT. The regional groupings used are those delineated by EUROSTAT and correspond to NUTS-3 regions. Output growth is expressed as the Gross Value-Added (GVA) in the manufacturing sector as a whole, while the growth of employment is approximated by the number of workers employed in this sector. Although the ideal measure of labour input requires data on *working hours*, nevertheless, regionally disaggregated data on working hours are not available and consequently, the total number of workers in the manufacturing sector will be used as a proxy for labour inputs. GVA per-worker is chosen because it is a measure of regional productivity and in general this is a major component of differences in the economic performance of regions and a direct outcome of variation in factors that determine regional 'competitiveness' (Martin, 2001).

3.3.2 Empirical Results

The analysis is carried out in two stages. The first stage involves estimating Eqs. (3.1), (3.2) and (3.3), for the overall period. This is an important period since there are several events took place, e.g. the crisis of 2008, EU enlargement and introduction of euro. The second stage aims to test empirically the possibility that cumulative causation has reversed by estimating the above set of equations for two separate periods, viz. 1995–2006 and 2007–2018. A successful future for the EU requires eradication of regional imbalances. This is based on the contention that reversing cumulative causation in favour of the less-developed region of the EU. To this aim, EU has implemented an active regional policy, and continues to do so. Testing, therefore, 'Verdoorn's Law' for two successive time periods may provide an indication of whether regional policies were successful or not. Table 3.1 shows the estimates of 'Verdoorn's Law. for the period 1995–2018.

[13] Berant (1996) notes that spatial autocorrelation invalidates OLS regressions in a way similar to heteroscedasticity and serial autocorrelation and the estimated coefficients will be biased.

Table 3.1 'Verdoorn's law': Non-spatial specification, EU-27, 1995–2018

Estimated equation: $\dot{l}_{i,t} = a + \beta \dot{q}_{i,t} + u$, OLS, Sample: 1,294 NUTS-3 regions						
a	β	R^2	[ser]	F(1, 1292)	[p-value]	Implied v
−0.3329**	0.4615**	0.4380	[0.2492]	1007.117	[0.0000]	1.8570**
LIK	−36.9777	AIC	77.9555		SBC	88.2865
Diagnostic tests						
Ramsey REST specification test[1]			[p-value]			
Test statistic: F(1, 1291) = 2.9544			[0.0858]			
Test for Normality of the residuals[2]			[p-value]			
Test statistic: Chi-squared 5.5356			[0. 0627]			
Test Statistics for Heteroscedasticity[3]			[p-value]			
White	LM = 52.5745		[0.0000]			
Breusch-Pagan	LM = 72.9915		[0.0000]			
Koenker	LM = 32.1953		[0.0000]			

Notes (1) Null Hypothesis: Specification is adequate
(2) Null hypothesis: Error is normally distributed
(3) Null Hypothesis: Heteroscedasticity is not present
** indicates statistical significance at 95% level of confidence
[ser] denotes the standard error of the regression
AIC, SBC and LIK denote the *Akaike*, the *Schwartz-Bayesian* information criteria and Log-likelihood, respectively. For each diagnostic test, the associated statistics together with the p-values are reported. All numbers are rounded to four decimal places

Given the existing literature, it comes as no surprise that the point estimate of $\dot{q}_i$ is in accordance with the model discussed in Sect. 3.2[14]. The value of R^2 can be considered as satisfactory, given the nature of the data. Moreover, the probability associated with the F-statistic for overall significance of the regression rejects the null hypothesis of zero coefficients. According to the associated p-value, at least some of the regression parameters are nonzero and that the regression equation does have some validity in fitting the data (i.e. the independent variable is not purely random with respect to the dependent variable). A set of diagnostic test, however, indicates that estimating Eq. (3.2) at the NUTS-3 level has several problems. The probability associated with the x^2 test accepts the null hypothesis of normality only at 10% level of significance. Similarly, the null hypothesis of adequacy is accepted only at 10% level. More seriously, perhaps, is heteroscedasticity. In a spatial context, a frequent problem is the presence of non-constant variances. This is mainly due to problems related to data collection. These refer to the different dimensions or sizes of

[14] It is important to note that Verdoorn (1949) suggested that the relationship between the growth of productivity and the growth of employment could be used to *forecast* labour requirements and hence to give 'a rough idea of how much industrial productivity must be expand to absorb a certain availability of labour' (p. 4) [emphasis added]. Although this suggest another application of the 'Verdoorn's Law' and opens up a promising area of research, nevertheless, it goes beyond of the scope of this paper.

Table 3.2 'Verdoorn's law': Spatial specifications, 1995–2018

Estimated equation: $\dot{l}_{i,t} = a + \beta\dot{q}_{i,t} + (\boldsymbol{I} - s\boldsymbol{W})^{-1}e$, ML, Sample: 1,294 NUTS-3 regions		
a	−0.2187*	−0.1705*
b	0.4763*	0.4606*
s	0.7801*	
λ		0.6236
LIK	−32.2887	−33.0478
AIC	70.5774	72.0956
SBC	86.0739	87.5921
Estimates of returns to scale		
v	1.90	1.85

Notes (1) Figures in brackets are the t-ratios
(2) An asterisk (*) indicates statistical significance at 95% level of confidence
(3) LIK denotes the Log-Likelihood statistic. All numbers are rounded to four decimal places

the various spatial units that compose the area under consideration, the unbalanced distribution of population/economic activities within regions, variations in the degree of urbanisation, the presence of relatively large rural areas and so forth. The three tests set out in Table 3.1 accept the alternative hypothesis of heteroscedasticity. This is, perhaps, not so surprising if one considers the heterogeneity of the regions in the EU. Based on the aforementioned tests, the null hypothesis of homoscedasticity (or the assumption of constancy of the conditional variance) for Eq. (3.2) cannot be accepted, at the usual levels of significance. A spatial specification, therefore, might be more appropriate in the case of the EU regions. Table 3.2 presents the results from estimating Eqs. (3.3) and (3.4).

If one was to select one of the two models in terms of their ability to capture increasing returns, a criterion, used extensively in spatial econometrics is the *Log-Likelihood* statistic (LIK). According to this criterion, the best-fitted model is the one that yields the greater value of the LIK criterion (Anselin, 1988). It can be seen from Table 3.2 that the calculated values of this criterion increase, as anticipated, with the introduction of spatial interaction. Such results suggest a significant spatial dimension in the process of manufacturing growth across the EU regions. In short 'space matters' (Dawkins, 2003, p. 132). The LIK criterion shows a preference towards the spatial-error model. The superiority of this model is also supported by both the criteria for model selection applied here, namely the *Akaike* (AIC) and the *Schwartz-Bayesian* (SBC) information criteria.[15] It is important to note that all estimates show little variation and are very close to those implied by Kaldor's model. Thus, in line with Thirlwall's (2002, p. x) suggestion that 'the only way knowledge

[15] As a rule of thumb, the best fitting model is the one that yields the minimum values for the AIC or the SBC criterion. The SBC test has superior properties and is asymptotically consistent, whereas the AIC is biased towards selecting an overparameterized model.

can progress in the social sciences is by repeated experiments', the results reported in Table 3.2 provide further corroboration of 'Verdoorn's Law'. Moreover, estimates obtained from Eqs. (3.3) and (3.4) imply a higher degree of scale returns, compared to that by non-spatial specification of 'Verdoorn's Law'. This is an indication that spatial interaction enhances scale returns. Indeed, it is almost an article of faith of regional economics that production is characterised by substantial economies of scale. It might be argued, therefore, that spatial interaction in conjunction with scale returns sustain regional growth differentials, which in turn is a powerful source of dualism.

The validity of 'Verdoorn's Law' in the context of the EU regions is established by the statistical significance of the critical coefficient. All estimates are significantly greater than unity at the 0.95 confidence level. McCombie and de Ridder (1984) came to the conclusion that estimating the 'Verdoorn's Law' using *regional* data provides a strong confirmation of the existence of increasing returns in manufacturing. There can be little doubt that estimates of v reinforce the validity of the thesis that the manufacturing sector is subject to substantial increasing returns at the *regional* level; an element which is central to the theory of cumulative causation. Taken at face value the estimates in Table 3.2 seem to suggest that the process of manufacturing growth across the EU regions is a *cumulative* one[16]. This hypothesis, however, needs further empirical analysis. Recollect that the Verdoorn effect refers to the fact that growth in labour productivity is partly dependent on output growth. According to Dixon and Thirlwall (1975), the 'Verdoorn effect' is a source of regional growth rates differences only to the extent that the Verdoorn coefficient varies between regions. Estimating Eq. (3.3) for each EU country suggests that the nature of this relationship is far from uniform (Table 3.3)[17].

The obtained results clearly show that the Verdoorn coefficient is subject to considerable variation across the EU. The weight of evidence points to the possibility that the 'Verdoorn effect' is a sustaining factor of regional growth differentials. A comparison of the estimated values of v provides considerable support to the argument that the process of manufacturing growth in the EU is characterised by 'dualism'. Indeed, as the coefficient suggests manufacturing in 'advanced' North European countries (Belgium, Germany, Denmark, France and Austria) exhibits a higher degree of increasing returns. On the other hand, manufacturing in most Eastern countries seem to operate with constant returns. This contrition, however, does not characterise Hungary and Poland, countries located close to advanced Northern countries. Similarly, constant returns seem to appear in Southern countries, with Portugal and

[16] Disenchantment and scepticism with equilibrium ideas runs through geographical analysis. Indicatively, consider the following passage from Smith (1967): 'It is the periods and processes of geographical change, of active settlement and colonisation, of urban foundation and growth, or of industrial and commercial change, that stimulate most interest and that have been most significant in the formation of landscape (p. vi)'. Indeed, as Chisholm (1975) notes 'Smith stresses the importance of processes generating change and thereby adverts to an age-old problem [...], namely how to infer the causal chain of processes from observed spatial patterns (p. 116)'.

[17] Using Eq. (3.4) gave similar results. Nevertheless, using AIC and SBC criteria, Eq. (3.3) is preferred over the other two specifications. For brevity only the Verdoorn coefficient is reported.

Table 3.3 'Verdoorn's law', estimates for each EU country, 1995–2018

Belgium	0.6417
Bulgaria	0.3072
Czech Republic	0.3445
Denmark	0.5926
Germany	0.6062
Estonia	0.2557
Ireland	0.0456
Greece	0.3721
Spain	0.3333
France	0.6150
Italy	0.2748
Latvia	0.1806
Lithuania	0.2816
Hungary	0.5477
Nederland	0.2984
Austria	0.5677
Poland	0.4567
Portugal	0.5129
Romania	0.2871
Slovenia	0.2001
Slovakia	0.3900
Finland	0.3874
Sweden	0.1057
United Kingdom	0.3082

Greece exhibiting some degree of increasing returns. In short, the results suggest a significant spatial dimension to the phenomenon of scale effects.

In an attempt to test if the process of cumulative causation exhibits tendencies of reversing or, at least, occurring in a slower pace, 'Verdoorn's Law' is estimated using all three specifications by splitting the time span into two parts, i.e. 1995–2006 and 2007–2018. Although, the distinction can be seen as somehow arbitrary, nevertheless, it provides some indications if the process of cumulative causation has reversed or, at least, slowed down. A number of different specifications and estimation techniques were used and the results are reported in Table 3.4.

As perhaps, anticipated the results provide further support to 'Verdoorn's Law' and confirm the hypothesis of increasing returns in European manufacturing. The estimated coefficient is highly statistical significant while estimates of ν cluster around 1.62–1.72. As for the overall period, the results show a preference towards the spatial-error model. This condition also holds for the period 2007–2018 (Table 3.5).

Table 3.4 'Verdoorn's law': 1995–2006

Depended Variable: $\dot{l}_{i,t}$ Sample: 1,294 NUTS-3 regions			
	OLS	ML	ML
a	0.1401*	−0.0856*	−0.1148*
b	0.4058*	0.4182*	0.3842*
s		0.5181*	
λ			0.3804*
LIK	191.5065	195.3028	193.6601
AIC	−379.0129	−384.6056	−381.3202
SBC	−368.6819	−369.1091	−365.8237
Estimates of returns to scale			
ν	1.68	1.72	1.62

Notes (1) Figures in brackets are the t-ratios
(2) An asterisk (*) indicates statistical significance at 95% level of confidence
(3) LIK denotes the Log-Likelihood statistic. All numbers are rounded to four decimal places

Table 3.5 'Verdoorn's law': 2007–2018

Depended variable: $\dot{l}_{i,t}$ Sample: 1,294 NUTS-3 regions			
	OLS	ML	ML
a	−0.1343*	−0.1002*	−0.0816*
b	0.3717*	0.3807*	0.3677*
s		0.6453*	
λ			0.4788*
LIK	423.9716	445.2874	431.5001
AIC	-843.9432	−884.5748	−841.5037
SBC	−833.6122	−869.0783	−857.0002
Estimates of Returns to Scale			
ν	1.59	1.61	1.58

Notes (1) Figures in brackets are the t-ratios
(2) An asterisk (*) indicates statistical significance at 95% level of confidence
(3) LIK denotes the Log-Likelihood statistic. All numbers are rounded to four decimal places

Table 3.4 shows a lower value of *ν* for the period 2007–2018. It might be argued that after 2006 there was some improvement. This outcome can be considered as an indication that the pace of cumulative causation has slowed down. This may, partly, attributed to the effects of technology diffusion across the EU regions, leading some 'less-advanced' regions to shift their production structure towards more advanced techniques, reflected in high growth rates. Another explanation may possibly be sought in the operation of negative externalities caused by over-concentration of manufacturing establishments in initially advanced manufacturing regions. These regions may have reached a certain 'threshold' stage, which caused manufacturing establishments to move toward adjustment regions; a movement encouraged also by regional policy. Nevertheless, estimates of ν still remain high, reinforcing the argument that initially advanced manufacturing continues to grow at the expense of all other regions, although at a lesser extent. In other words, despite some improvements in favour of less-advanced regions, the process of cumulative causation was merely slowed rather than reversed.[18] The results reported here seriously cast doubt on the hypothesis of regional equilibrium and support to Kaldor's argument about the dualistic nature of advanced capitalist economies, in the sense that an advanced 'centre' coexists with a less-advanced 'periphery'. Further analysis, however, shows that this situation, although sustainable, nevertheless a reversing is not impossible.

Setterfield (1997) argues that '[…] initially self-perpetuating high relative growth through cumulative causation may, therefore, endogenously create the conditions for a subsequent era of slow relative growth' (p. 372). It might be argued that such conditions come about from the particular policies and in general 'responses' to the problems of growth and productivity (e.g. methods of production, approaches to process/product/organisational innovation, and extent of subcontracting, movements in the value chain). Moreover, certain responses could lock in some regions in high paths of growth while others in low growth paths as well as descend/ascend paths. Still this point deserves further thought.

The latter could occur, for example, if regions locked in low growth paths shift their production structure towards more advanced techniques, i.e. a technology diffusion effect. Cumulative causation could also operate in a slower pace if techniques that lock regions in high-growth paths become obsolete, causing a relative decline in their growth rates. As already mentioned, over-concentration in advanced industrial regions could also be conceived as a source of reversing the process of cumulative causation. Yet the root of the matter is here. If over-concentration of manufacturing establishments in advanced regions suppresses their growth rates, and if less-advanced regions provide incentives for the movement of manufacturing establishments towards less-developed regions, then cumulative causation could operate at a slower pace. More detailed analysis, both theoretically and empirically is necessary. In this context, some remarks from Chisholm (1975) are highly pertinent: 'All events occur in space as well as in time, and if there is a readily identified direction of causation in the time dimension—the more recent being affected by the less recent

[18] Several studies point out that there is a process of regional convergence in the EU (e.g. Corrado et al, 2005). Indeed, most studies find a negative relation between growth rates and the initial level of productivity. Richardson (1984), however, notes "In the relatively near future, an opportunity will develop to test the appropriateness of the neoclassical compared with the cumulative causation model. The key question is whether regional per capita income will stabilise close to equality (i.e. an approximation to neoclassical equilibrium) or whether they will cross over, with the 4 lower income regions (S. Atlantic, East South Central, West South Central and Mountain) then becoming progressively richer than the 4 regions of the Northeast and Midwest. The latter development would be more consistent with the cumulative causation model. The competing hypotheses of interregional income equilibrium and the "cross over" is the most intriguing question in contemporary regional economics" (pp. 22–23).

but not vice versa—the same cannot be said of space. And so it becomes necessary to seek out the frameworks within which to examine multi-directional systems of causation. This implies careful examination of the ways in which phenomena are linked in space, and especially the flows of goods, people and information between locations. […] However, to link together the study of forms and of the processes that give rise to them, accurate description is not enough. We need a framework of explanatory theory, to provide us with a rational understanding of the inter-linking of processes and their relationships to spatial forms' (p. 121). These arguments suggest a host of questions. What are the factors leading to cumulative causation and why is their influence so different in different periods? What then is the purpose of this analysis? Perhaps the main purpose should be to provoke interest and discussion in the applicability of disequilibrium models of regional growth. Is it not time to abandon models of equilibrium in favour of more realistic approaches of regional analysis with more content?

3.4 Concluding Points

There appears to be a strong literature successfully testing 'Verdoorn's Law' across the European regions using spatial econometric techniques. Using regional data on growth in employment and output for the EU countries, the results reported here provide strong confirmation for the hypothesis of increasing returns in the European manufacturing and, hence, the cumulative nature of regional growth. Empirical estimation of 'Verdoorn's Law' indicates that a cumulative mechanism exists, locking regions in high or low growth paths. This is in accordance with the post-Keynesian view of regional growth, which adduces that increasing returns lead to a disequilibrium state. This in turn makes regional disparities even wider in a *cumulative* way perpetuating the gap between 'centre' and 'periphery'. In this respect, it is interesting to note that a estimation of 'Verdoorn's Law' for each country implies that the EU is characterised by geographical dualism, in the sense that initially successful regions follow high growth paths and less-successful regions are 'lock-in' a relatively lower growth-path. This can be attributed to the fact that manufacturing activity is concentrated in relatively few regions, which follow a high growth path at the expense of the remaining regions. Further analysis, however, indicates that the process of cumulative causation has slowed down in favour of the less-advanced regions, although at a slow pace. A spatial specification of 'Verdoorn's Law' was tested for the 1995–2018 period as well as for two sub-periods, viz. 1995–2006 and 2007–2018, so as to 'capture' a possible 'shift' in growth paths in favour of less-advanced regions, due to the combined effect of technology diffusion and negative externalities in developed regions. It is important, once more, to underline that degree of increasing returns in the period 2007–2018 is slightly lower than that obtained for the period 2007–2018. This exercise provides an indication, although rough, that less-developed regions shifted to a path of faster manufacturing growth. It seems that spatial agglomerations surpassed a certain threshold and became a diseconomy that slowed down the process of cumulative growth, despite the 'pessimistic' predictions of the theory of cumulative causation. However, reversing the process of cumulative causation turns out to be more difficult than that.

There is one last issue to which a few words must be devoted. Regional policies in EU have been in operation for many years, yet regional differentials in growth still remain. As already pointed out, it is established that the value of increasing returns is less in the terminal period, relatively to those obtained for the initial period. This may be taken as an indication the process of cumulative causation across the EU regions is slowing down. A definite opinion, however, seems to be worth further and detailed and focussed investigation. Despite some improvement cumulative causation still operates and 'locks-in' regions into high and slow growth paths. This may be a signal to policy-makers in EU to pursue a more active regional policy in order to overcome the process of cumulative causation. This may be a difficult task but not unachievable.

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Chapter 4
Firms' Human Resource Management for Local Economy and Wellbeing

Daisuke Nakamura

Abstract This article addresses how firms can utilise human resource management through cooperative behaviour across a region. The outcome may improve not only the efficiency of production for the local firm but also the level of residents' wellbeing. The conceptual idea of this article is similar to that of localisation economies, which work within the same industry. However, our idea is applicable among different industries as long as intermediaries properly operate the regional economic system for some local issues in a small-scale non-metropolitan area. Hence, rural agglomeration economies are partly employed in this analysis together with incentive theory about firms, individuals, and intermediaries. As described throughout the article, rural agglomeration economies are different from established notions of agglomeration economies such as localisation economies and urbanisation economies. This article also demonstrates how a sustainable region, which has the optimal economies of scale and scope under partnerships with neighbouring areas, can be organised.

Keywords Agglomeration economies · Division of labour · Labour pool · Comparative advantage · Incentive theory

JEL Classifications D62 · I26 · M54 · R58

4.1 Introduction

This article contributes to rural development studies by organising special coordination within an area. Studies on rural development are important for modern society, in particular cases in which a rural population decreases, typically because of a shrinkage of economic activity due to the ageing of society. This is a serious issue in developed countries, in which rapid national economic growth can no longer be expected and the national economy faces severe international economic competition in terms of cost-saving contests. In such a circumstance, firms must engage in

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their productions more efficiently with value-added competitive forces under limited available resources. Here, we demonstrate how firms in rural areas become secure on operational management as members of regional economic players. Especially, we focus on firms' human resource management to enhance the local economy and residents' wellbeing.

In other words, our primary objective through the analysis is to address how firms can utilise human resource management through cooperative behaviour across a region. Profit maximisation behaviour may be solely beneficial for that firm. However, once an efficiency of production is improved because of regional cooperation, the level of residents' wellbeing may also improve. Those phenomena are called externalities and were investigated in detail by Meade (1952) and Scitovsky (1954). Cooperative actions in a particular area can be referred to as localisation economies. Localisation economies are spatially constrained external economies of scale according to Parr (2002). These economies are also characterised as external to the firm and internal to the industry. Cooperative behaviour was described by Marshall (1892) and a concrete example in Italy was investigated by Capello (2015), who addressed the notion of 'trust' among the members of an industrial district.

Conversely, we here do not limit ourselves to the condition of 'internal to the industry'. This could relate to other types of agglomeration economies called urbanisation economies. Urbanisation economies are both external to the firm and to the industry. However, another condition must be added to define urbanisation economies. That is, there are so many people and economic players in the area. We also exclude this condition to examine the case of rural areas. When classifying agglomeration economies, such situations may be referred to as 'rural agglomeration economies' according to the definition of Parr (2015) on the topic of regional externalities. These ideas were partially expanded by Nakamura (2022a), who examined the relationship between profit maximisation and utility maximisation through a cooperative behaviour within a region and Nakamura (2022b) addressed an advanced regional economy beyond the market mechanism.

In this article, we show that rural agglomeration economies are valid among different industries as long as intermediaries properly operate the regional economic system. This includes the division of labour and the labour pool within the region. In addition, incentive theories on firms, individuals, and intermediaries should be argued to sustain these benefits in the long term. This may expand the horizon of the analysis to include comparative advantage, effective policy actions, and well-motivated behaviours of people with the notion of equity. We also demonstrate how a sustainable region, which has optimal economies of scale and scope under partnerships with neighbouring regions, can be organised under a circumstance in which a single region cannot suffice the required division of labour as a sustainable criterion of the local economy in terms of availability on resources.

These aspects are studied throughout the article as follows. Section 4.2 introduces a location model with a simplified regional economy based on a framework of the labour market. The model is described through hypothetical scenarios in Sect. 4.3. Incentive theory is discussed as an extension of this in Sect. 4.4, before the conclusion is presented in Sect. 4.5.

4.2 Location Model

In this section, we examine a simple location model with the following assumptions. First, there is a closed economic district such as a small city or town. Members of the regional adult population can be either employed, unemployed, or not in the labour force. There are some business firms, which employ residents to engage in production as high-skilled or unskilled workers. For simplicity, there is no inter-regional commute for work at this stage of the analysis. In labour markets, it is common to face temporary leave, as life remains uncertain at all times. For firms, maximising profits under uncertainty can be a risk, unless they are always ready to change labour without delay.

The above description can be expressed by a formal representation descripted by Eq. (4.1).

$$T_r = \mu T_e + (1 - \mu) T_u \sigma \tag{4.1}$$

Here, T_{r} ($T_{\mathrm{r}} \geq 0$) is the total regional adult population, T_{e} ($T_{\mathrm{e}} \geq 0$) is the number of employed residents, T_{u} ($T_{\mathrm{u}} \geq 0$) is the number of employed residents who need temporary leave, and μ ($\mu \geq 0$) is the ratio of those who can fully engage in work. Here, the parameter μ may be a part of workers who cannot avoid unexpected life events such as maternity leave. In addition, σ ($0 \leq \sigma \leq 1$) is an index of flexibility for replacement of human resources. For instance, $\sigma \rightarrow 0$ implies that replacement is more difficult because the job is specialised, such as work requiring high-skilled workers.

Equation (4.1) is a part of the firm's profit function (π). The entire form can be expressed by Eq. (4.2).

$$\pi = p f(L, K) - w_L L - w_k K \tag{4.2}$$

Here, p ($p \geq 0$) is the product price, w_{L} ($w_{\mathrm{L}} \geq 0$) is the unit wage, L ($L \geq 0$) is the number of residents in the labour force, w_{K} ($w_{\mathrm{K}} \geq 0$) is the unit price for capital, K ($K \geq 0$) is the amount of capital, and f (L, K) is the production function of the firm. Regarding the relationship between Eq. (4.1) and Eq. (4.2), we can state that as $T_{\mathrm{e}} = \delta L$, δ ($0 \leq \delta \leq 1$) is the weight with which this firm dominates the regional labour force. In other words, $\sigma \rightarrow 1$ as there are fewer firms in this region. Additionally, for simplicity at this stage of the study, every individual in the labour force has the same skill level.

If the value of parameter μ in Eq. (4.1) is not large enough, this firm may not be able to employ workers at the optimal level of L and its profit maximising condition cannot be attained. That is the situation for firms that face a misallocation of human resources within the organisation. Even though the volume of T_{r} is large enough, it remains insufficient because the firm's requirements and the job candidates' characteristics may not always match. An image can be illustrated by Fig. 4.1, in which a worker, individual I_1, is supposed to be temporarily unavailable and a replacement is needed.

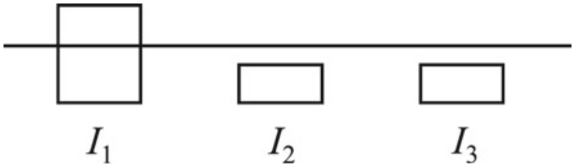

Fig. 4.1 Human resource allocation

If there is a nominated person, individual I_2, replacement is not possible because the volume of task completed by individual I_1 may not be fully compensated. In that case, another person, individual I_3, in addition to individual I_2 can jointly take this offer and the firm would be able to operate.

Alternatively, a more complex pattern can be considered in which worker I_1 has two different types of tasks, one that can be done only by this person and one that can be done by almost anyone else. If another person such as individuals I_2 and I_3 can complete all of the tasks of individual I_1, a replacement can be made. However, if individual I_1 just specialises on his or her expertise task and the remaining tasks can be conducted by individual I_2 or I_3, this could be a feasible alternative and perhaps better for all parties, including the firm, because of a comparative advantage. The following section investigates how the misallocation of resources can be avoided by coordinating specific systems within the area.

4.3 Hypothetical Analysis

This section demonstrates how misallocation of human resources can be avoided by describing two hypothetical scenarios, Case *A* and Case *B*. Case *A* is a situation in which potential local resources are being more utilised, while Case *B* attempts to improve the level of μ in Eq. (4.1), that is, the ratio of residents who can fully engage in work.

(Case *A*)

In this scenario, the misallocation of resources is improved by utilising potentially available local resources. In addition to the definition of the labour force, the total number of adults in the region is provided, as expressed in Eq. (4.3).

$$T_a = T_r + T_u + T_g \tag{4.3}$$

The above expression shows that the total number of adults in the region, T_a ($T_a \geq 0$), is the sum of the total number of workers T_r ($T_r \geq 0$), the number of unemployed T_u ($T_u \geq 0$), and the number of people who are not in the labour force T_g ($T_g \geq 0$).

The above scenario suggests a policy in which potential local resources are more utilised. There, potential resources are people who are unemployed and who are not in the labour force, that is, T_u and T_g in Eq. (4.3). They may be able to find new jobs much easier if there are sufficient opportunities for them to improve their skills. In other words, the provision of local training programmes may result in more job opportunities, as they would have more opportunities to engage in skilled labour with respect to supply and demand in the local labour market as long as there are advanced economic activities such as export-base sectors. Here, 'local programmes' are different from services supplied by private firms, which require a cost burden and travel to the site of the services. Conversely, 'local programmes' can receive these services with little or no charge to receive and it is not necessary for residents to travel a long distance to reach these services.

In this case, how locally operated management can provide these services should be considered. Perhaps local firms can offer affordable job training seminars to residents because these are useful as soon as they start working in the region. Such offers may send signals to the local job market about what kinds of skills are desired. Additionally, the frequency of offers might indicate how many workers are needed by local firms.

(Case *B*)

This scenario is a policy for $\sigma \to 1$ through regional cooperative coordination. Such a scenario is applicable for a situation in which an individual must stay at home with his or her children instead of working somewhere outside the home. In many cases, both public and private agencies offer nursery services with contracts. If these are inflexible to coordinate and individuals face barriers to work, it may be possible to find a better outcome through regional cooperative coordination. An important condition here is to have trust among members of the region.

Trust can be grown through community-based events and meetings, unless there is a specific industry that emerges from localisation economies, as exemplified by Capello (2015). Otherwise, the initial incubation may be led by the local authorities and/or publicly owned agencies. This can be easier as the hierarchical order of the urban system is lower. In other words, small-scale areas such as non-metropolitan or rural areas should benefit more because they generally have less complex local administrative and functional systems than large-scale areas such as large metropolitan regions in which more economies of scale and scope are available (see Parr, 2008 for the structure of administrative and functional systems within the framework of central place theory).

(Cases *A* and *B*)

Our argument does not necessarily promote either Case *A* or Case *B*. Rather, both cases may be compatible and play different roles. While Case *A* can be effective for both individuals and firms, it is more difficult to coordinate opportunities under limited resource availabilities. In this sense, it should be easier in Case *B* to organise cooperative behaviour but incentives and motivation for individuals to participate are needed. That is, both cases would be beneficial if they could be coordinated at any time, and the next concern should be given to long-term sustainable arrangements. Regarding this point, the following argument may be relevant.

An incentive policy can be made by deposit and refund systems in the field of environmental economics (c.f., Hanley et al., 2013). Services within this framework of the analysis are treated as club goods. Here, both types of markets are involved in our argument, namely, markets for factors of production and markets for services. Markets for factors of production may have demand side as firms and supply side as households. Conversely, markets for services have demand side as households and supply side as intermediaries. For both markets, incomplete information can be covered by informal exchanges of communication. Firms must provide necessities for work with respect to quantity, quality, tasks, duration, and so on. Households are required to show what kind of services they desire and what they can do. The extent may depend on the hierarchical urban level. In other words, informal matters are more accessible in lower hierarchically ordered areas, whereas more variety and a greater volume of resources are available in higher hierarchically ordered areas.

4.4 Application

We have previously revealed that there are effective policies regarding the local job market system. It is now necessary to reveal how such a coordination can be securely organised. Here, a presence of intermediaries can be important. Intermediaries are agents that connect two facets of needs such as lenders and borrowers matched by commercial banks (see Baumol & Blinder, 2012). Local stakeholders in an area as intermediaries may be public characters, such as local governments and local universities, as local universities are sources of expertise on education and research and might seek collaboration with local governments. Such external opportunities can include local spillovers through recurrent education and advanced research opportunities. Once the system is well organised, a value-added highly advanced regional system in social and economic terms would be expected.

As our primary concern is given to rural development strategies, the argument returns to the level of community, which is the aggregation of local economic agents. Unless barter trade is easily arranged among regional members, it is necessary to consider funding matters in the modern socio-economic system. A typical failure of the system is the issue of the free-riding problem. Memberships with fees, commonly defined as 'club goods', may be needed. That is the part of variable cost. The remaining part—that is, the fixed cost part—the incubation process (see take-off stage in Rostow, 1956 and Parr, 2001) may require subsidiary payment or outsource fundings. During that process, effort to increase the volume of members as a role of denominator is desired. After the take-off stage, smaller fees for all can be coordinated in addition to variable costs. This does not imply that intermediaries are running as commercial companies. Rather, they are solely better able to utilise the established resource allocation.

For a potentially problematic case such as one in which there is no intermediary such as a local university within the observing area, it may be useful to apply them for a wider-areal coordination. Wider-areal coordination is necessary to arrange neighbouring regional partnerships (see Nakamura, 2022a). If an inter-regional transportation system is well-organised, the commuting area can be expanded and a better job-matching environment may be expected with expansion of the supply area, in line with central place theory (see also Lösch, 1938; Parr, 1993a, 1993b). Such coordination may be more strongly required as the replacement partly works ($\sigma \leq 1$) as firms access job-match agencies or regional externalities. Otherwise, the region is self-sufficient when $\sigma = 1$ and replacement works perfectly.

It is now necessary to discuss social welfare. Through this coordination, firms' efficiency improves because losses are reduced. For individuals, more job opportunities or a more stable regional system supported by community cooperation can be expected, which requires large participation rate. If Case *A* and Case *B* are both available, individual income can be expected to rise and expanded skills for jobs may be available. This might be also beneficial for the region in terms of a sustainable regional economy because of the presence of more advanced members in the area. This situation is attainable if informal information and coordination are used. In addition, the principle of 'locally knowing each other' through rural agglomeration economies may increase reductions of negative externalities and increments of positive externalities. Hence, it is important to react to mismatches in the system. Mismatches may be caused by quantity and/or quality and can be adjusted by the combination of Case *A* and Case *B*.

Once again, it is easier for firms to find unskilled workers than skilled ones. In other words, skilled workers are more inflexible regarding replacement in the labour market. However, training opportunities for local people may be partially flexible for skilled workers, which may be beneficial in the long term not only to the firm but also to the individual and to the region. Even though the population is small in a region, they can sustain because there are more education opportunities. Wider-areal coordination may boost this specific strategy because such areas might struggle to pursue economies of scope. However, this may require sufficient infrastructure arrangement regarding transportation and communication among different neighbouring areas.

Our final discussion should focus on incentive theory for its sustainability. Without incentive strategies, free-riding and other problems might occur, as discussed earlier in this article. It would be unsustainable if some parties brought about system inequity by taking advantage of merits. A concrete strategy is a reward system as a part of a rural development scheme. For instance, when someone becomes available to look after other people in a regional system, intermediaries can connect between supply and demand. When supported people become available to support others, then their roles shift to suppliers. However, if they refuse such shifts, a shortage of this system might be observed. Additionally, if supported people desire things to an excess, then a shortage will occur under limited resources. Therefore, policies must include debates on moral hazards and incentives to avoid any arguments of trigger strategy in game theory, which could be enacted by firms and individuals. Then, a better rural development under fully considered shifts that minimise potential hazardous changes in local environment would maintain the cooperative atmosphere.

4.5 Conclusion

This article has examined how rural agglomeration economies can work effectively to allocate human resources within a specific economic area. We revealed that such a system does not emerge spontaneously and certain incubation processes may be required as part of a rural development policy. Here, intermediaries are played by local institutions such as universities, which may also have a spillover effect that improves the regional welfare level by providing advanced education and research opportunities to the local economy. A wider-areal coordination enables us to apply this framework even though there may be no intermediary within the observed area.

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Chapter 5
The Influence of Co-Agglomeration of Producer Services and Manufacturing on Urban Total Factor Productivity in China

Na Wang

Abstract This paper examines the influence of the co-agglomeration of producer services and manufacturing on urban TFP based on a dynamic panel model. It is found that the co-agglomeration of producer services and manufacturing can hinder the improvement of urban total factor productivity in the whole country and small and medium-sized cities. And on this basis, this paper focuses on the mechanism of manufacturing agglomeration between producer services agglomeration and urban total factor productivity based on a mediation effect model. It can be concluded that there is a "partial mediation effect" between producer services agglomeration and urban total factor productivity through manufacturing agglomeration, which indicates that producer services agglomeration can improve urban total factor productivity by inhibiting manufacturing agglomeration.

Keywords Industrial co-agglomeration · Producer services agglomeration · Manufacturing agglomeration · Total factor productivity · Mediation effect

5.1 Introduction

Since the reform and opening up, China has made remarkable achievements in economic development. While China's economic aggregate is growing rapidly, its industrial structure is constantly optimized and upgraded, and the proportion of the tertiary industry (service industry) continues to rise. In recent years, the proportion of value-added producer services[1] in GDP has generally shown an upward trend, while

[1] Producer services are services that mainly provide intermediate inputs for production activities (that is intermediate demand services).

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the proportion of consumer services[2] has slowly declined. In 2019, the value-added of the manufacturing industry accounted for 27.8% of GDP, the value-added of the service industry accounted for 53.8% of GDP, and the value-added of the producer services accounted for 39.1% of that of the service industry, contributing over 20% to GDP.[3]

In the process of rapid development of urban economy, the regional economic development is gradually declining due to excessive reliance on manufacturing industry, and the thinking logic of local governments has begun to shift from "priority development of manufacturing industry" to "coordinated development of multiple industries". At the same time, when in the face of increasingly fierce market competition, the production efficiency improvement effect brought by the traditional market division of labor characterized by "separated production" is becoming less and less ideal. However, the "external performance" obtained by the industries or enterprises based on vertical or horizontal correlation due to the close proximity of "collaborative production" and "integrated production" is more and more significant, which fundamentally drives the transformation of the two industries from "separated agglomeration" to "collaborative agglomeration". Therefore, the influence of the collaborative agglomeration of producer services and manufacturing has gradually become prominent (Wu, 2018).

Industrial agglomeration refers to the high concentration of enterprises in the same industry within a specific geographical range. The theoretical research can be traced back to the industrial zone theory proposed by Marshall (1890/1961), which emphasizes that the specialized agglomeration brings external economy, and the benefits of agglomeration economy come from localized labor market sharing, intermediate input sharing and knowledge spillover. The traditional industrial agglomeration mostly focuses on the agglomeration of a single industry, but in reality, industrial activities are more often represented as the phenomenon of collaborative agglomeration among different industries. The concept of industrial collaborative agglomeration (hereinafter abbreviated as co-agglomeration) was first proposed by Ellison and Glaeser (1997), which deepened the theory of industrial agglomeration under the background of industrial interaction and integration development. Industrial co-agglomeration refers to the horizontal association formed by sharing labor and knowledge and technology spillover between different industries in the agglomeration, and the vertical association between upstream and downstream industries with input–output relationship, as well as the agglomeration of different industries in the same region (Wang et al., 2021). Some scholars have analyzed the mechanism of industrial co-agglomeration. Krugman (1991) constructed the C-P model and pointed out that increasing returns and saving transportation costs can be regarded as the "centripetal force" of industrial agglomeration, but the immobility of certain production factors and the external diseconomy of agglomeration can hinder industrial agglomeration, which is called "centrifugal force". Venables (1996) developed

[2] Consumer services are services that directly provide final consumption services to residents or individual consumers (that is final demand services).

[3] This is calculated according to the data of China Statistical Yearbook 2021.

an industrial vertical association model from the point of view of industry longitudinal association, and proposed that incomplete competition and transportation costs can cause forward and backward association between upstream and downstream industries. When the transportation cost is at the middle level, it will cause industrial co-agglomeration, and the further reduction of transportation cost will promote the industrial diffusion (Chen & Chen, 2012).

At present, there are two main viewpoints on the research of industrial co-agglomeration effect. That is to say, industrial co-agglomeration has positive and negative effects on productivity improvement.

On the one hand, industrial co-agglomeration has obvious externalities on productivity improvement. From the perspective of MAR externalities, the two industries in co-agglomeration will share the large market of supply and demand based on input–output correlation and the labor market shared by the general agglomeration economies (Henderson, 2003). It can also further promote the spillover of knowledge and technology among enterprises, and make their respective enterprises improve the learning ability of the corresponding "sales market" and "factor market" (Zhao et al., 2014), and then promote the common improvement of production efficiency of producer services and manufacturing enterprises. From the perspective of Jacob's externalities, knowledge spillover and learning effects among different industries are often more significant because breakthrough innovation often occurs in the process of cross-integration of different industries (Boschma & Iammarino, 2009). Since the co-agglomeration of producer services and manufacturing provides a good opportunity for the integrated development of the two industries, the mutual learning effects between enterprises in different industries can promote the improvement of productivity of producer services and manufacturing, and then promote the economic growth of the whole city. From the perspective of Porter's externalities, technological innovation and knowledge spillover originate from mutual competition among enterprises rather than monopoly (Porter, 1998). The co-agglomeration of producer services and manufacturing creates a relatively favorable growth environment for enterprise competition, and the fierce competition will make inefficient enterprises unable to survive in the large market (Venables, 2011), thus promoting the productivity of the co-agglomeration area. Some scholars believe that industrial co-agglomeration can share the market, infrastructure and labor force based on input–output correlation, promote the spillover of knowledge and technology among enterprises, and then achieve innovation-driven economic growth through division of labor and technological externalities. Connell et al. (2014) confirmed that industrial clusters can promote knowledge sharing and cooperative innovation. Lanaspa et al. (2016) found that industrial co-agglomeration can directly promote regional economic growth. Chen et al. (2016) tested the efficiency enhancement effect and spatial spillover effect of industrial co-agglomeration from the spatial dimension and proposed that the adjustment of spatial layout by industrial co-agglomeration is a realistic choice to achieve the improvement of urban production efficiency. Wang et al. (2021) also believed that in the development process of co-agglomeration of manufacturing and producer services, the eastern, central and western regions are limited by development differences, and each region should focus on the selection of different segmented industries based on its own advantages, so as to continuously drive the urban economic development.

On the other hand, in addition to the above positive factors, the influence of industrial co-agglomeration on productivity also shows a certain negative effect. Firstly, the negative effect shows as the crowding effect. In the process of industrial co-agglomeration, various transaction costs and talent search costs are saved for the input–output communication of producer services and manufacturing enterprises. However, when industrial agglomeration in a region is excessive, the crowding effect under diseconomies of scale will increase the cost of factors such as land rent, transportation and time. Intensive economic activities lead to the congestion of transport facilities and public infrastructure, and environmental degradation, which are detrimental to the improvement of urban productivity. Henderson's research (1986) showed that the agglomeration effect of industrial agglomeration can change to the crowding effect. Ke (2010) verified the existence of a serious crowding effect in China by using the data of prefecture-level cities. Wu (2019) concluded that it is not appropriate to hastily push forward the "two-wheel drive" strategy under the existing conditions based on the threshold model of 246 cities in China. In the case of low specialized agglomeration of manufacturing or producer services, the improvement of industrial co-agglomeration can affect the healthy development of the entire urban economy due to resource misallocation. Secondly, the negative effect shows as the crowding out effect. The co-agglomeration of regional industries attracts the gathering of a large number of production factors, thus crowding out the resources of other regions. Restricted by sunk costs, producer services enterprises, especially manufacturing enterprises, in the industrial co-agglomeration area cannot easily exit from a certain area, so that enterprises with relatively low productivity stay in the industrial agglomeration area for a long time or even evolve into "zombie enterprises", thereby reducing the production or service efficiency of relevant enterprises (Wu, 2018). This negative locking effect of co-agglomeration may reduce the total factor productivity of cities. Combes (2000) showed that agglomeration effect can hinder economic growth and productivity improvement by establishing a linear test model. Chen and Chen (2011) used the data of 69 cities in Zhejiang Province to verify that producer services and manufacturing may have crowding out effect at a smaller scale (cities), and a more complementary effect at a larger scale (provinces).

From the above, it can be seen that industrial co-agglomeration may positively promote the improvement of total factor productivity and promote economic development. On the contrary, it is also possible to negatively inhibit the improvement of total factor productivity and hinder economic development. The existing studies mostly focus on the influence and effect of industrial co-agglomeration on total factor productivity and economic growth. It is necessary to further explore the mechanism of the influence of the internal relationship between producer services agglomeration and manufacturing agglomeration on urban total factor productivity. Therefore, this paper focuses on the mechanism of manufacturing agglomeration between producer services agglomeration and urban total factor productivity, and explores the influence path of producer services agglomeration on urban total factor productivity through manufacturing agglomeration. The contribution of this paper is to test the role of manufacturing agglomeration between producer services agglomeration and urban total factor productivity from the perspective of producer services category by constructing a mediation effect model of manufacturing agglomeration.

5.2 Calculation of Indicators

5.2.1 Calculation of Total Factor Productivity

There are different methods for measuring total factor productivity (hereinafter referred to as TFP) in existing studies, including parametric methods (Solow residual value method, production function and stochastic frontier function method, etc.) and non-parametric methods (data envelopment analysis method, referred to as DEA, etc.). This paper calculates Malmquist productivity index based on DEA model. Malmquist index can be decomposed into technical efficiency change index ($effch$) and technical change index ($techch$). Technical efficiency change represents the efficiency value of rational and full utilization of resources under the current technological level, while technical change represents to the contribution of new technology to the improvement of TFP (Liu & Li, 2009). Referring to the decomposition method of Zofio (2007), $effch$ can be further decomposed into pure efficiency change index ($pech$) and scale efficiency change index ($sech$). In addition, $tfpch$ is the comprehensive TFP index, and its value has three cases. When $tfpch > 1$, TFP rises; When $tfpch = 1$, TFP is constant; When $tfpch < 1$, TFP declines.

The calculation of urban TFP is measured by the input-orientated DEA-Malmquist model. When DEA-Malmquist model is used to measure TFP, the accuracy and scientificity of the results largely depend on the selection of input and output indicators. The data of TFP are selected from China Urban Statistical Yearbook. In the process of sample selection for prefecture-level cities, this paper adopts the principles of ample period optimality and sample individual optimality, and also fully considers the accuracy of strict data. For some missing data of individual cities, the missing data in t period are completed by exponential smoothing method according to the data in neighboring periods $t-1$ and $t+1$, respectively. Considering the completeness and accuracy of the data, the sample is determined as the data of 285 prefecture-level municipal districts[4] from 2003 to 2017. The specific processing of each variable is as follows:

(1) Output indicators. The output results are reflected by GRP and local fiscal revenue of each city. Although most studies use GRP as the economic output index of a region, in order to prevent the deviation of GRP, this paper adds the fiscal revenue of each city in addition to GRP to adjust the output indicators more reasonably and make the results more accurate. Although the relative efficiency is obtained by using DEA-Malmquist method to calculate TFP, and the price factor is not treated in some literatures, the nominal GRP and fiscal revenue are still deflated in this paper. Due to the lack of GRP deflator at the city level, this paper uses the consumer price index of the province where the city is located in 2000 as the base period to deflate the nominal GRP of 285 cities.

(2) Labor input. The labor in the input index is based on the data of urban employees. Because it is difficult to define urban labor force, it is very difficult to scientifically measure the input of labor force in a city per unit time. On the basis based of many references, this paper adopts employees as the labor input variable of urban economic activities, which refers to the number of people aged 16 and above who engage in certain social labor and obtain labor remuneration or business income. The sum of employees in urban units, private and individual employees is adopted in China Urban Statistical Yearbook.

(3) Capital investment. The calculation method of capital stock refers to the perpetual inventory method initiated by Goldsmith (1951), and the calculation formula is: $K_{it} = (1 - \delta)K_{it-1} + I_{it}$. Where, I_{it} is the gross fixed capital formation (GFCF) of city i in year t, K_{it} is the physical capital stock of city i in year t, and δ is the depreciation rate. Due to the lack of total fixed asset formation data at prefecture-level, the ratio of each prefecture-level city to the total fixed assets investment of the province is used to estimate the total fixed assets formation of each prefecture-level city by multiplying the amount of fixed assets formation at the provincial level in this paper. The depreciation rate is 9.6%[5] estimated by Zhang et al. (2004). Referring to the estimation methods of asset stock in the base period by Hall and Jones (1999) and Shan (2008), taking 2000 as the base period, the base period asset stock of each prefecture-level city is estimated by the ratio of the actual fixed assets formation in

[4] The data of municipal districts include all urban areas, excluding the data of county-level cities and counties. The concept of city is not clearly defined in the existing empirical studies. At the same time, this paper uses the data of urban municipal districts in a strict sense for the sake of data accuracy. The existing urban statistics are divided into municipal districts and the whole city. The reasons for using the data of municipal districts are as follows: firstly, all functions of cities are concentrated in municipal districts, and the statistical index data of municipal districts are convenient to eliminate non-urban factors; secondly, at present, China implements the management system of "cities leading counties". The number of counties in each city is different, and the proportion of agricultural population and agricultural economy in the whole city varies greatly among cities. However, the municipal districts are relatively stable, which is convenient for the historical comparison of the city itself and the horizontal comparison of domestic and foreign cities.

[5] According to existing studies, the commonly used depreciation rates are 6%, 9.6% and 10.96%. Among them, when the depreciation rate is 9.6%, the conclusion that the calculation error of fixed asset formation in prefecture-level cities is smaller has been verified.

2001 to the sum of the depreciation rate and the average growth rate of the actual fixed assets formation[6] from 2000 to 2005.

(4) Natural resources input. In addition to necessary social resources such as labor and capital, some natural resources will also be used in the production process. Considering the availability of indicators, this paper selects land and water resources as two natural resources. Land resources are represented by the area of urban construction land, and water resources are represented by the total amount of urban water supply.

5.2.2 Calculation of Industrial Co-Agglomeration Index

The data of employment in producer services and manufacturing are from the annual editions of China Urban Statistical Yearbook. Since there is no statistics on producer services in the China Statistical Yearbook, it is necessary to define and classify producer services in the tertiary industry. The classification of producer services in existing literatures and statistical institutions is different. Based on the classification of producer services by China's National Bureau of Statistics in 2019[7] and referring to the classification method of existing literature (Wu, 2019; Xuan & Yu, 2017), producer services include five major industries[8] in this paper: transportation, warehousing and postal industry, information transmission, computer services and software industry, financial industry, leasing and commercial industry, scientific research, technical services and geological exploration industry. Referring to Xuan and Yu (2017), producer services are further divided into high-end producer services and low-end producer services. High-end producer services are mainly knowledge and technology intensive industries, including information transmission, computer services and software industry, financial industry, scientific research, technical services and geological exploration industry. However, the knowledge and technology intensive level of low-end producer services is relatively low, including transportation, warehousing and postal industry, as well as leasing and business services.

Here, the producer services agglomeration index, manufacturing agglomeration index and industrial co-agglomeration index are calculated respectively. The calculation formula is as follows:

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[6] Based on the prices in 2000, the actual fixed assets of 285 prefecture-level cities are converted according to the fixed capital investment price index of the province in which the prefecture-level cities are located.

[7] In 2019, China's National Bureau of Statistics revised the National Economic Industry Classification (GB/T 4754–2017).

[8] In the existing researches and literatures, producer services are divided into six categories (real estate industry is added on the basis of five categories (Wang et al., 2021)) or seven categories (water conservancy, environment and public facilities management industry, wholesale and retail industry are added on the basis of five categories (Han and Yang 2020)). This paper selects producer services in a narrow sense to define them.

(1) Producer services agglomeration index

$$sr_i = \frac{E_{is}}{E_i} / \frac{E_s}{E} \tag{5.1}$$

where, sr_i represents the agglomeration index of producer services in city i, E_{is} represents producer services employment in city i, E_i represents the total employment in city i, E_s represents national producer services employment, and E represents the total national employment.

(2) Manufacturing agglomeration index

$$mr_i = \frac{E_{im}}{E_i} / \frac{E_m}{E} \tag{5.2}$$

where, mr_i represents the agglomeration index of manufacturing in city i, E_{im} represents manufacturing employment in city i, E_i represents the total employment in city i, E_m represents national manufacturing employment, and E represents the total national employment.

(3) Industrial co-agglomeration index

$$r_i = \left[1 - \frac{|sr_i - mr_i|}{sr_i + mr_i}\right] + [sr_i + mr_i] \tag{5.3}$$

where, r_i represents the index of industrial co-agglomeration in city i, sr_i represents the agglomeration index of producer services in city i, mr_i represents the agglomeration index of manufacturing in city i.

5.3 Model

5.3.1 Data and Variables

The main data are from China Urban Statistical Yearbook 2004–2018, and the price index data are from China Price Statistical Yearbook 2018. According to the household registration statistics of agricultural and non-agricultural populations, the population classification is based on the total population and non-agricultural population at the end of 2008 in China Urban Statistical Yearbook. Since 2009, the non-agricultural population has been changed to the annual average population. In order to maintain the consistency of data, the total population at the end of the year is used in this paper, namely the registered population at the end of the year. However, there may be a part of agricultural registered population working in non-agricultural sectors in urban areas of China. Therefore, the use of non-agricultural population may underestimate the size of the city, especially for the economically developed cities in coastal areas, where there may be some errors in the areas with a large inflow of migrant workers. Data of all variables are obtained from municipal districts.

The description of each variable is shown in Table 5.1. In order to avoid heteroscedasticity, all variables are calculated using logarithms. Among them, the explained variable is urban TFP (tfp). It should be noted that since the above Malmquist index reflects the relative change rate from period t to period $t + 1$, it is transformed into the base period of 2003 (the TFP of 2003 is set as 1), and the value of TFP for each city in each year is calculated. The key explanatory variable is the industrial co-agglomeration index (r).[9] The control variables include variables that directly and indirectly affect urban TFP, mainly including urban actual per capita GRP ($agrp$), urban government fiscal expenditure (exp), urban employment density (emp), urban industrial structure (ind), urban human capital (huc), urban real estate development investment (rei), urban medical services (bed), urban infrastructure (str) and urban traffic conditions (bus).

GRP per capita can measure urban labor productivity because cities with higher levels of economic development tend to have higher labor productivity. The increase of government fiscal expenditure helps to stimulate the total demand of urban economy, thus stimulating the development of urban economy and improving urban TFP. Urban employment density reflects the impact of labor supply per unit area on urban economic development. High employment density can improve labor productivity, thus promoting economic efficiency. However, at the same time, high employment density also means high labor supply per unit area, which may reduce income and inhibit industrial and economic development. Urban industrial structure is expressed by the ratio of the tertiary industry to the secondary industry. When the proportion of the tertiary industry is relatively high, the high skill-intensive industry can improve technical efficiency and promote technological progress, which is conducive to the improvement of urban TFP. However, the tertiary industry may also absorb more low-end labor force, restricting the improvement of urban TFP. The scale of urban real estate investment can affect the supply change of real estate market, thus affecting the real estate investment of enterprises and the housing purchase demand of residents, and indirectly affect the urban economic growth. In addition, a set of variables representing urban public services and infrastructure are controlled, which include the number of hospital beds per 10,000 people reflecting urban medical service level, the road area per capita reflecting urban infrastructure, the number of buses per 10,000 people reflecting urban traffic conditions, the number of college

[9] Other explanatory variables mr, sr, $high\_sr$, low_sr in Table 5.1 will be used in the mediation effect model.

Table 5.1 Variable symbol specification

Variable type	Variable name	Variable symbol	Data processing
Explained variable	Urban total factor productivity	tfp	Measured based on DEA-Malmquist model
Explanatory variable	Industrial co-agglomeration	r	Industrial co-agglomeration index
	Manufacturing agglomeration	mr	Agglomeration index of manufacturing
	Producer services agglomeration	sr	Agglomeration index of producer services
	High-end producer services agglomeration	$high\_sr$	Agglomeration index of high-end producer services
	Low-end producer services agglomeration	low_sr	Agglomeration index of low-end producer services
	Urban actual per capita GRP	$agrp$	2000 as the base period (yuan)
	Urban government fiscal expenditure	exp	Proportion of fiscal expenditure in GRP
	Urban employment density	emp	Ratio of urban employed population[10] to built-up area (person/km^2)
	Urban industrial structure	ind	Ratio between the tertiary industry and the secondary industry
	Urban human capital[11]	huc	Number of college students per 10,000 people (person/10,000 person)
	Urban real estate investment	rei	Proportion of investment completed in real estate development[12] to GRP
	Urban medical services	bed	Number of hospital beds per 10,000 people (pieces/10,000 person)
	Urban infrastructure	str	Road area per capita (person /m^2)
	Urban traffic conditions	bus	Number of buses per 10,000 people (vehicles/10,000 person)

Source The author presumes

Table 5.2 Descriptive statistical analysis of various variables

Variable	N	Min	Max	Mean	Std. dev
tfp	4275	0.4	7.4	1.4	0.6
r	4275	0.0	1.0	0.7	0.2
mr	4275	0.0	2.9	0.9	0.5
sr	4275	0.1	2.6	0.8	0.3
high_sr	4275	0.1	3.0	0.9	0.4
low_sr	4275	0.1	3.4	0.7	0.4
agrp	4275	1210.2	370,845.0	39,127.4	35,845.6
exp	4275	1.5	142.8	14.9	8.7
emp	4275	412.3	30,169.4	4159.9	2160.4
ind	4275	0.1	5.3	1.0	0.6
huc	4275	0.0	2548.59	421.07	393.16
rei	4275	0.3	107.0	13.6	9.6
bed	4275	3.4	297.6	61.0	27.6
str	4275	0.3	108.4	10.6	7.7
bus	4275	0.2	115.0	7.4	7.0

Source The author presumes

students per 10,000 people reflecting urban human capital. These variables themselves also mean the guarantee of high-quality of life in the city and attract labor and enterprises and other production factors to further gather in the city, which is conducive to the improvement of urban economic efficiency. The descriptive statistical analysis of each variable is shown in Table 5.2. The minimum, maximum, mean and standard deviation of the observed data object of each variable are shown, respectively.

Based on the panel data of 285 prefecture-level municipal districts in China from 2003 to 2017, this paper constructs the following econometric models in order to examine the influence of industrial co-agglomeration on urban TFP.

$$tfp_{it} = \alpha_0 + \alpha_1 tfp_{it-1} + \alpha_2 r_{it} + \beta Z_{it} + \mu_i + v_t + \varepsilon_{it} \quad (5.4)$$

[10] Urban employment population includes the number of employees in urban units, the number of private and self-employed employees.

[11] Generally speaking, it is more appropriate to use the human capital index of the number of college graduates. Due to the limitation of data, the number of college students is used as the proxy variable of human capital in this paper.

[12] The amount of investment completed in real estate refers to the investment in office buildings and other supporting service facilities and land development projects developed by all kinds of registered real estate companies, commercial housing construction companies and other real estate legal persons, as well as houses, factories, restaurants, hotels, resorts and other entities that are actually engaged in real estate or business activities; simple land transactions are not included.

In Eq. (5.4), the explained variable is tfp_{it}, which represents the TFP of the city i in year t, and tfp_{it-1} is the TFP of the city i in the lag period of $t-1$. Considering the continuity and dynamic of economic growth, the TFP with a one-period lag is put into the econometric model as an explanatory variable. The key explanatory variable in the model is the industrial co-agglomeration index (r_{it}). Other control variables of each model are Z_{it}. μ_i and v_t are regional individual effect and time effect respectively, and ε_{it} is random disturbance term.

5.3.2 Estimation Method

The most commonly used estimation methods of panel data model are fixed effects model and random effects model, but when the explanatory variables are endogenous, the parameter estimation results of these two models are biased and inconsistent. For the model in this paper, on the one hand, the explained variable with one-period lag is used in the explanatory variable; on the other hand, there may be a simultaneous endogenous problem between urban industrial co-agglomeration and urban economic growth. For this dynamic panel data model with endogenous explanatory variables, the generalized moment estimation method (hereinafter referred to as GMM) is usually used.

Whether GMM estimation method can obtain uniformly effective estimation coefficients depends on whether the difference of disturbance terms has second-order autocorrelation and whether the selection of instrumental variables is effective. The following two tests are needed: firstly, the statistical value of AR (2) is used to test whether the difference of the disturbance term of the original model has second-order autocorrelation. If the AR (2) test cannot reject the null hypothesis (H_0: the disturbance term has no autocorrelation), it means that there is no second-order autocorrelation in the random disturbance term of the first-order difference equation. Secondly, the validity of all instrumental variables is determined by over-identification constraint test (Sargan/Hansen test). If the Sargan/Hansen test cannot reject the null hypothesis (H_0: all instrumental variables are valid), it means that the setting of instrumental variables is reasonable.

GMM estimation method is divided into difference GMM and system GMM. System GMM can effectively control the possible endogenous and heteroscedasticity problems in the model compared with difference GMM. Moreover, this method can take the lag term of the weak exogenous variables as the instrumental variable of corresponding variables by using a first-order difference to the estimated model, which can not only help to alleviate the problems of weak instrumentality and finite sample error of differential GMM, but also improve the efficiency of estimation, so as to obtain a consistent and effective estimation. In addition, GMM estimation can be divided into one-step estimation and two-step estimation according to the choice of the weight matrix. In general, the standard covariance matrix of the two-step estimation method can better deal with the problems of autocorrelation and heteroscedasticity. Due to the large regional differences among 285 prefecture-level cities in China, that is, the samples of 285 prefecture-level cities are likely to have heteroscedasticity, so the two-step system GMM estimation method is adopted in this paper. In order to prevent the two-step system GMM from underestimating the standard error of regression coefficient, $vce(robust)$ is added to correct the standard error. Meanwhile, a time dummy variable is added to satisfy the irrelevance of the error term.

5.4 Empirical Analysis and Results

5.4.1 Influence of Industrial Co-Agglomeration on Urban TFP

According to the dynamic panel model of Eq. (5.4), models (1)–(3) in Table 5.3 report the two-step system GMM estimation results of national cities, 130 large cities and 155 small and medium-sized cities.[13] Meanwhile, models (4)-(6) in Table 5.3 respectively report the robustness test results of each sample. By eliminating extreme values (outliers), the sample values of explained variables (tfp) and key explanatory variables (r) in the models (1)–(3) that are less than 1% quantile and greater than 99% quantile are replaced with the values at 1% and 99% quantile, respectively. The estimation methods of each model are consistent with the original model.

From the fitting effect of the two-step system GMM in Table 5.3, in all models, the p values of the first-order autocorrelation test AR (1) of the two-step system GMM are less than 0.05, while the p values of AR (2) are greater than 0.05, indicating that there are no second-order autocorrelation of the difference of the disturbance term in the first-order difference equation. The p values of over-identification constraint test (Hansen test)[14] are all greater than 0.05, which cannot reject the null hypothesis of "joint effectiveness of instrumental variables". Meanwhile, the lag term of the explained variable (tfp_{t-1}) is significant in all models, which is sufficient to prove the robustness of the models. Therefore, the above results show that GMM estimation results of the two-step system are reliable and effective. On the basis of ensuring the validity of the models, the estimation results are further analyzed.

As shown in models (1)–(3) of Table 5.3, the coefficients of industrial co-agglomeration index are negative and statistically significant in the whole country, small and medium-sized cities, which means that the co-agglomeration of producer services and manufacturing can reduce urban TFP. That is, when the industrial co-agglomeration increases by 1% in that year, the urban TFP of the whole country and

[13] According to the year-end population of municipal districts, during 2003–2017, cities with an average population of more than 1 million are classified as large cities, while cities with an average population of less than 1 million are classified as small and medium-sized cities.

[14] Since Hansen test is more robust than Sargan test (Chen 2014), only the results of Hansen test are concerned here.

Table 5.3 Influence of industrial co-agglomeration on urban TFP

Variable	sys-GMM			sys-GMM (robust test)		
	National (1)	Large (2)	Small-medium (3)	National (4)	Large (5)	Small-medium (6)
tfp_{t-1}	0.636***	0.798***	0.520***	0.636***	0.803***	0.526***
	(12.49)	(15.84)	(7.68)	(12.28)	(17.09)	(7.62)
r	−0.244***	−0.035	−0.256**	−0.241***	−0.047	−0.233**
	(−3.07)	(−0.43)	(−2.30)	(−2.81)	(−0.57)	(−2.07)
$agrp$	0.862***	0.480***	1.175***	0.839***	0.468***	1.158***
	(8.80)	(5.57)	(8.12)	(8.72)	(6.05)	(8.26)
exp	0.281***	0.158***	0.297***	0.273***	0.151***	0.295***
	(6.78)	(3.58)	(4.79)	(6.62)	(3.72)	(4.74)
emp	−0.256***	−0.146***	−0.252***	−0.246***	−0.143***	−0.240***
	(−6.38)	(−4.22)	(−4.46)	(−6.39)	(−4.29)	(−4.28)
ind	0.050	−0.034	0.224***	0.053	−0.037	0.233***
	(1.32)	(−1.11)	(3.12)	(1.48)	(−1.29)	(3.48)
huc	0.054**	0.098**	0.053	0.050**	0.089**	0.041
	(2.11)	(2.38)	(1.56)	(2.09)	(2.43)	(1.24)
rei	0.032*	0.040	0.013	0.031*	0.046	0.012
	(1.74)	(1.37)	(0.51)	(1.74)	(1.55)	(0.49)
bed	−0.162***	−0.166***	−0.191**	−0.153***	−0.166***	−0.184**
	(−3.86)	(−3.03)	(−2.44)	(−3.96)	(−3.42)	(−2.40)
str	−0.311***	−0.218***	−0.383***	−0.303***	−0.209***	−0.364***

(continued)

Table 5.3 (continued)

Variable	sys-GMM			sys-GMM (robust test)		
	National (1)	Large (2)	Small-medium (3)	National (4)	Large (5)	Small-medium (6)
	(−7.01)	(−4.22)	(−4.74)	(−7.03)	(−4.60)	(−4.58)
bus	−0.269***	−0.197***	−0.268***	−0.264***	−0.184***	−0.261***
	(−5.99)	(−3.94)	(−4.43)	(−5.85)	(−4.60)	(−4.35)
c	−5.418***	−3.372***	−8.867***	−5.285***	−3.24***	−8.178***
	(−7.86)	(−4.77)	(−6.63)	(−7.80)	(−5.12)	(−6.92)
Number of instruments	216	140	140	216	140	140
AR(1)	0.000	0.000	0.000	0.000	0.000	0.000
AR(2)	0.317	0.140	0.967	0.417	0.184	0.872
Hansen test	0.132	0.316	0.181	0.099	0.323	0.146
Observations	3990	1820	2170	3990	1820	2170

Source The author presumes
Note (1) sys-GMM:two-step system GMM estimation method
(2) The sample of large cities is 130, and the sample of small and medium-sized cities is 155
(3) As for the selection of instrumental variables, in the national models (1) and (4), the lag (0 1) of tfp_{t-1}, $agrp$ are selected as GMM instrumental variable, and the lag (2 5) of r, huc are selected as GMM instrumental variables simultaneously, and other variables are used as their own IV instrumental variables. In different scale city models (2), (3), (5), (6), the lag (0 1) of tfp_{t-1} is selected as GMM instrumental variables, and the lag (1 1) of $agrp$, r, huc are selected as GMM instrumental variables simultaneously, and other variables are used as their own IV instrumental variables
(4) AR (1) and AR (2) of the autocorrelation test of disturbance terms and Hansen test are all statistics accompanied by p values. T-statistics are reported in brackets of the table. All models use the t-statistics corrected and calculated by cluster robust standard error
(5) ***, * * and * are significant at the significance level of 1, 5 and 10%, respectively

small and medium-sized cities will decrease by 0.244% and 0.256%, respectively. However, industrial co-agglomeration has no significant influence on urban TFP in large cities.

In all models, the increase of the actual per capita GRP and the proportion of government fiscal expenditure can improve urban TFP. In contrast, the increase of employment density, the number of hospital beds per 10,000 people, road area per capita and the number of buses per 10,000 people can restrict the improvement of urban TFP. Since most of the employees of municipal districts are employed in the secondary and tertiary industries. Although the increase in the supply per unit area of employees in the secondary and tertiary industry may improve labor productivity, but the high employment density also means a high labor supply per unit area, which puts downward pressure on wages and offsets the impact of higher labor productivity and wage level brought by the increase in employment density (Wang, 2022). Therefore, it is also possible to reduce income, which not only inhibits economic development but also restricts the improvement of TFP. Compared with large cities, this phenomenon is more obvious in small and medium-sized cities from the size of the variable coefficient. As most of the cities in the central and western regions are areas of population outflow, infrastructure construction and public services may not yet have economies of scale. This also leads to the excessive increase of infrastructure construction and public services, which restricts the improvement of urban TFP instead of promoting that. The restrictive effect of population agglomeration on urban TFP in western cities also proves the problems of the above phenomenon (Wang, 2022). Compared with large cities, this phenomenon is also more obvious in small and medium-sized cities. In addition, the improvement of human capital level can promote the improvement of urban TFP in large cities. But only in small and medium-sized cities, the increase of the proportion of tertiary industry can improve the urban TFP. Compared with small and medium-sized cities, the improvement of human capital level in large cities often brings about a higher knowledge spillover effect, which is easier to improve labor productivity and urban TFP.

Models (4)–(6) in Table 5.3 report the robustness test results of the national sample and sub-city-size sample in which industrial co-agglomeration affects the urban TFP after deleting outliers. On the basis of ensuring the validity of the model, the corresponding robustness test of each model also shows the same result. That is, the negative influence of the co-agglomeration of producer services and manufacturing on urban TFP is still stable in the whole country and small and medium-sized cities. However, the co-agglomeration of producer services and manufacturing has no significant inhibitory effect on urban TFP in large cities. Other control variables are also consistent with the results in models (1)–(3).

To sum up, industrial co-agglomeration can hinder the improvement of urban TFP in small and medium-sized cities, while the influence of industrial co-agglomeration on urban TFP cannot be determined in large cities. The agglomeration of producer services in small and medium-sized cities has a higher effect on the improvement of urban TFP than that in large cities (Wang, 2022). Meanwhile, industrial co-agglomeration hinders the improvement of urban TFP. It can be inferred that manufacturing agglomeration not only hinders the improvement of urban TFP, but also its hindering effect is the main reason that the negative force of industrial co-agglomeration on urban TFP is greater than the positive force.

The conclusion that industrial co-agglomeration significantly inhibits the improvement of urban TFP is quite different from the conclusion that industrial co-agglomeration is beneficial to productivity improvement in most existing literatures. When industrial co-agglomeration acts on urban TFP, there are many impact paths with conflicting forces. If the negative force is greater than the positive force, the overall result is negative. The reason why the negative force of industrial co-agglomeration affecting urban TFP is greater than the positive force is that the overall quality of industrial co-agglomeration is low, and on the other hand, the industrial co-agglomeration is inversely proportional to the index of industrial location entropy in some cases (Wu, 2018). According to Eq. (5.3), when the degree of specialization concentration of one constituent industry is low, the lower the degree of specialization concentration of the other constituent industry is, the higher the industrial co-agglomeration index is. Such a collaborative index lacking industrial accumulation and precipitation is naturally not conducive to productivity improvement. This is because not only the overall scale of industrial co-agglomeration is limited, but also co-located input-output relation between producer services and manufacturing is weak. Therefore, the positive force released by the benign interaction between the external economy and the industry is very limited. As a result, the negative force released by the sunk cost and the undesirable agglomeration combination rises significantly in relativity, resulting in a negative overall result.

As mentioned in some literatures, based on the distance measure index of industrial agglomeration, enterprises in the same industry tend to cluster in a small spatial scale, while in a large regional scale (about 150km), they tend to vertically connect the co-agglomeration among different industries (Duranton & Overman, 2008). Based on the data of municipal districts in China, this paper finds that the industrial co-agglomeration concentrated in the center part of the city is more likely to produce crowding effect or crowding out effect. Although industrial co-agglomeration saves various transaction costs, the crowding effect under diseconomies of scale can increase the cost of factors, and intensive economic activities can lead to congestion of traffic and public infrastructure, and environmental degradation, further hindering the improvement of urban productivity.

5.4.2 Mediation Effect[15]

In order to further investigate the mechanism of the co-agglomeration of producer services and manufacturing on urban TFP, this paper uses a mediation effect model to

[15] When considering the influence of independent variable X on dependent variable Y, if X influences Y by influencing variable M, then M is called a mediation variable. The effect caused by the mediation variable is called a mediation effect.

explore whether producer services agglomeration affects urban TFP through manufacturing agglomeration. In other words, the indirect effects of producer services agglomeration (X) on urban TFP (Y) are investigated by taking manufacturing agglomeration as the intermediary variable (M). Meanwhile, from the perspective of producer services category, this paper examines the role of manufacturing agglomeration in the relationship between producer services agglomeration and urban TFP.

In order to avoid the intercept terms irrelevant to the method discussion in the regression equation, all variables are centralized (that is, the data is subtracted from the sample mean, and the mean of the centralized data is 0). Referring to the setting of mediation model by Wen and Ye (2014), this paper constructs a mediation effect model as follows:

$$Y_{it} = cX_{it} + \mu_{1i} + \upsilon_{1t} + \varepsilon_{1it} \tag{5.5}$$

$$M_{it} = aX_{it} + \mu_{2i} + \upsilon_{2t} + \varepsilon_{2it} \tag{5.6}$$

$$Y_{it} = c^{'}X_{it} + bM_{it} + \mu_{3i} + \upsilon_{3t} + \varepsilon_{3it} \tag{5.7}$$

In Eqs. (5.5)-(5.7), Y is the dependent variable, X is the independent variable, and M is the intermediary variable. In Eq. (5.5), coefficient c is the total effect of independent variable X on dependent variable Y. In Eq. (5.6), coefficient a is the effect of independent variable X on intermediary variable M. In Eq. (5.7), coefficient b is the effect of intermediary variable M on dependent variable Y after controlling the influence of independent variable X, and coefficient $c^{'}$ is the direct effect of independent variable X on dependent variable Y after controlling the influence of intermediary variable M. μ_i and υ_t are regional individual effect and time effect, respectively, and ε_{it} is random disturbance term. The mediation effect is equal to the coefficient product ab.

Referring to Wen and Ye (2014), the above parameters are tested: firstly, the significance of coefficient c of Eq. (5.5) is tested. If the coefficient c is significant, the next step of indirect effect test is based on the theory of mediation effect. If the coefficient c is not significant, it is considered that there is a suppression effect and then the next step of indirect effect test is carried out. Secondly, the significance of coefficient a of Eq. (5.6) and coefficient b of Eq. (5.7) are tested. If the coefficients a and b are both significant, the indirect effect is significant; if at least one of a and b is not significant, the Bootstrap method[16] is required to test ($H_0 : ab = 0$; if H_0 is

[16] The bootstrap method is a method of repeated sampling from a sample. Taking repeated samples from a given sample with backdrops to produce many samples, the resulting estimates of the product of coefficients are arranged from smallest to largest, where the 2.5th percentile and 97.5th percentile form a 95% confidence interval for ab, from which the test can be performed. If the confidence interval does not include 0, then the coefficient product is significant. Such a test method is called the Bootstrap method with non-parametric percentile, and its test power is higher than Sobel test (Fritz and MacKinnon 2007; MacKinnon et al., 2004). This paper uses the confidence interval

rejected, the indirect effect is significant). Finally, the significance of the coefficient $c^{'}$ of Eq. (5.7) is tested. If the coefficient of $c^{'}$ is not significant, that is, the direct effect is not significant, it means that there is only a mediation effect (also known as a “complete mediation effect”[17]), if the coefficient of $c^{'}$ is significant, and the symbols of ab and $c^{'}$ are the same, then the indirect effect is a “partial mediation effect”. The intensity of the indirect effect is indicated by the ratio of indirect effect to the total effect c (ab/c). When the symbol of ab and $c^{'}$ are different, the indirect effect is caused by the “suppression effect”[18] (Mackinnon & Lamp, 2021; Mackinnon et al., 2000). The absolute value of the ratio of suppression effect to direct effect ($\left|ab/c^{'}\right|$) represents the intensity of the indirect effect.

Based on Eqs. (5.5)–(5.7), a mediation effect model of manufacturing agglomeration in national, large cities and small and medium-sized cities is established respectively, and the stepwise test regression coefficient method is used to test the mediation effect. Table 5.4 reports the test results of the effects of producer services agglomeration (sr) on urban TFP mediated by manufacturing agglomeration (mr).

The model (1) in Table 5.4 tests the estimation results of the total effect of producer services agglomeration on urban TFP. The coefficient c of producer services agglomeration is 0.098, which indicates that the agglomeration of producer services contributes to the improvement of urban TFP. Model (2) tests the estimation results of the impact of producer services agglomeration on manufacturing agglomeration. The coefficient a of producer services agglomeration is −0.405, which indicates that the agglomeration of producer services inhibits the agglomeration of manufacturing. After controlling the agglomeration of producer services in model (3), the estimation result of the impact of manufacturing agglomeration on urban TFP as a mediating variable shows that the coefficient $c^{'}$ of producer services agglomeration is 0.068 and the coefficient b of manufacturing agglomeration is −0.074. Because the symbols of indirect effect coefficient ab and direct effect regression coefficient $c^{'}$ are the same and positive, it indicates that manufacturing agglomeration shows a “partial mediation effect” between producer services agglomeration and urban TFP, and the

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after deviation correction with higher test power, that is, the so-called non-parametric percentile Bootstrap method deviation correction (Edwards and Lambert 2007; Fritz and MacKinnon 2007; MacKinnon 2008).

[17] The case of complete mediation is rare. When the total effect is small (but significant), the indirect effect may be less than 70% of the total effect, and the direct effect is not significant. The result is a complete mediation, which is contrary to common sense. When it is considered that there is a complete mediation, the possibility of other intermediaries is excluded. Preacher and Hayes (2008) called for abandoning the concept of complete mediation and treating all mediations as partial mediations.

[18] The suppression effect is a common phenomenon that the total effect is suppressed in the mediation effect model, and its manifestation is the opposite symbol of direct effect and indirect effect. Because the indirect effect offsets part of the direct effect, the absolute value of the total effect is less than that of the direct effect. The suppression effect will increase the total effect between the independent variable and dependent variable. After controlling the suppression variable, the effect of the independent variable on the dependent variable will increase.

Table 5.4 The mediation effect of manufacturing agglomeration

Variable	Stepwise test regression coefficient method (National)			Stepwise test regression coefficient method (Large)			Stepwise test regression coefficient method (Small-medium)		
	Step 1(tfp)	Step 2(mr)	Step 3(tfp)	Step 1(tfp)	Step 2(mr)	Step 3(tfp)	Step 1(tfp)	Step 2(mr)	Step 3(tfp)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
sr	0.098***	−0.405***	0.068***	0.061***	−0.364***	0.046**	0.134***	−0.444***	0.097***
	(7.06)	(−15.77)	(4.76)	(3.23)	(−12.15)	(2.33)	(6.81)	(−11.54)	(4.87)
mr			−0.074***			−0.043***			−0.082***
			(−9.08)			(−2.96)			(−7.83)
$agrp$	0.212***	0.381***	0.240***	0.131***	0.394***	0.148***	0.313***	0.290***	0.337***
	(15.93)	(15.42)	(17.74)	(7.34)	(13.97)	(7.91)	(15.38)	(7.25)	(16.57)
exp	0.035***	−0.082***	0.029**	0.040*	0.157***	0.046**	0.035**	−0.136***	0.024
	(2.71)	(−3.43)	(2.26)	(1.95)	(4.92)	(2.27)	(2.09)	(−4.13)	(1.44)
emp	−0.084***	0.078***	−0.078***	−0.048***	0.077***	−0.045***	−0.090***	−0.019	−0.092***
	(−6.99)	(3.51)	(−6.56)	(−2.95)	(2.99)	(−2.75)	(−5.10)	(−0.54)	(−5.26)
ind	−0.054***	−0.281***	−0.075***	−0.032*	−0.262***	−0.043**	−0.022	−0.304***	−0.047***
	(−4.84)	(−13.50)	(−6.63)	(−1.95)	(−10.04)	(−2.56)	(−1.34)	(−9.39)	(−2.84)
huc	−0.003	0.090***	0.004	−0.002	0.078***	0.004	0.001	0.085***	0.007
	(−0.51)	(9.72)	(0.407)	(−0.31)	(8.30)	(0.88)	(0.09)	(9.07)	(1.46)
rei	−0.004	0.118***	0.005	−0.013	0.043**	−0.011	−0.009	0.122***	0.001
	(−0.50)	(7.58)	(0.55)	(−0.97)	(2.04)	(−0.84)	(−0.84)	(5.63)	(0.07)
bed	−0.036**	−0.113***	−0.045***	−0.044*	−0.099***	−0.048**	−0.057***	0.015	−0.056***
	(−2.49)	(−4.18)	(−3.09)	(−1.96)	(−2.80)	(−2.15)	(−2.77)	(0.37)	(−2.75)
str	−0.085***	0.053**	−0.082***	−0.038**	0.063**	−0.035**	−0.129***	0.112***	−0.120***

(continued)

Table 5.4 (continued)

Variable	Stepwise test regression coefficient method (National)			Stepwise test regression coefficient method (Large)			Stepwise test regression coefficient method (Small-medium)		
	Step 1(tfp)	Step 2(mr)	Step 3(tfp)	Step 1(tfp)	Step 2(mr)	Step 3(tfp)	Step 1(tfp)	Step 2(mr)	Step 3(tfp)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	(−7.15)	(2.37)	(−6.89)	(−2.31)	(2.44)	(−2.15)	(−7.58)	(3.35)	(−7.11)
bus	−0.050***	−0.032	−0.052***	−0.058***	0.047*	−0.056***	−0.030*	−0.078**	−0.037**
	(−4.57)	(−1.56)	(−4.83)	(−3.75)	(1.95)	(−3.63)	(−1.93)	(−2.56)	(−2.37)
C	−1.158***	0.431***	−0.126***	−0.199***	0.415***	−0.181***	−0.098***	0.448***	−0.061**
	(−7.53)	(11.03)	(−5.98)	(−7.23)	(9.59)	(−6.45)	(−3.15)	(7.35)	(−1.97)
Adj R-squared	0.1785	0.3472	0.1940	0.1755	0.4094	0.1788	0.2049	0.3058	0.2253
Observations	4275	4275	4275	1950	1950	1950	2325	2325	2325
Indirect/Total			0.308			0.254			0.273

Source The author presumes

proportion of the mediation effect is $ab/c = 0.308$. It shows that by inhibiting manufacturing agglomeration, the promoting effect of producer services agglomeration on urban TFP will be increased by 30.8%.

Similarly, the stepwise test regression coefficient method is used to test the mediation effect of manufacturing agglomeration in the sample of large cities and small and medium-sized cities. The specific regression coefficient values are shown in models (4)–(9) of Table 5.4, which is unnecessary to repeat. It is found that there is a "partial mediation effect" in large cities and small and medium-sized cities. It shows that by inhibiting manufacturing agglomeration, the promotion of producer services agglomeration in large cities and small and medium-sized cities on urban TFP will be increased by 25.4% and 27.3%, respectively. It also can be seen that the producer services agglomeration in small and medium-sized cities has a great effect on urban TFP by inhibiting the manufacturing agglomeration than that of producer services agglomeration in large cities.

Further, from the perspective of producer services category, producer services agglomeration is divided into high-end producer services agglomeration ($high\_sr$) and low-end producer services agglomeration (low_sr). Table 5.5[19] reports the test results of the effects of high-end and low-end producer services agglomeration on urban TFP mediated by manufacturing agglomeration. There is a "partial mediation effect"[20] whether in the national samples or in the urban samples of different sizes. The results of models (1) and (2) show that by inhibiting manufacturing agglomeration, the promotion effect of high-end and low-end producer services agglomeration on urban TFP will be increased by 19.9% and 51.0%, respectively. It can be concluded that the promotion effect of national low-end producer services agglomeration on urban TFP by inhibiting manufacturing agglomeration is higher than that of high-end producer services agglomeration. The results of models (4) and (5) show that by inhibiting manufacturing agglomeration, the promotion effect of low-end producer services agglomeration in large cities and high-end producer services agglomeration in small and medium-sized cities on urban TFP will be increased by 21.5% and 13.2%, respectively. However, the coefficient c' of producer services agglomeration in models (3) and (4) is not significant, which indicates that there is only a mediating effect. That is, although high-end producer services agglomeration in large cities and low-end producer services agglomeration in small and medium-sized cities can effectively inhibit the negative effect caused by manufacturing agglomeration, they do not achieve the purpose of improving urban TFP.

Based on the above analysis results, further discussion is conducted.

No matter in the national sample, or in large cities and small and medium-sized cities, the agglomeration of producer services will improve urban TFP, while the agglomeration of manufacturing will hinder the improvement of urban TFP. Manufacturing agglomeration shows a "partial mediation effect" between producer

[19] Due to the limited space, Table5.5 is a summary of the test results of each key variable.

[20] Although the coefficient c' of models (3) - (5) is not significant, that is, the direct effect is not significant, but the total effect is smaller, and the possibility of other mediators cannot be excluded, so it cannot be regarded as a "complete mediation".

Table 5.5 The summary results of the mediation effect of manufacturing agglomeration

	National		Large		Small-medium	
Variable	*high_sr*(1)	*low_sr*(2)	*high_sr*(3)	*low_sr*(4)	*high_sr*(5)	*low_sr*(6)
c	0.091***	0.038***	0.037**	0.039***	0.140***	0.042***
	(7.42)	(3.77)	(2.19)	(2.79)	(8.08)	(2.90)
a	−0.238***	−0.240***	−0.264***	−0.181***	−0.217***	−0.308***
	(−10.26)	(−12.75)	(−9.77)	(−8.06)	(−6.24)	(−10.96)
c'	0.073***	0.019*	0.025	0.031**	0.121***	0.014
	(5.93)	(1.83)	(1.42)	(2.16)	(7.06)	(0.93)
b	−0.076***	−0.081***	−0.047***	−0.046***	−0.085***	−0.092***
	(−9.47)	(−9.93)	(−3.32)	(−3.27)	(−8.29)	(−8.74)
Observations	4275	4275	1950	1950	2325	2325
Indirect/Total	0.199	0.510	0.337	0.215	0.132	0.677

Source The author presumes

services agglomeration and urban TFP, which indicates that producer services agglomeration can improve urban TFP by inhibiting manufacturing agglomeration. That is, manufacturing agglomeration has an inhibitory effect on the improvement of urban TFP, while promoting the agglomeration of producer services can inhibit manufacturing agglomeration, thus achieving the purpose of improving urban TFP.

In recent years, the Chinese government has been paying more attention to modern service industries such as producer services. In order to obtain as much support as possible from the central government in industrial development, local governments have followed the central government's industrial policies to blindly promote the development of modern services represented by producer services, in order to realize the industrial structure upgrading as soon as possible. In the absence of effective planning, this "blooming everywhere" development model is more likely to deviate from local comparative advantages and resource endowment characteristics, resulting in vicious homogeneous competition and repeated construction (Xi et al., 2015), forming a low-quality cluster of productive services in various regions. The low-quality repetitive construction of producer services cannot provide low-cost and high-quality specialized intermediate services for the large-scale production of manufacturing industry, so it is easy to be disconnected from the development demand of manufacturing industry. As a result, the positive effect of producer services agglomeration on TFP is offset by the negative effect of manufacturing agglomeration. Instead of improving total factor productivity, industrial co-agglomeration will reduce total factor productivity.

In small and medium-sized cities, the agglomeration of high-end producer services will improve urban TFP by inhibiting manufacturing agglomeration. Although the mediation effect of manufacturing agglomeration between low-end producer services agglomeration and urban TFP is relatively obvious, which indicates that the promotion of low-end producer services agglomeration in small and medium-sized cities can effectively inhibit the negative effect caused by manufacturing agglomeration, but it ultimately fails to play a role in improving urban TFP. It can also be seen from the results in Table 5.4 that the manufacturing agglomeration in small and medium-sized cities has a larger negative effect on urban TFP. Combined with the results in Table 5.3, the co-agglomeration of producer services and manufacturing in small and medium-sized cities has a negative effect on urban TFP, which indirectly indicates that the high-end producer services agglomeration has a limited effect on inhibiting manufacturing agglomeration to improve urban TFP. In small and medium-sized cities, the co-agglomeration of producer services and manufacturing is more likely to produce crowding or crowding out effects. The results[21] in Table 5.4 also show that the infrastructure conditions of small and medium-sized cities are poor, and the congestion effect of transport facilities and public infrastructure under diseconomies of scale is more likely to increase the factor cost and hinder the improvement of TFP.

In large cities, the agglomeration of low-end producer services will improve urban TFP by inhibiting manufacturing agglomeration. Although the mediation effect of manufacturing agglomeration between high-end producer services agglomeration and urban TFP is relatively obvious, it ultimately fails to play a role in improving urban TFP. It shows that the promotion of high-end producer services agglomeration in large cities can effectively inhibit the negative effect caused by manufacturing agglomeration, but it does not achieve the purpose of improving urban TFP like small and medium-sized cities. It can also be seen from the results of Table 5.4 that the manufacturing agglomeration has a smaller negative effect on urban TFP. Combined with the conclusion in Table 5.3, the co-agglomeration of producer services and manufacturing in large cities has no significant impact on urban TFP, which indirectly indicates that the positive effect of low-end producer services agglomeration on urban TFP is not enough to offset the negative effect caused by manufacturing agglomeration. The results[22] in Table 5.4 show that, on the premise that the infrastructure conditions in large cities are conducive to promoting manufacturing agglomeration, the co-agglomeration of regional industries will attract a large number of production factors and crowd out the resources of other regions. Restricted by sunk costs, it is difficult for enterprises to exit or enter freely, and the co-agglomeration of negative lock-in effect may not be conducive to improving TFP or even reducing it (Wang et al., 2021).

[21] In the model (8) of small and medium-sized cities in Table 5.4, the improvement of urban transport facilities is not conducive to improving manufacturing agglomeration, and urban medical services have no significant impact on manufacturing agglomeration.

[22] In the model (5) of large cities in Table 5.4, the improvement of urban transport facilities and urban infrastructure is conducive to improving manufacturing agglomeration.

5.5 Conclusions

Based on the panel data of 285 prefecture-level cities in China from 2003 to 2017, this paper constructs a dynamic panel model to investigate the influence of the co-agglomeration of producer services and manufacturing on urban TFP. And on this basis, a mediation effect model of manufacturing agglomeration is constructed to explore the influence path of producer services agglomeration on urban TFP through manufacturing agglomeration from the perspective of producer services category.

The following conclusions can be drawn:

Firstly, the co-agglomeration of producer services and manufacturing can hinder the improvement of urban TFP in the whole country and small and medium-sized cities, while the influence of the co-agglomeration of producer services and manufacturing on urban TFP cannot be determined in large cities. Further, the above conclusions are still robust based on the robustness test.

Secondly, no matter in the whole country, or in large cities and small and medium-sized cities, the agglomeration of producer services can improve urban TFP, while the agglomeration of manufacturing can hinder the improvement of urban TFP. Manufacturing agglomeration shows a "partial mediation effect" between producer services agglomeration and urban TFP, which indicates that producer services agglomeration can improve urban TFP by inhibiting manufacturing agglomeration. That is, manufacturing agglomeration has an inhibitory effect on the improvement of urban TFP while promoting the agglomeration of producer services can inhibit manufacturing agglomeration, thus achieving the purpose of improving urban TFP. Among them, the agglomeration of low-end producer services in large cities and the agglomeration of high-end producer services in small and medium-sized cities will improve the urban TFP by inhibiting manufacturing agglomeration.

Based on the above conclusions, there are the following policy implications. Cities should develop productive services and manufacturing that match the local advantages according to their own comparative advantages, economic scale and endowment characteristics. Therefore, the "two-wheel drive" strategy of industrial co-agglomeration should not be spread across the country. This strategy is relatively more suitable for promotion in cities where producer services agglomeration and manufacturing agglomeration are complementary or matched. Especially in the municipal districts of small and medium-sized cities, the agglomeration of high-end producer services should be actively promoted, which will help improve urban TFP by inhibiting the agglomeration of manufacturing. At the same time, we should promote the development of low-end producer services that meet the needs of the manufacturing development to reasonably match resources and thus improve urban TFP. However, we should actively promote the complementary and coordinated development of high-end producer services and manufacturing, and improve the quality of specialized agglomeration of producer services and manufacturing guided by technological progress, so as to improve urban TFP in the municipal districts of large cities.

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Chapter 6
The Green Industry of Northern Sweden—Will the Boom also Build Growth?

Lars Westin

Abstract Currently, Northern Sweden faces a phase of new industrialisation. Large "green" industrial projects are located or planned to be initiated in the region. Attractors are a reliable supply of green energy, land for large establishments and social as well as political stability. Initially, the actors are factories for the production of batteries and fossil-free steel, but also bitcoin mines, data server halls, etc. have been established. Following are consultants, real estate actors, architects, planners etc. In this respect, the green "reindustrialisation" has the potential to change the relatively slow growth in the region. The first long wave of industry ended in the 1970s, in a process that involved many elements of a "resource curse". In the paper, after a presentation of facts, visions and narratives connected with this change, we analyse the economic background and forces behind the stagnation. We ask if the region have the insights and leadership that may exploit the situation and move the region on to a path of growth? Labour and housing are needed, but the region must also develop institutions, narratives and habits that will keep and attract a broader set of assets. Legislation, policy and narratives at national and European levels are other obstacles for growth.

Keywords Green industry · Sustainability · Regional growth · The curse of resources · International industry localisation · International trade · Northern Sweden · Regional policy

JEL F16 · F63 · N54 · N94 · O18 · R11

6.1 Introduction

For the moment, Northern Sweden witnesses an upsurge of major attention from industrial actors with an interest to locate new or develop current facilities in the region. Industries and investors are searching for locations of "green industries". Although definitions are numerous, one aspect of a green industry is that it is an

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industry producing with low, zero or negative carbon impact.[1] For many reasons, of which the access to "green" hydroelectric and wind power is a core aspect, parts of Northern Sweden can offer locations that are economically advantageous from a green industry point of view but also offer a possibility to develop a narrative for the located company that may be attractive for a broad spectra of "green" minded customers.

As much of the Nordic sphere, Northern Sweden offers traditional factors of location for industrial production such as land, but it also offers hydroelectric power as well as political and social stability. Together those are factors that may create a trademark of sustainability for products from the region. This request from industry for "green locations" is also triggered by the overall global "sustainability mega trend" expressed by many households, civil organisations and policy makers. A fact that have inspired a large share of e.g. the European industry to take a lead in the development and supply of new fossil-free products, products that also have to be produced in places and in factories fulfilling high claims on overall sustainability, i.e. ecological, social and political conditions, while also be a profitable business.

The political and industrial response in Northern Sweden to this "new industrial reality" has by no means been slow, instead, the typical narrative is that the region now "is back on track", back into its historical position, as a region strongly focused on natural resource-based industries and related production.

Actually, the region lost this industry focused position in a long process from around 1950 to 1980. Hence, since then, the future of Northern Sweden in many aspects has been perceived as problematic. As previously discussed in Westin (2015), the overall population for Northern Sweden, here defined as the four northernmost counties, has been locked in around 900 000 inhabitants. As we will come back to below, during the second half of the twentieth century the region was pressed by the global movement of industry towards Asia, where a lower unit cost than in Sweden was the attractor, while also global costs of transportation continued to fall.

For a while and due to this, the population of the relatively small cities of Northern Sweden has, with the exception for the largest city, Umeå, been almost unchanged. Although it is growing, Umeå only has around 132 000 inhabitants in the municipality, and around 160 000 if the local labour market (the functional urban region) is

[1] The definitions of "green growth" and "green industry" are numerous and rather wide. OECD (2015) defines green growth broadly, as growing the economy in an environmentally sustainable way, through the promotion of growth and development while reducing pollution and greenhouse gas emissions, minimising waste and inefficient use of natural resources, maintaining biodiversity, and strengthening energy security. Other definitions focus on the reduction of green-house gases. UNIDO (https://www.unido.org/our-focus-cross-cutting-services-green-industry/green-industry-initiative; read 2022–08-22) defines "green industry" as economies striving for a more sustainable pathway of growth, by undertaking green public investments and implementing public policy initiatives that encourage environmentally responsible private investment. Hence, especially for UNIDO, green industry is a public policy. As may become more obvious later, in this paper we deal with industrial actors that themselves are the driving force for development of green industrial solutions.

considered.[2] This places the city after the ten largest municipalities and local labour markets in Sweden.

This pessimistic consideration may be contrasted against the rapid industrialisation, population growth and general development the region could witness during the nineteenth century and the first half of the twentieth century. When the process of outsourcing and relocalisation of industry towards Asia now, in the beginning of the twenty-first century, in much has slowed down, due to global instability, a less optimistic view on especially the development in China, increasing unit costs of production from higher salaries in Asia and, for some consumer products, the time cost of trade from Asia to Europe, the return of industry to Western Europe is on the agenda.

According to common theories of international trade, transportation and industrial location (e.g. Isard, 1977), this would not come as a surprise, the patterns of comparative advantage in response to changes e.g. in factor proportions within countries could explain the initial movement to Asia, while the same processes more recently have been working in the reverse direction—towards Europe. If increased political and trade risks are added, a reverse of the patterns of localisation and trade becomes inevitable.

Given this, two questions are raised in this paper. Is the situation for North Sweden similar as it was during the most expansive phase, is it possible or even of interest for the region to search for, or have as a goal to find a path back to lost days? Secondly, what is needed for the region to take advantage of the interest for green locations, in order to find and develop a new path of growth, where it avoids the pitfalls that lead to stagnation?

The outline of the paper is as follows. In the following section we present the green industry initiatives, especially in Skellefteå, and analyse the current situation with respect to assets, factors of production and spatial structure in the region. Thereafter the processes that led to the parting of industry from the region in the fifties' and the path into stagnation from there are discussed. Clearly, the general competitive situation now is not the same as 50 years ago, a return to old strategies and narratives will with a high probability not take the region out of its stagnation. In the following section we try to find the roots of the stagnation in factors related to the curse of resources, although a resource curse will take other expressions in the Nordic welfare state than in other types of economies. This leads to our question regarding what is needed in order to find a new path of development that makes it possible for the region to leave the curse and find a sustained path of growth? We suggest what we consider as the most important steps that must be taken for this to happen. Finally, the paper is concluded.

[2] Westin (2008) discusses the city system of Northern Sweden more detailed.

6.2 The New "Green Industry" in Northern Sweden

For the moment, the vision of Northern Sweden as a region for "green industry" is a mix of actual ongoing investments in factories and start-up of production on one hand and ideas, plans and mobilisation of capital for future investments on the other. Anyhow, all together this has become a new narrative for the region, a region where industry is in the forefront of the green transition to a sustainable, fossil-free or at least fossil neutral world.

The company Northvolt and its factory in Skellefteå, have become the forefront for the visual part of this narrative. In the city, with around 73 000 inhabitants, 700 kms north of Stockholm and 100 kms north of Umeå, Northvolt is since 2019 constructing a "Gigafactory", a "mega sized" plant, the "Northvolt Ett" for the production of the "greenest battery cell" possible, currently batteries of lithium-ion (Li-ion) type.[3] Another plant, Revolt, for the recycling of used batteries will also be established. As we have touched upon, this is an industrial response to a fast-increasing demand for batteries for electric vehicles, storage of energy and various industrial applications (Fig. 6.1).

Fig. 6.1 The Nortvolt Ett "Gigafactory" in Skellefteå, Northern Sweden. *Source* Northvolt.com homepage. With permission from Northvolt AB

[3] In English Northvolt Ett would be Northvolt One. Below we will also mention Nortvolt Fem, that is Northvolt Five.

Fig. 6.2 The Voltpack Mobile System. Produced by Northvolt. *Source* Northvolt.com homepage. With permission from Northvolt AB

The first batteries and mobile energy storages (the “Voltpack Mobile System” in Fig. 6.2) are delivered with the goal to produce up to 40 GWh per year. The investment by Northvolt is estimated to become around 6 billion euros until 2025. Considering that the annual Gross Regional Product (GRP) of the county Västerbotten, where Skellefteå and Umeå are located, amounts to around 12 billion euros, while during an ordinary year around 3 billion euros of those are in the form of investments, the size of this specific investment in the region becomes obvious.[4]

The first activities in 2017 by Northvolt in the region and the associated media coverage, immediately increased the interest from existing companies, various entrepreneurs, and capital interest to announce other projects within “green industry” to be located in the region. LKAB, a large state-owned mining company active in the smaller mining cities Kiruna and Gällivare, 350 kms to the north-west of Skellefteå, soon presented a vision to produce fossil-free iron ore. Investments for about 20–30 billion euros until 2040. HYBRIT, a consortium consisting of LKAB together with SSAB (a state-owned steel company) and Vattenfall (state-owned producer of hydro-electric power) announced an interest to produce fossil-free steel and has initiated the construction of a pilot plant in Luleå, 100 kms to the north of Skellefteå as well. A competitor, the private company H2 Green Steel, with owners involved in Northvolt, also plans to produce fossil-free steel in the city of Boden, near Luleå. An investment that initially amounts to 2 billion euros until 2024.

Hence, it is estimated that around 100 billion euros will be invested in the coming years by private and state-owned companies in green industries in Northern Sweden (Nyheter, 2022). Such figures are obviously filled with uncertainty, but together with an estimated direct and indirect impact on employment from those industries of

[4] The return of green industry to old industry cities with growth problems is for sure not only a Swedish phenomenon. The Economist (2022), in the tale of two American cities, points on how Youngstown, Ohio after years of population decline, mange to attract industries again, now battery production and production of electric vehicles to its “Voltage Valley”.

around 30 000 jobs in the region, the figure has added to the interest from local actors as well as from outside to consider the region with new eyes and with recalculated investment plans.

At most, when complementary investments and when the demand for new employees in both private and public sectors in the region are added, the special governmental coordinator for the transformation Peter Larsson in SVT, the Swedish public service television channel,[5] argued that the population in the two northern counties where Kiruna, Gällivare, Boden, Luleå, Skellefteå and Umeå are located, will increase with around 100 000 inhabitants until 2035. From the current 500 000 inhabitants, this would be a substantial growth of around 20%.

Those figures have already been criticised. It has been argued that especially the investments above within iron and steel industry probably not will generate a large number of new employees direct in the factories. Instead, the tendency for many years has been that through investments in new machinery, the number of employees in capital intensive and process-oriented industries have declined, while total production and thus the productivity per worker has increased. Investments in "green" steel will over time probably not change this process, it has been argued.

There has also been a challenge to recruit workers to the Northvolt factory and to other jobs in the private as well as the public sector. Since 1990s, the level of unemployment in the region has fallen. If before the crash in the finance and property markets in the beginning of the 1990s, that followed from deregulations that opened up those markets for international transactions, younger unemployed people stayed in the region, after the crisis they started to move to jobs instead. Jobs also became available in larger cities like Stockholm, especially within the fast-growing IT and computer game industries. The economic recession also meant that due to a deficit in the state budget, various forms of support to the unemployed were reduced, adding to the interest to move.

Hence, when the region now meets the boom of green industry, there is not as in the 1960s and 1970s, unemployed young people available in the region. Salaries will increase in order to attract people. People will move from existing employments in e.g. the Skellefteå area to the new jobs. Hence the "green boom" will not only have an impact on the new factories but most companies and a wide part of the public sector will be affected by the increasing demand for labour.

In order not to "overheat" the local labour market, recruitment of labour from the rest of Sweden and internationally has thus become a critical and important part in the establishment of the new green industries. Adding to this, as many other cities in the region, Skellefteå has for long time had a real estate market with few transactions, a low rate of new construction and large public engagement in the housing sector. Higher incomes and a larger demand for housing will for sure in the short run increase property values. The benefits of green industry investments will be a windfall gain to existing property owners. It will give incitements for new construction but it will also

[5] https://www.svt.se/nyheter/lokalt/norrbotten/historisk-satsning-i-norr-kraver-100-000-inflyttare; access date 2022–08-24.

become more difficult for new comers to find the home that matches the eventual expectations that are associated with the move to the region.

Hence, it has been a demanding task to initiate, vitalise and expand the housing market in the area. Since in Sweden municipalities have the planning monopoly, every construction has to be handled by and get a start permission from the municipality. There are moreover so called "national interest" with respect to nature, water, recreation, military security, heritage, etc. that at least in the short run constrains what is possible to develop. Since neighbours also have the right to have objections against a plan, it may take a while before a question by an actor to construct a house or develop a property has led to a decision to start.

Obviously, the new interest to develop the market for real estate in Skellefteå as well as in surrounding municipalities implies a demand for planners and case managers in the administration of Skellefteå and other municipalities. A more active property market also demands experience to tackle legislation and various interest from neighbours, and from the state. The municipality also has to develop new long-term plans, plans that have to be negotiated in order for a decision to be taken. Incomplete acts and missed consultations with legitim interests, implies a risk that a decision will be appealed at a higher legal entity. The time to start and costs f the process will increase for the actors.

On the other hand, when Northvolt contacted the city, Skellefteå was relatively well prepared. Since around 2010 the situation in and the future of the city had been discussed more intensively.[6] Umeå, to the south had been growing and had an active housing market for many years. The housing market in Skellefteå was not even characterised by vacancies. Hence, the municipality had initiated a process for new plans that could open for future development and an increase in the number of inhabitants. New staff within municipality management, planning and communication had been recruited and introduced. The dialog with various actors had been intensified.

But the process was not without obstacles. When the attempts to renew Skellefteå resulted in a suggestion to construct a new bridge over the river through central parts of the city, all political parties but the ruling party voted against the initiative. A referendum was made in 2014, and the votes said also here no to the bridge. The project was postponed. This could be said to be typical for a municipality where planning related initiatives have been low for many years, while suddenly the municipality or other developers take initiatives for change. When the Northvolt initiative was presented, it was so large and in line with the industrial narrative of Skellefteå that when in this process the bridge project once again, and against the outcome of the referendum, was actualised, there were no public objections.

Skellefteå has now in an as it seems intensive process formulated planning goals for its population growth with 90 and 100 thousand inhabitants as guidelines.[7] As said, the municipality was to some extent prepared, but the Northvolt factory has

[6] Although in Swedish, Steinvall (2021), attempts to present the history behind the decision by Northvolt to locate its first plant to Skellefteå and the activities that had been taken in Skellefteå before this became an option.

[7] According to the head of planning for Skellefteå. In Hedqvist, Lars. (2018).

been such a large commitment that the resources of the municipality almost are exhausted. The matching between the company Northvolt and Skellefteå as a municipality must although be considered as almost optimal. In any other of the cities in Northern Sweden with 70 000 or more inhabitants, Northvolt had had to compete with other interests and facts, such a location had meant a much more diffuse signal of sustainability to the market.

Skellefteå was a strong, relatively prepared municipality, a population that understood industry, perhaps more often as a history told by elderly and dominating politicians instead of from their own experience but a population with a strong social commitment, high degree of engagement in various associations and clubs. Altogether a strong social and cultural capital. The municipality is not dominated by a single strong manufacturing industry, but a set of medium and small sized industries. Boliden, the gold a copper mine company is important, but the mines of Boliden are outside the city and not visible in the city, as e.g. in Kiruna. Skellefteå also has its own municipality owned hydroelectric power company. If a location further to the north, in e.g. Luleå, Boden or Kiruna was chosen, Northvolt would have to compete with steelworks and mines about labour, it also had to deal with Vattenfall, the state-owned power company that would have its own agenda. In the university town Umeå to the south, the housing situation would be worse and further to the south various paper and pulp companies and aluminium plants would be competitors for labour and for energy. Those would also be more distorting for the Northvolt image as a green factory in a green city.

But still, can in this rather short time Skellefteå fulfil the task and deliver what is necessary? The two critical factors are construction of housing and recruitment of employees. Facing the risks associated with those, Northvolt has chosen a risk diversifying strategy, where the Skellefteå factory in the North of Sweden, producing the world's greenest battery in a city with the attitude of sustainability, continues to be the important production site in public communication and a strong market signal, but where Northvolt Labs in Västerås, as well as Northvolt Dwa in Gdansk, Poland, Northvolt Drei in Heide, Germany, Northvolt Volvo in Gothenburg, Northvolt Fem in Borlänge and Cuberg in the San Francisco Bay Area, USA are other facilities established, with production as well as development, research and management.

This points at a critical aspect of the "green industry" narrative and the future of the region of North Sweden, the fact that the region has had a long period of stagnation, only have small cities and that even if there are four universities within the region, the research and education within the appropriate fields of engineering is not strong. The small cities have neither been advantageous for the development of a rich industrial and consultant environment. Hence, Northvolt labs were located in Västerås in the larger Stockholm area, a city where also the engineer intensive industry company within energy, digitalisation and automatization, ABB, is located, ABB is among other products producing robots for industrial use.

The picture given above of the green industrial boom would not be complete if we not did mention that the cities of Boden and Luleå also have attracted interest for energy intensive facilities for storage of data in datacentres, mainly Facebook, and from Bitcoin miners. MNC Miner was such a company in Boden, although closed down in 2016 after around two years of activity. Other smaller datacentres have been established in the region, but ownership seems to some extent to be located in Stockholm. Also, in this case, there are two stories told. One is telling a story of success, such as Coates and Holroyd (2021) where the success story of the region is underlined.[8] A closer reading reveals that the only source to this positive picture is an article by Nilsen (2016) where the CEO of Luleå Business and Economic Development, a public–private company with the objective to create growth in the business in Luleå is interviewed. The other story is told from a study of the relative population growth of the city and its county, where the story of stagnation instead is told.

In order to understand how the region ended up in this situation, where over time many stories about booms and development have been told, but where growth related statistics, especially statistics related to human capital, instead have told the other story, we have to look back into the history of the region. This is an entry to our final aim, to give advice regarding pitfalls that have to be avoided if the region not shall find itself in a similar situation after the growth and coming normalisation, or even decline, of green industry investments.

6.3 The Birth and Parting of Industry in Northern Sweden

There have for a while been clear signs that the long cycle of out localisation of industry from Europe, Sweden and its regions to factories in Asia, that was initiated after WW2 has begun to reach its end. After succeeding wars and institutional instabilities, the economies of Asia one by one became integrated in the international economy, found their comparative advantages and developed trade. Incomes increased, efforts were put into education, research and infrastructure, with further increasing trade as the outcome. As previously in Europe and North America, country after country in Asia moved to production of more high-tech commodities. This also meant that industry establishments were relocated. Industry moved from country to country in search for cost reductions within fairly stable economies. Japan was early, followed by South Korea, currently each of the ASEAN countries are on their way to expand their economies and increase incomes (Westin, 2017). In the 21 century, it thus has become evident that the global balance has shifted, from the European-North American Atlantic sphere over to a North America–Asian Pacific sphere.

North Sweden had a strong comparative advantage in heavy industry based on natural resources from forestry, mines, hydroelectric power and land. This advantage had been built up over a long period from the eighteenth century. When railways in the end of the nineteenth century could replace shipping as the dominating means of transportation, this advantage was strengthened drastically. Both since deliveries became more regular and the market could be expanded, but also since it was possible

[8] "This essay (.. demonstrate…) that creative and determined northern regions can compete successfully in the age of technological transformation." Coates and Holroyd (2021), p.7.

to stabilise the food supply to Northern Sweden, with its shorter summers. The railway also meant that various machineries and tools could be imported to the region, a fact that improved productivity, increased salaries and lay a foundation for an increasingly market-based service economy, instead of the highly self-sustained economies of households that was common until then.

Together with investments in health care and education, the demographic shift took off in Sweden. Death rates decreased drastically, while birth rates were lagging and remained high for a couple of decennia. Demand for labour in the expanding industries of North Sweden could, at least initially, take care of the fast-growing population. New settlements, based on forestry and agriculture were developed all over the region, simple roads were constructed and a sparse network of rail tracks was established. Cities started to grow and public facilities for administration, health care, a system of justice and military installations were established. In much this started from the south, in the end of the nineteenth century, the city of Sundsvall had become the centre for economic activities in Northern Sweden and also played a role nationally. From Fig. 6.3, the fast growth of the population during the nineteenth century becomes obvious.

However, Fig. 6.3 also clearly shows the stagnation in the number of inhabitants that has been a sign for Northern Sweden since 1950. The reason behind this sharp break was the intensed mechanisation of agriculture, forestry, mining activities and household services (Westin, 2015). The chain saw, the tractor, the truck the washing machine are all symbols for how demand for labour was reduced. Nevertheless, in

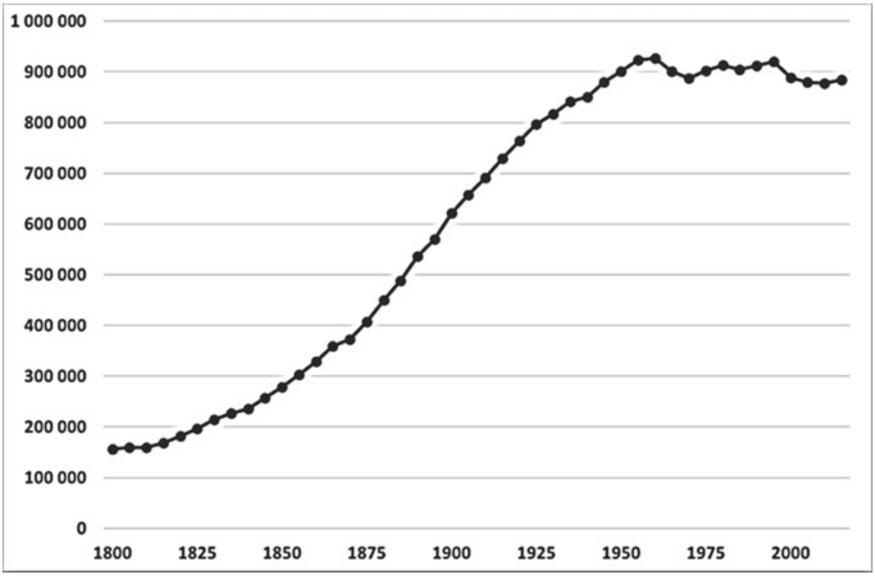

Fig. 6.3 Population in Northern Sweden, the four northern counties of Sweden 1800–2020. *Source of data* Statistics Sweden

contrast to many other natural resource-oriented economies in other countries, the region has not met an overall decline.[9] This is not to say that the development has been even. Some parts have continued to grow, but especially very sparsely populated areas and cities strongly specialised in natural resource industry, have had problems.

If mechanisation meant that the number of jobs in agriculture and industry declined in the 1950s and 1960s, the aforementioned competition from low cost countries in southern Europe and later in Asia, hit the industry in the region quite hard in the 1970s. It was only thanks to an increased ambition within public services and in the cities, development of private services and higher education that the population figures to some extent could be stabilised.[10]

When the Soviet Union collapsed in 1990, the Baltic states and Eastern Europe became new very close competitors with salaries only a fifth of those in Sweden. Northern Sweden had not established a stronger urban structure, and another wave of out localisation of industry hit the region, as well as Sweden as such. It took a couple of years before new IT focused industries could make Sweden competitive again, while Northern Sweden lost more of its population.[11]

6.4 The Curse of Resources, Resource Rents and the Narratives of Northern Sweden

Hence, if Sweden, in the beginning of the new millennia, showed signs to be back on a growth path based on the IT, human capital and "creative" industries, the situation in Northern Sweden was not equally advantageous. The growth of the IT based industries as well as new media was strongly focused on Stockholm and the Stockholm region. Figure 6.4 compares the shares of the total Swedish population registered as living in Stockholm country, and in the four counties in Northern Sweden taken together.

The figure is a complement to Fig. 6.3 above and summarises well the relative development of Northern Sweden during the last 200 years. In the first half of the nineteenth century, the interest from investors, often international, for the forests of Northern Sweden attracted labour and made the population grow. At the same

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[9] For example, sometimes the high-profile supporters of the boom of green industry in the region categorises it as a modern Klondike. In that case the city in centre was Dawson City, that at most had around 40 000 inhabitants. Today the city has around 1 500 inhabitants.

[10] An active regional policy also had a strong impact on the process. Eriksson, M. and L. Westin (2013) and Westin, L. and M. Eriksson (2015) discuss how regional policy were formed, but is also critical against some aspects of the policies. Especially how to much resources were focused on small settlements instead of giving substantial resources to some larger cities, in order to create an urban system in the region with cities that could compete with Stockholm and Gothenburg about labour and jobs, especially within more advanced human capital-intensive industries.

[11] Eliasson, K., M. Johansson och L. Westin (1998) studies how the changing comparative advantage of Sweden in relation to e.g. the Baltic states and other states in Eastern Europe will hit Swedish regions differently, dependent on their factor intensities and exiting industrial specialisation.

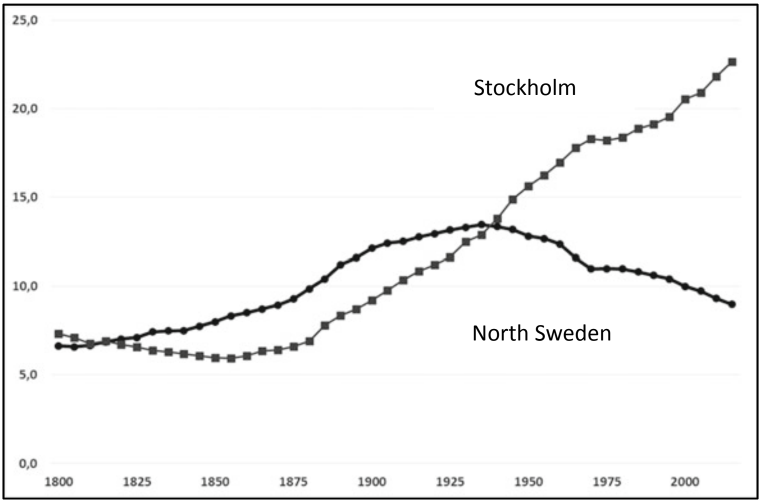

Fig. 6.4 Share of the Swedish total population for the Stockholm county and North Sweden, defined as the four northern counties of Sweden during 1800–2020. *Source of data* Statistics Sweden

time, the city of Stockholm was in a difficult period, due to underdeveloped waste management, sewage systems and water purification, core aspects of a functional city.

With the railways, and investments in water disposals for the city, Stockholm became a liveable city, but also became the city in the middle, the core, of the Swedish railway network. Stockholm central station was constructed in 1871, a building that can symbolise the return of Stockholm as an important city. As we have said, the railway network was important for Northern Sweden, but railway transportation implied an even larger positive impact on Stockholm. In this respect, the second half of the nineteenth century implied a growth of both Stockholm and Northern Sweden. But around 1900 the speed of growth started to decline in the north, while Stockholm continued or even periodically increased its growth. Around 1930, the "switch" was a fact. Stockholm profited from the fact that it now had become a "modern" capital, increasingly integrated in an international context, and could benefit from economies of agglomeration.

Northern Sweden instead, was as we saw in Fig. 6.3 still growing, but the growth rate declined. The problem Northern Sweden met is well known in association with "the curse of resources". If the natural resources in the region had been a blessing for over hundred years, they and the industrial, political and cultural structures this economy had established, in the middle of the twentieth century locked the region in a growth trap, what Watkins (1963) denoted the "staple trap".[12]

Regions locked in by the staple trap are hampered by power structures within the resource industries, but also labour unions, politicians and other elites with a base in

[12] Much of the writings about the curse and the staple trap, has its origin in the experiences from the Canadian economy. Others important authors in this respect are Innis, H. (1930, 1956) and North, D. (1955).

the resource sector. The forces for change, for new service industries and generally for stronger urban contexts in the region have in this context difficulties to gain power (Westin, 2006). A typical feature of the curse of resources is a combination of external ownership and weak internal capital and real estate markets. Generally, this is shown in the relatively flat urban structure of a resource rich region. In 1950 the largest municipality, measured by the administrative borders of today, in Northern Sweden was Sundsvall with a population of 77 000 inhabitants. The same year, the Stockholm municipality alone had 975 000 inhabitants with a county consisting of many strong smaller adjacent municipalities. During the period 1900–1950, Sundsvall had met periods of low growth, much of this could be explained by the increased competition from Stockholm due to the improved railways (sic!) and road connections, as well as a malfunctioning property market. Actually, already since the nineteenth century a substantial share of the resource rent from the forest industries in the Sundsvall area had been invested in real estate at attractive locations in the central parts of Stockholm.

Table 6.1 below shows how the urban hierarchy of Northern Sweden has continued to be problematic, but also how it has gone through major changes during the last seventy years. In 1950, when the total population in Northern Sweden began to stagnate, Skellefteå, where Northvolt now invests, had become almost as large as Sundsvall, so far the largest city in the region. The growth of Skellefteå had been fast since around 1930, when gold was found in the smaller village Boliden to the west of the city.

Umeå and Luleå were still relatively small cities. Overall, the urban structure was more compressed. Sundsvall was although still stronger as a city, had a longer history, was richer and with municipalities around it that added to its agglomerative strength. The surrounding of Skellefteå was weaker and possible supporting structures were at a larger distance from the city.

The table also shows that Skellefteå almost has had a constant population since 1950. The gold mine in Boliden was important for the establishment of various

Table 6.1 Major cities (municipalities) in Northern Sweden, population 1950 and 2020, population growth and share of total population in Northern Sweden 2020. Current administrative borders. *Source of data* Statistics Sweden

City	Population 2020	Population 1950	Per cent growth 1950–2020	Share of total population in Northern Sweden 2020
Umeå	130 224	46 282	181	14
Sundsvall	99 439	76 657	30	11
Luleå	78 549	40 174	96	9
Skellefteå	72 840	73 715	-1	8
Östersund	63 985	43 400	47	7
Örnsköldsvik	55 807	60 143	-7	6

successful mechanical industries in Skellefteå, and those became the fundament to the current strong industrial self-image. That self-image of being an industrial city was deep. When the Swedish government offered the city, due to its industrial profile, the planned School of engineering at the university level for Northern Sweden, the city turned the offer down, and instead asked for even more industries to be located in the city. Instead, the School of engineering was located to Luleå, in 1971. It has had a positive impact on Luleå, the city passed Skellefteå in number of inhabitants. But Luleå has had a similar strong self-image as the town with a steel work. It has taken a long time for the city to broaden its self-image from steel towards a knowledge-based city, especially since the Luleå University of Technology, the current name of the School of engineering, has a research profile with a focus on materials, geology, geoscience and other aspects of natural resources engineering.

Four of the cities in Table 6.1 have been growing between 1950 and 2020. All of them are county capitals and sites for public administration and universities. Umeå also has the university hospital, serving the four northern counties. However, the degree of urbanisation in northern Sweden is still rather low. Umeå, the largest city is not among the ten largest municipalities in Sweden and its share of the population in Northern Sweden is as can be seen in the table only 14%. Taken together those six largest municipalities only include 56 per cent of the regional population. Northern Sweden is still quite sparsely populated with many municipalities and villages of small size.

As we have seen, already in the 1930s, the small size of the cities in the region was a hold back on its growth. Since Sundsvall, the previous major city not managed to take the lead, a natural leader, a centre and a strong voice for the region has been lacking for a substantial time. Instead, competition among the cities for grants has been a typical behaviour (Westin, 2006). Umeå has almost constantly been growing, from a small start as a city for schools, a diverse set of industries and military units to becoming the largest municipality with administration, two universities and the university hospital, as well as a steadily growing sector of mechanical and engineering industries, IT and game related business. More recently, a broadening set of consultants and private services have located themselves in the city. In this respect, the city has another, more diverse structure and social life compared with Sundsvall, Luleå and Skellefteå. The city Östersund is from an urban culture aspect, more similar to Umeå with its small-scale industries, winter sport and tourism. During recent years, the Umeå region and the region around Östersund thus belong to the parts of Northern Sweden that are growing.

However, none of those cities can attract advanced private services directed towards business or advanced institutes of research, etc. at any larger extent. In Sweden, an urban area seems to have a size of over 300 000 inhabitants in order to become reasonably well represented within those sectors. Of cause, there are always services that only can be located in the national capital.

To summarise this part, since 1950 the region has made an internal transformation with regard to its urban hierarchy as well as its employment structure. From employment in natural resource-based industries and associated machinery production to a more diversified structure, with a large share of employment in public sector works and services. It is not the case that employment in the resource-based industries and to this connected business has disappeared but it is not as dominating as previously.

Nevertheless, both in internal and external mindsets the region still often is considered as the resource base for Sweden, from which export of forest, ore and steel builds a stable fundament for the Swedish economy at large. The region is in this respect not considered as a region with an urban future, contrary, it should be preserved as a country side dominated region, a heritage that may be visited now and then. From both accessibility and export considerations, investments in infrastructure have been the dominating policy measure of interest for politicians and businesses. Public sector employment and infrastructure in exchange for state incomes from export of resources has been the implicit development agenda (Westin, 2006). Once again, Umeå has been an outlier, urban development, culture, construction and an active property market instead have been targets for the city.

Taken together, the policies and actions taken, have kept the regional population constant, while as we have seen, the regional share of the Swedish population slowly decreases. This has had at least two impacts. The number of parliamentarians from the region decreases and the region has since 1930 slowly lost political power, mainly to the Stockholm area. Now and then, strong regional politicians have counteracted this process, but those voices seem also the have become fewer. For a region with a "growth" policy in much based on public investments, grants and jobs, this loss of political power will obviously sooner or later be fatal. Secondly, the unbalanced growth between cities and change of urban "leadership" within a constant regional population causes tensions and a lack of coordinated action.

Moreover, Northern Sweden does as a "region" only consist as a narrative. It has no real arena of itself for policy making, strategic considerations and decision making. Instead the four counties have by themself, well-developed internal policy arenas, while policy makers from each of those counties have their centres of policy debate and actions in Stockholm. For those, communication with Stockholm often is more important than with other parts of the geographically large region, a structure that easily is visible in the passenger transport networks.

So, when Northvolt decided to establish their "giga factory" in Skellefteå, after a process where also other cities in the region had been on the list of possible locations, their reactions were diverse. It seems that the other cities did have unclear priorities and perhaps also lacked understanding of the broad impact such an establishment could have. Especially, when the size of the investments became clearer, the criticism was directed internally towards leading politicians in each city for their lack of preparedness and insights in the possible benefits and gains it would imply for the municipality. More indirectly some also criticised Northvolt for their choice of location.[13] Other regional actors started to search for an investor with another

[13] At the national level, another debate started. With the electricity the green industries needed in order to produce their products for storage of electricity and fossil-free steel, the export of hydroelectricity to the southern and central parts of Sweden from North Sweden may drastically be reduced. Excess supply in the north seemed to be shifted to excess demand. Since the already existing excess demand for electricity in the south had caused the price in the south to increase, the question was if the green industry really was the way to take for Sweden. The picture and debate

battery producer. Clearly, the Northvolt project offers a multitude of risks for the municipality engaged, risks that some municipality leaders took notice of. Today, it is too early to make a summary of costs and benefits for the municipalities or for the region. However, so far at this date, the impact on and in Skellefteå of the Northvolt factory has been considerable. The question is if this only will change the internal order of size between the cities in Northern Sweden again or if the overall stagnation also may be aborted?

6.5 Leaving the Curse—Actions Needed for Sustained Growth

Northern Sweden has attracted interest from investors within "green industry" developments. Obviously, this is an important and eager task. During history, factors of production such as forests, mines, land for agriculture, wind power plants, or land for reindeer herding as well as waters for fishing, fish farms and hydroelectric power have been other attractors of interest. Those have in turn given locational advantages for manufacturing industries, data centres, handicrafts of various kinds etc. Tourists and explorers have for long been attracted to the region. Recently the quality of service in the tourist sector has improved. After decades of unconcern, lack of management and capital, tourism in the region has become increasingly professionalised.

Various supporting activities to the resource industries within e.g. transport engineering, machinery for sawmills, paper and pulp industries, mines and treatment of timber have as a consequence been developed regionally. Where distance and time of communication to larger agglomerations have been substantial, local services and public production, like schools, social services, justice and police have been established.

The research and education facilities in the region have attracted resources from actors within forest and mining as well as organisations and public actors associated with those. Health care, business economics, public administration, social services etc. have also attracted public money.

The enumeration of activities above could sign a region in fast and broad growth. Instead, while producing and exporting its resource related products, the region has continuously had a net import of food stuff and engineering products. Since the 1950s, the region has had difficulties to employ its inhabitants, with unemployment and outmigration as consequences. Unemployment almost disappeared in the 1990s, when a distinct shift in attitude could be witnessed among young people, from preferences for employment in local traditional industries over to more service and knowledge-oriented sectors. Those were although underdeveloped sectors in the

got a picante addition, when municipalities in the south said no to wind power mills, due to negative impacts on their views, at the same time as the number of mills in northern Sweden passed one thousand.

sparsely populated region. Hence, unemployment almost disappeared, while outmigration of young people increased. If previously smaller localities had experienced unemployment and outmigration, now outmigration of young, especially educated youngsters, also became a feature of the cities.

In this long, periodic process, now and then Northern Sweden has faced the sort of hype and hopes a new wave of interest may offer, of the sort that now may be witnessed in association with "green industry". Buzzwords for each of those periods are transport industry, universities, airports, high speed railways, a new steel factory, textile industry, plastic bicycles, space, car test facilities, IT, digitalisation, broadband, public sector works, a line of gold mines, data centres etc. A lesson that has to be remembered is that each such wave, or perceived boom, from a new technology or a new policy measure with associated interest from politicians, public administrators or various investors, has an end. Not always by a complete layoff, but a substantial reduction of employment and financial flows to the region. The force of liquidation may be international competition or competition from other regions in Sweden with associated outsourcing, closure or labour-saving investments.

In all those cases, the threat to the region has been associated with the problem to keep human capital and any rents from the assets in the region. This would not have been a problem if the region had had cities large enough to develop service and knowledge intensive industries, i.e. if the region had higher capacity internally to shift its growth from its abundant capital in the form of natural resources over towards growth of human capital. The lack of larger cities also has meant that a substantial part of the resource rent and other rents from various assets leave the region.

A part of this leakage takes the form of taxes and profits within state-owned enterprises, that to some extent is returned as public sector investment. This has reduced the speed of contraction and actually helped to keep the region with its stable population. Hence, given our sketched experiences from history and before we suggest ways for the region to gain from this recent interest from "green industry" investments, we must thus distinctly identify the threats visible on the horizon.

In this respect, one has to remember that the "green industry" boom of Northern Sweden actually consists of two parts, the "green" part that indicates what sort of products North Sweden now has an absolute advantage in, compared with the rest of Sweden, and the "industry" part that indicates that not only North Sweden but also other countries in Europe, again has gained a comparative advantage in industry production related to machinery and engineering.[14]

First of all, manufacturing industries and industries based on natural resources will both continue to be an important part of northern Sweden but these industries will also face labour-saving productivity improvements through automatization and

[14] Had it not been for the war by Russia on Ukraine, Eastern Europe with its relatively lower cost for labour would have had an even stronger general advantage for industry that moves back from Asia. As we have touch upon, Northern Sweden to some extent, and for a while, compensates for higher labour cost by offering green energy, a well-educated labour force and cities that with social and political stability fulfil the request from an industry that want to market itself as sustainable in a broad sense.

introduction of robots. In the case of battery production, like the Northvolt factory in Skellefteå, we would expect it initially to be relatively labour-intensive. Over time, when the technology of making and recycling batteries have been developed, also in this case labour will be replaced by increasingly automated production lines and production will be more capital intensive. In the industries connected with green steel and mining, this first labour-intensive phase may not even materialise. We have also seen that Northvolt is investing in other places, as the Northvolt Labs factory in Västerås, where besides the development of batteries, research and development in relation to the design of an efficient line of production for batteries etc., may be assumed to be on the agenda.

The Northvolt factory in Skellefteå is marketed as a site for production of the world's greenest batteries with a low-carbon footprint as well as battery recycling. That claim probably is true, but sooner or later more sites and companies, even in Central and Eastern Europe, will probably also develop similar, or almost similar, attributes with respect to their production. For a while, it will although give Northvolt in Skellefteå both a comparative and absolute advantage. But for the municipality Skellefteå and the larger region it already now is time to cogitate on the next step after, or in parallel with, the Northvolt induced boom. Competition will increase, more factories will be located in the region and salaries will be raised, this will demand more robots, but first of all a socially and culturally efficient working environment, a city and region that is attractive as an area for living and raising children.

By this, we are ready to discuss our policy suggestions. Over time, Northern Sweden has experienced wave after wave, cycle after cycle of new industries entering the region. They have for some time dominated the agenda, peaked and declined. Some, like textile industry has almost completely disappeared, others like log-driving in the rivers and forestry work have moved over to trucks and more recently to trains, or have been mechanised so that only a couple of forest harvesters make the same work as previously thousands of workers. In private services such as banks and shops, employment also is reduced due to digitalisation. Data servers and storage halls, as well as wind power mills mostly employ technicians for regular maintenance. Those are not large employers in relation to the cost of investment or annual turnaround. Fly in of maintenance staff—and fly out after the work is done, is another risk for the region.

In this situation, it is possible to put efforts in attempts to attract even more battery plants or to figure out what the next boom will entail. Instead, our suggestion here, is that the three most urgent and important tasks for the region to focus on are the following:

- Develop structures that may as far as possible guarantee that the salaries, taxes and rents generated from the green industry boom, the natural resources and coming cycles of new production will be reinvested in the region in order to increase its assets.
- Develop strong structures for the attraction of human capital to the region
- Develop the urban system of Northern Sweden, the small cities have to be supplemented with stronger cities and urban areas.

During the foreseeable future, Northern Sweden will encompass production based on the natural resource capital located in the region. However, this production will employ less labour direct in production, while technicians, consultants and advanced researchers may increasingly be demanded. Hence, in order for the region to rape the salaries from resource-based production, those more advanced categories of labour must be attracted to the region. Generally, those jobs are localised in larger urban agglomerations, where the labour market is denser, alternatives ample and information spreads fast.

If the region, as soon as possible can give priority for a development of such urban environments and attractive housing areas, the risk is reduced that fly in-fly out will be a dominating feature and outcome on the labour market. Unfortunately, this has already often become the case when it comes to investments in large machineries and specialised construction tasks, such as bridges. Fly in - fly out of labour imply that the municipality where a facility or object is located, will miss the incomes from municipality taxes. It also means that a substantial part of the salaries paid to labour active in the municipality will leak out from the local economy and thus reduce the size of the indirect and induced impacts on the economy from investments in the region. It is thus important to critically consider the investment phase of a green industry as different from the phase of operation. Nowadays, a phase of investment will be characterised by substantial leakages out from the region, while the injection and number of employees from the operational phase per euro turnover, will be very dependent on the type of production. Data centres are a typical sector with relatively few employees and a low injection per euro produced by the centre.

Resource-based production will generate company tax incomes. In Sweden, those will be a part of the national budget. If the region wants to "attract back" a part or an increasing part of those incomes through political activities, one important aspect is that the share of the regional population in relation to the total national population should not decline, rather increase. Over time and in a parliament based on a democratic voting system, where one person has one vote, a region with an increasing share of the national population will increase its number of parliamentarians. The political interest for the region and the future of its voters will also increase. As we have noted, the regional share of the Swedish population, and actually also the number of parliamentarians instead has decreased. Obviously, public investments are not made only with the share of population as a single criterion, but various public investments within the educational, social, cultural and communication sectors are related to the size of population and the growth of population. Once again, we thus can conclude that a region with an ambition to leave the course and transform resource rents into human and cultural related capital, must take its attractiveness on labour seriously and for that reason especially focus on the development of larger cities.

Finally, successful resource-based industries generate a resource rent that belongs to the owners of the industries. In the case of state-owned companies, the impact on the region is similar as for the tax incomes, strongly dependent on its share of population and its growth. Even if the owners are not local, some rents may anyhow be reinvested in the region, but lack of knowledge regarding potentially profitable alternatives in the region and personal knowledge may instead with slightly higher probability lead to investments more nearby the owner's place of living or in other environments with established channels of information to the owner and places that offer a reasonable long run return at a low risk. The real estate market of growing and large cities is one such option. For a long time, Northern Sweden has, in line with this argument, generated resource rents that instead have been invested in the property market of e.g. the growing Stockholm area.

Clearly, this reasoning is crucial when it comes to the second point above, development of the human capital of the region. The major obstacle for the region is housing. As said, overall the level of unemployment is low in the region, while especially the cities with more than 50 000 inhabitants have an excess demand for housing. Typically, privately owned homes are a shortage. Hence the shortage of labour with various competences, that often is a dominating theme for a large part of the labour market in North Sweden, in much actually is a housing problem. The region urgently needs a higher rate of construction.

Our analysis of the city system has showed (Westin, 2008) that the region cannot offer a competitive alternative in the sizes of urban agglomerations from 150 000 inhabitants and above. In Sweden around ten municipalities have a population between 150 000 to 200 000 inhabitants, none of those are in Northern Sweden, needless to say, neither of the three Swedish cities with more than 300 000 inhabitants are within the region.

Hence, it is of an urgent need for the region to develop at least one city with initially at least 150 000 inhabitants. If the region could create a city with 200 000 inhabitants, this city would become one of the five largest cities in Sweden. The municipality of Umeå has as its explicit goal to reach 200 000 inhabitants, it thus needs 70 000 more inhabitants compared with today. That is the size of the current cities of Luleå and Skellefteå. A demanding task.

6.6 Conclusions

In this paper we have analysed some central aspects of “the boom” generated by ongoing and planned “green industry” investments in Northern Sweden. Factories has been constructed, but so far, the direct impact on the regional economy most of all is located to the municipality of Skellefteå. However, this has already caused tensions among other cities in the region. Land for large scale industrial development is now prepared also in other municipalities. Attempts to attract other battery producers have been made. In this respect, the existing relations between the cities in the urban system of North Sweden to some extent have been challenged.

Such tensions and measures taken are clearly local and regional signs both of how a changing international order with respect to global localisation and international trade generally always have local impacts, but also a sign of how the need to transform current ways of production into sustainable production, have created new forms of advantages for some nations, regions and cities. A new narrative, a new vision, for Northern Sweden has in this respect also to be found.

Apparently, investors within the green industry as such, but also investors focused on real estate have turned their interest toward the north. In several respects, this came as a surprise for a large part of the region, but also for national leaders. The need for new housing, premises for business and for public service has been apparent for a long time. For cities that generally have had a very low annual rate of construction and an overall risk adverse property sector, this meant a new challenge. Even if both the number of vacancies and the rate of unemployment have been low in the region, expected risks have often dominated over expected returns from construction.

We have highlighted that so far, the visible impacts of green industry is located in the city of Skellefteå, but most of all the green industry investments have challenged the dominating narrative for the region, the internal narrative as well as the narrative upheld by external actors. From our point, the most important is that the scepticism or even negative attitudes, especially among parts of the dominating cultural actors against growing cities in Northern Sweden has lost general attention. At the political arena, definitely an agenda more positive to urban development can be heard. However, still, the view that Northern Sweden should continue to be a large countryside, a site for Europe to gain minerals from or a remote sparsely populated region open for excursions and voyages of discovery is frequently articulated.

The regional economic history of Northern Sweden offers a rich source for students of industry location and policy, where path dependence and policy failures as well as successful industrial and policy initiatives may be identified. For those that have a positive attitude, seventy years of stagnation may have come to an end. However, our thought is that this demands quite drastic changes both in the narrative and visions of the region, as well as in realised practices. There is thus a strong need to develop a new urban policy for the region but also to abandon or loosen many national legal constraints on land use in the region. The question is if the region has the capacity and leadership to take such a struggle with the national, and European levels, and to remake itself in a more urban way.

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Chapter 7
Revitalization of the Economy of Northeast China

He Gao and Yoji Taniguchi

Abstract The economic stagnation in the Northeast China showed sharp contrast with the rapid economic growth of China as a whole. Revitalization of Northeast China is one of the important practices in regional development. Besides the long term influences of planned economy, the changes of population, especially aging and lower birth rates were also regarded as important factors. However, the decrease of the working-age population and total population are not necessarily to impact negatively on economic growth if labor productivity and capital stock increase. In addition, though Jilin province, Liaoning Province and Heilongjiang Province locate in the Northeast China and are the main parts of the old industrial base, there are still many differences from perspectives of aggregate demand and supply, and it is essential to consider the complementarities among these provinces when making strategic policies. So to revitalize the Northeast economies in the new era, making strategies and policies individually may not be the best method, building up the complementary relationship among the three provinces based on their characters and designing "hub-and-spoke" for different industries in detail are better choices. At the same time, the government should make decisions from demand-side perspective subject to demographic change, decarbonization and the trend of the fourth industrial revolution driven by cutting-edge technologies and digital transformation.

Keywords The Northeast economies · Aging and lower birth rate · Complementary relationship · Demand-side · Industrial transformation

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7.1 Introduction

China's economic growth rate has entered the era of slowing down in the early 2010s after continuous high levels for a long time. Even so, real GDP in 2021 was 43.4 times that in 1978, real GDP per capita was also 29.4 times of the same period, the relatively high growth rate has lasted until the 2020s.[1] Under such background, it is very obvious that the economies of three provinces in the Northeast China are relatively backward. Both from 2001 to 2021 and from 2011 to 2021, the average annual real economic growth rates of three provinces in the Northeast China all ranked at the bottom in 31 provinces, autonomous regions and municipalities of China, Jilin Province ranked 29th, Heilongjiang Province ranked 30th, Liaoning Province was the last, that is 31st. The percentage of total GDP of the three provinces to that of China decreased from 9.0 in 2002 to 4.9 in 2021.

At the same time, the proportion of total population of the three provinces also has decreased relatively, i.e., the percentage decreased from 8.4 in 2002 to 6.9 in 2021. The two decreasing trends occurred in every province of the three ones. Moreover, nominal GDP per capita has declined relatively very obviously. Taking the overall level of nominal GDP per capita of China as reference value 100, from 2002 to 2021, the value decreased from 136.8 to 80.3 in Liaoning Province, from 79.7 to 68.5 in Jilin Province, and from 89.5 to 58.4 in Heilongjiang Province.

The purpose of this paper is to analyze the background of relative stagnation of the economies of the three provinces in the Northeast China (hereinafter referred to as the Northeast economies) and explore the methods of vitalization. In Sect. 7.2, we discuss the relationship between the trend of Northeast economies and aging and lower birth rate. In Sect. 7.3, we examine the relationship between aging and lower birth rate and the economic growth. In Sect. 7.4, we summarize the economic characteristics of the three provinces as the basis of the 5th section. In Sect. 7.5, we illustrate the policy choices of vitalization in the near future according to the economic development strategies of the three provinces. The last section is the conclusion and problems which should be explored in the future.

7.2 Aging and Lower Birth Rates in China and the Northeast Economies

7.2.1 The Dynamics of Aging and Lower Birth Rate

According to the recent three national population censuses, China has been experiencing aging and lower birth rate. On the one hand, the percent of the population who are from 0 to 14 years old (young population) to the total population decreased from 22.9% in 2000 to 16.6% in 2010, but recovered to 18.0% in 2020. On the other

[1] The following data are based on National Bureau of Statistics of China, "Statistical Data".

hand, with the increasing total population, the percent of the population who are 65 and over 65 years old (aged population) increased sharply, from 7.1% in 2000, 8.9% in 2010 to 13.5% in 2020. As the result, the percent of the population who are from 15 to 64 years old (working-age population) increased from 70.0% in 2000 to 74.5% in 2010 at first and then decreased to 68.5% in 2020. The proportion trend of the population in working-age (working-age population, 15–64 years old) shows that China's economy is changing from demographic bonus to demographic onus.

While in the Northeast economies, there existed more rapid development of aging and lower birth rate. Not only the proportion of young population decreased, but also the proportion of aged population rose fast from 2000 to 2020. In general, the progress of lower birth rate slowed down but aging increased sharply. In the dynamics of working-age population, there is the same transformation from demographic bonus to demographic onus as the whole nation. The trends mentioned above are presented in all of the three provinces (Table 7.1).

To compare the average level of China as a whole with the level of the Northeast economies, we can summarize three points as follows. Firstly, the proportion of the young population in the Northeast three provinces was lower and with larger decrease range than the national average level. Especially, the national average level increased slightly during recent ten years, while still decreased in the Northeast three provinces. Secondly, the proportion of the aged population increased sharply with faster speed than that of national average level, especially from 2010 to 2020. Thirdly, the proportion of working-age population was higher than the national average level, but decreased from 2010 to 2020 together with that of the whole nation.

7.2.2 The Analysis of Aging and Lower Birthrate in Detail

There are many aspects in examining aging and lower birth rate. So we try to summarize the related indicators shown in Table 7.2. Because of deficiencies in the statistics of population in the Northeast three provinces, some data are not available. In order to facilitate comparison, we present the related data about the severe situation of aging and lower birth rate in Japan.

There are four indicators to measure lower birth rates. The first one is total fertility rate (TFR) less than the value of 2.08 which can maintain the number of total population. From this aspect, lower birth rate started from 1974 in Japan, and from 1992 in China. It is difficult to make sure the accurate starting year for the Northeast economies because of insufficient data, but it is certain that it appeared before 2000. The second one is the decrease in baby birth. In Japan it started before 1970s though there were 9 exceptions till now, while started from 2017 in China and is similar in the Northeast economies. In recent years, more people are concerned about the large lower birth rate in the Northeast economies than national average level. The third one is the absolute decrease of population who are aged from 0 to 14. Japan started from 1979 (except in 1981), while China started from 1997, but stopped from 2010. The fourth one is the proportion of the population who are aged from 0 to 14 declined,

Table 7.1 Age composition and its change in China: 2000, 2010 and 2020

Ages	Year	National Total	Northeast	Liaoning	Jilin	Heilongjiang
0–14 (%)	2000	22.9	18.4	17.7	18.9	18.9
	2010	16.6	11.7	11.4	11.9	12.0
	2020	18.0	11.0	11.1	10.3	10.3
15–64 (%)	2000	70.0	75.0	74.4	75.5	75.7
	2010	74.5	79.1	78.3	79.8	79.7
	2020	68.5	72.6	71.5	74.1	74.1
65 and over (%)	2000	7.1	6.6	7.9	5.6	5.4
	2010	8.9	9.1	10.3	8.3	8.3
	2020	13.5	16.4	17.4	15.6	15.6

Source National Bureau of Statistics of China, *China Population Census Yearbook*

that is the relative decrease of the young population. Japan started from 1975, China presented this trend from 1992 to 2011, and no obvious change after 2012.

There are also four indicators related to aging. The first one is the absolute increase of aged population (who are 65 and over 65 years old). Japan started before 1970, and China started from 1996. The second one is the increasing proportion of aged population (relative increase). Japan started before 1970, China also started from 1996. The third one is the increasing average age of total population, both Japan and China started before 1970. The fourth one is the increasing median age of total population. Japan started before 1970, China started from 1970.

We list three indicators related to working-age population, especially related to demographic onus. The first one is the absolute decrease of population who are aged from 15 to 64 (working-age population). Japan started from 1996 (two exceptions after that), and China started from 2014. The second one is the decreasing proportion of the working-age population (relative decrease). Japan started from 1993, and China started from 2011. The third one is the decrease of labor force. Japan presented it during 1999 to 2012, and then disappeared. And no such information is available in China.

Two indicators can express the reversal of lower birth rate and aging. The first one is the reversal of absolute numbers (or relative values, proportion in the total population) of the population who are aged from 0 to 14 and from 65 and over 65. It occurred from 1997 in Japan, no such phenomenon occurred in China as a whole, but has presented in the Northeast economies until 2018. The second one is the reversal of the numbers of birth and death. Japan started from 2007, the same situation presented in China as the first indicator, and the Northeast economies started from the second half of the 2010s.

The long effect of aging and lower birth rate is a decrease of total population. The change of total population can be divided into natural change (number of birth-number of death) and social change (inbound number-outbound number). The natural decrease occurred both in Japan and in the Northeast economies. So the decrease

Table 7.2 Indicators on declining birth rate and aging population

Indicators	Definitions	Japan	China	Liaoning	Jilin	Heilongjiang
Declining birth rate	Total fertility rate (TFR) < 2.08	1974	1992	before 2000	Before 2000	Before 2000
	Decrease of births	Before 1970 except 9 times	2017	2018	2017 except 2019	2009 except 2012, 2014, 2016
	Decrease of population aged 0–14 (absolute decrease)	1979 except 1981	1997–2010 except 2002	1992 but intermittent	NA	1992 except 1999, 2005
	Decrease of composition of population aged 0–14 (relative decrease)	1975	1992–2011	1992 but intermittent	Before 2000 but intermittent	1992 except 2005
Aging population	Increase of population aged 65 and over (absolute increase)	Before 1970	1996	At least 1991 except 1994, 1996, 2010	NA	1994 except 2010
	Increase of composition of population aged 65 and over (relative increase)	Before 1970	1996	At least 1991 except 1994, 1996, 2010	Before 2000 but intermittent	1994 except 2010
	Increase of average age	Before 1970	Before 1970	NA	NA	NA
	Increase of median age	before 1970	1970	NA	NA	NA
Declining working-age population	Decrease of population aged 15–64 (absolute decrease)	1996 except 2 times	2014	2012	NA	2011

(continued)

Table 7.2 (continued)

Indicators	Definitions	Japan	China	Liaoning	Jilin	Heilongjiang
	Decrease of composition of population aged 15–64 (relative decrease)	1993	2011	2011	2013	2011
	Decrease of the labor force population	1999–2012	NA	NA	NA	NA
Declining birth rate and aging population	Reversal of population aged 0–14, and population aged 65 and over	1997	No reversal	2012	2018	2016
	Reversal of births and deaths	2007	No reversal	2017 (2015)	2018 (2019)	2015 (2015)
Declining population	Decrease of total population	2011	No decrease	2017 (2012)	2012 (2011)	2011 (2011)
	Decrease of total households	No decrease	No decrease	No decrease	No decrease	No decrease

Note NA = not available

Source Statistical Bureau of Japan, "Population Estimates" and "Labor Force Survey"; National Institute of Population and Social Security Research (IPSS), "Population Statistics" and "Population & Household Projection"; National Bureau of Statistics of China, "Statistical Data," and *China Statistical Yearbook*; Each Province's Bureau of Statistics, *Statistical Yearbook*; Population Division of the United Nations, "World Population Prospects 2022."

of total population started from 2011 in Japan, and the Northeast economies also started from the 2010s. But China as a whole has not natural decrease, so there is no decrease of total population. In addition, neither Japan nor China presented decrease of family households related to the indicator of decrease of total population.

In general, the progress of aging and lower birth rate in the Northeast economies is faster than that of China as a whole, a decrease of total population also presented early because of natural decrease. Outflow of working population and graduates with higher academic degrees to other developed regions in China was generally regarded as one of the important reasons for the decrease of population in the Northeast economies. Anyway, the Northeast economies follow Japan in aging and lower birth rates and decrease of total population.

7.3 The Relationship of Population Growth and Economic Growth

7.3.1 Regional Situation

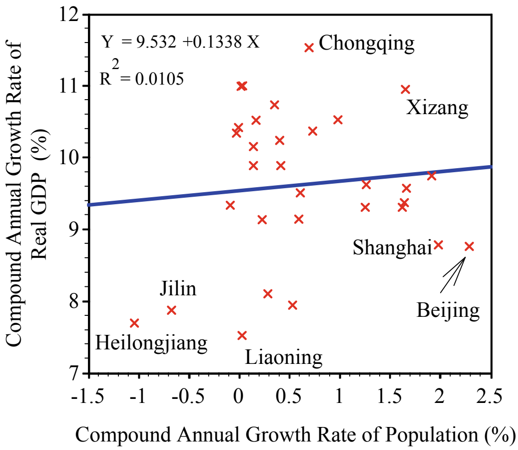
As the aging and lower birth rate, the absolute and relative decrease of working-age population and the decrease of total population are expected to bring negative effects for economic growth, but what is the fact?

Figure 7.1 shows the relationship of compound annual growth rate of population and compound annual growth rate of real GDP of 31 regions in China from 2002 to 2021. The regions with higher growth rate of population are not necessarily with higher economic growth rate, while the regions with median growth rate of population have higher economic growth rate. It is worth noting that some regions with negative growth rate of population have lower but not negative economic growth rate.

Figure 7.2 presents the relationship of compound annual growth rate of population and compound annual growth rate of real GDP per capita of 31 regions in China from 2002 to 2021. It shows that the regions with higher growth rate of population has lower growth rate of real GDP per capita. It is worth noting that there are relatively higher growth rate of real GDP per capita in the regions where with a negative growth rate of population.

To compare two figures shows that under the conditions of lower or negative growth rate of population, economic growth rate is not inevitably lower or negative, but the growth rate of real GDP per capita is relatively higher. So we should not conclude the negative effects of the decrease of total population on the macroeconomics (economic growth rate) and standard of living (real GDP per capita) from the current situation.

Fig. 7.1 Relationship between population growth and real GDP growth in China: 2002–2021 *Source* Our calculation is based on National Bureau of Statistics of China, "Statistical Data," and *China Statistical Yearbook 2021*



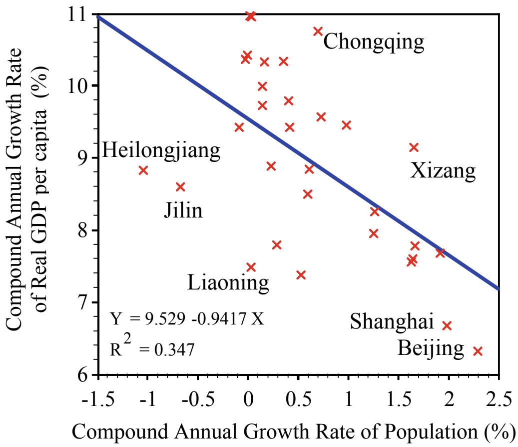


Fig. 7.2 Relationship between Population Growth and Real GDP Growth per capita in China: 2002–2021 *Source* Our calculation is based on National Bureau of Statistics of China, "Statistical Data," and *China Statistical Yearbook 2021*

7.3.2 Logical Illustration

In order to make clear the relationship of population growth and economic growth, we use simple formulas to deliberate as follows.

Firstly, let us analyze the formula (7.1).

$$\mathrm{Y} = \frac{Y}{Lw} \times Lw = \frac{Y}{Lw} \times \frac{Lw}{L} \times L \tag{7.1}$$

Here, Y = real GDP, L = population, Lw = working-age population, Y/Lw = labor productivity, Lw/L = ratio of working-age population. In order to simplify, suppose Lw = working population or number of workers.

As shown in Sect. 7.2, there are some differences between China as a whole and the Northeast economies. That is to say, though both of them have decreasing trends in Lw and Lw/L, the Northeast economies have a decreasing trend in L. So in the effects on Y, the Northeast economies have larger negative effects than that of national level. According to formula (7.1), whether the decrease of total population and working-age population has an effect on the decrease of Y or not, the change of labor productivity (=Y/Lw) is the key factor, that is.

If Y/Lw increase ≤ (Lw/L) *L decrease, then Y decrease. · · · negative (−) growth.

If Y/Lw increase ≥ (Lw/L) *L decrease, then Y increase. · · · positive (+) growth.

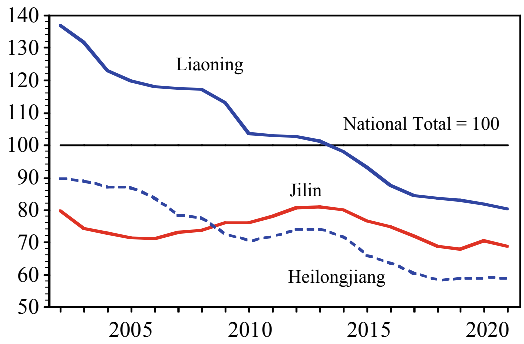
or

If Y/Lw increase ≤ Lw decrease, then Y decrease. · · · negative (−) growth.

If Y/Lw increase ≥ Lw decrease, then Y increase. · · · positive (+) growth.

Secondly, let's consider the changes of real GDP per capita (= Y/L).

Fig. 7.3 Nominal GDP per capita: 2002–2021. *Source* National Bureau of Statistics of China, "Statistical Data"



$$\frac{Y}{L} = \frac{Y}{Lw} \times \frac{Lw}{L} = \frac{Y}{K} \times \frac{K}{Lw} \times \frac{Lw}{L} \tag{7.2}$$

Here, K = capital stock, Y/K = the reciprocal of capital-output ratio or capital coefficient, K/Lw = ratio of capital to labor.

If Y/Lw increase$\leqq$ Lw/L decrease, then Y/L decrease.

If Y/Lw increase$\geqq$ Lw/L decrease, then Y/L increase.

If (Y/K)*(K/Lw) increase$\leqq$ Lw/L decrease, then Y/L decrease.

If (Y/K)*(K/Lw) increase$\geqq$ Lw/L decrease, then Y/L increase.

So the key factors are the changes of Y/Lw, Y/K and K/Lw, especially the trends of labor productivity and capital stock, to examine the increase of real GDP per capita or standard of living.

Combining with Figs. 7.1 and 7.2, we can see that even if L, Lw and Lw/L decreased, Y and Y/L still increased based on the rises of K, Y/K and K/Lw. So the absolute and relative decrease of working-age population and the decrease of total population will not be necessary to reduce economic volume and economic growth, the increase in technologies enhancing labor productivity and capital stock will promote economic volume, economic growth and standard of living.

The real GDP and the real GDP per capita of the Northeast economies are increasing, but as shown in Fig. 7.3, the latter is decreasing relative to the national average level. Especially, Liaoning Province and Heilongjiang Province decreased with larger margins. It shows that it is necessary to make strategic policies to revitalize the Northeast Economies.

7.4 The Characters of the Northeast Economies

According to the analysis in Sect. 7.3, labor productivity, technological progress and capital stock are the key factors to the revitalization of the Northeast economies. It is essential to discuss the characters of the Northeast economies at first from demand-side and supply-side before putting forward the possible suggestions of revitalization.

Firstly, Fig. 7.4 shows the percentages of consumption and investment expenditures. From the first half of 2000s to the first half of 2010s, the consumption proportion of the Northeast three provinces experienced large decrease, after that Liaoning Province increased largely, Heilongjiang Province increased with median margin, and Jilin Province had no obvious change. And the capital stock proportion experienced large increase from the first half of 2000s to the first half of 2010s, then Liaoning Province decreased sharply, Heilongjiang Province decreased with median margin, and Jilin Province still had no obvious change. So these three provinces have different trends with the national average level.

Secondly, Fig. 7.5 shows the industrial structures of the Northeast economies and the whole nation according to GDP proportion. For the primary industry, the proportion of Heilongjiang Province rose as an exception with a popular decreasing trend. The proportions of the three provinces were all higher than the national level. For the secondary industry, Liaoning Province had the similar trend with the national level, Jilin Province was relatively stable, and Heilongjiang Province decreased sharply. For the tertiary industry, the proportions of all of the provinces increased together with the national level, though Heilongjiang Province started from lower level, all the proportions were over 50% in 2021.

From the advantages of industrial products and farm, livestock and aquatic products, in 2020, crude oil and cars accounted for over 20% of total products, and ethylene, motor vehicles and beer accounted for over 10% of the total. But for the Northeast economies, the shares of the main products including the above decreased in a long time.

In the main industrial products, the share of Liaoning Province was the largest but with a declining trend, the steel products (crude steel, rolled steel, pig iron), ethylene, metal-cutting machine tools and coke were advantageous. Accordingly, Jilin Province had advantages in motor vehicles and cars and Heilongjiang Province had advantages in crude oil and ethylene as part of industrial products. Table 7.3 shows in detail.

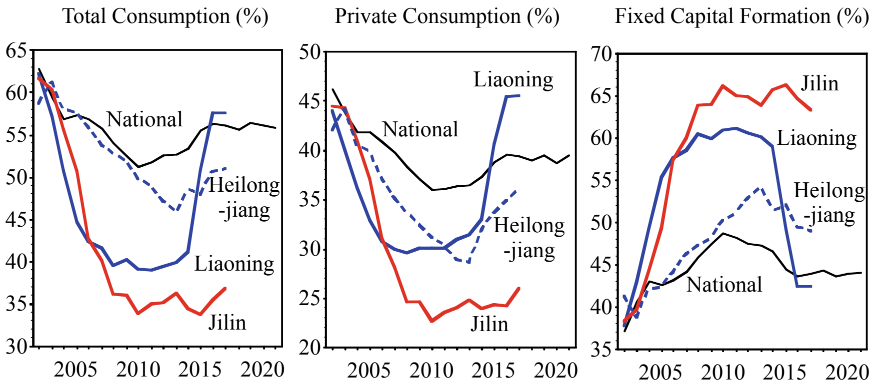


Fig. 7.4 Composition of GDP (Gross Domestic Expenditure): 2002–2021. *Note* Denominator = GDP—Trade Balance of Goods and Services. *Source* National Bureau of Statistics of China, "Statistical Data"

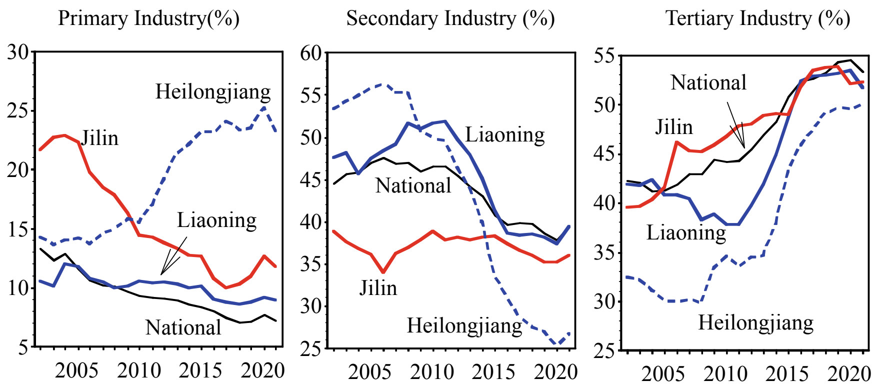


Fig. 7.5 Composition of GDP: 2002–2021. *Source* National Bureau of Statistics of China, "Statistical Data"

Table 7.3 The Northeast economies' share of main industrial products

Industrial products	Northeast economies' share (%)					2020 share (%)			2020 ranking		
	2002	2005	2010	2015	2020	Liao-ning	Jilin	Heilong-jiang	Liao-ning	Jilin	Heilong-jiang
Crude oil	41.1	34.9	27.9	25.8	22.9	5.4	2.1	15.4	7	10	2
Cars	22.6	13.2	16.3	19.8	20.4	4.0	15.6	0.8	8	3	17
Ethylene	26.1	20.4	16.1	18.2	18.6	8.5	4.0	6.1	5	11	8
Motor vehicles	24.5	17.0	14.2	13.3	13.7	3.0	10.5	0.3	14	2	22
Beer	16.6	15.4	12.9	12.5	10.9	5.0	2.1	3.8	8	16	10
Pig iron	13.0	10.8	11.5	10.8	10.7	8.1	1.6	1.0	4	18	22
Crude steel	13.0	10.7	11.0	9.4	9.5	7.1	1.4	0.9	4	19	24
Primary plastic	15.1	12.2	8.2	7.5	8.8	5.1	1.3	2.3	8	20	15
Coke	8.5	7.5	8.4	7.0	7.9	4.9	0.8	2.3	6	23	13
Rolled steel	12.8	10.5	9.1	7.6	7.6	5.7	1.3	0.7	4	21	25
Plate glass	9.7	7.0	3.6	2.5	6.6	4.9	1.3	0.4	7	20	27
Metal-cutting machine tools	10.8	23.5	20.0	13.2	6.4	6.3	0.0	0.1	6	–	24
Electricity	8.9	7.7	6.4	5.6	5.5	2.7	1.3	1.5	17	24	23
Cigarettes	4.7	4.7	4.6	5.0	5.0	1.1	2.2	1.6	23	19	21

Source National Bureau of Statistics of China, "Statistical Data"

As shown in Table 7.4, in the main farm, livestock and aquatic products, the shares of the Northeast economies were high, especially in Heilongjiang Province which had an increasing proportion in the primary industry. Cereal (rice and corn) and beans (soybean) were the top ones and cow milk and wool are also at the top of the list. Jilin Province had large shares in corn, soybean and beef, and Liaoning Province had relatively large shares in corn, poultry eggs and cashmere. The share of aquatic products was high in Liaoning Province which is the only province with coastal areas in the Northeast economies.

Above all, the Northeast three provinces have more differences than the commons in consumption and investment from demand-side, and the proportion changes of the primary industry and the second industry, industrial products and farm, livestock and aquatic products mentioned above. From this aspect, to discuss the countermeasures of revitalizing the Northeast economies in the same way is not correct, it is necessary to think about the complementary relationship from the differences among the three provinces.

7.5 The Strategy of Revitalizing the Northeast Economies

7.5.1 Structural Transformation of Chinese Economy and Change to the "New Normal"

The relative stagnation of the Northeast economies was recognized early, Chinese central government made the decision of revitalizing the Northeast China in 2003 after the large-scale development of western China from 2000. According to *Some opinions on Implementing the Revitalization Strategy of Old Industrial Bases in Northeast China* released in October 2003, the old industrial bases including the one in Northeast China ever made important contributions to reform and opening-up, and modernization, but existed some problems, such as lower-level marketization, high proportion of state-owned economy, slow adjustment of industrial structures and aging equipment and technology, imperfect social security and employment systems, recession of leading industries in resource-based cities, etc. So the Northeast economies should use abundant natural resources, enormous capital stock, good industrial basis, technological and educational advantages, a large number of technological talents and better fundamental conditions to transform traditional industrial bases, introduce advanced technologies and build new-style industrial bases with stronger competitiveness. And the government put forward some opinions including deepening the reform of state-owned enterprises, upgrading the secondary industry, modernization of agriculture, accelerating the development of the tertiary industry, promoting economic transformation of resource-oriented cities, strengthening the infrastructure, and enlarging internal and external opening up.

China's nominal GDP per capita in the first half of 2000s was less than USD 1000, and China was in the stage of increasing demand. In fact, China's economy realized

Table 7.4 The Northeast economies' share of farm, livestock and aquatic products

Farm, livestock and aquatic products	Northeast economies' share (%)					2020 share (%)			2020 ranking		
	2002	2005	2010	2015	2020	Liao-ning	Jilin	Heilong-jiang	Liao-ning	Jilin	Heilong-jiang
Grain	14.6	15.3	18.3	20.9	20.4	3.5	5.7	11.3	12	5	1
Cereals	14.0	14.8	18.1	21.1	20.4	3.7	6.0	10.7	12	5	2
Rice	9.7	11.1	16.6	17.8	18.9	2.1	3.1	13.7	15	10	1
Corn	28.6	28.6	30.2	34.4	32.3	6.9	11.4	14.0	7	2	1
Beans	38.0	40.6	41.1	37.9	45.0	1.1	3.2	40.7	21	7	1
Soybean	44.7	48.8	47.5	44.0	51.4	1.2	3.3	46.9	13	6	1
Meat	9.7	11.3	10.6	10.5	11.2	4.9	3.1	3.3	10	17	16
Pork	7.0	8.8	9.0	8.9	10.5	4.5	2.6	3.5	9	17	14
Beef	18.2	21.9	19.7	20.8	17.5	4.6	5.8	7.2	10	7	4
Cow milk	21.7	19.8	23.6	24.0	19.7	4.0	1.1	14.5	8	17	2
Sheep wool	15.7	14.3	16.1	13.8	10.7	1.8	2.6	6.4	11	7	4
Goat wool	4.9	8.1	13.9	10.4	12.0	7.0	1.6	3.4	7	14	10
Cashmere	5.2	12.3	12.9	7.7	8.5	7.9	0.2	0.4	4	15	14
Poultry eggs	14.5	17.5	17.2	15.9	16.5	9.6	3.5	3.4	4	9	11
Seawater aquatic Products	14.2	14.8	12.5	13.4	11.4	11.4	–	–	5	–	–

Source National Bureau of Statistics of China, "Statistical Data" the real GDP growth rate over 10% driven by investment and industrial sectors in 2000s. The Northeast three provinces also realized about 10% (compound growth rate of nominal GDP was 13–17%) from 2003 to 2011. Four trillion yuan stimulus policy after Lehman Shock also promoted the economic growth.

However, the large-scale stimulus policies brought about overcapacity, excess real estate inventory and high debt leverage. The prices of real estate and stocks also rose many times, shadow banking emerged which represents increasing unsound and nontransparent financing activities. Then Chinese economic policies centered on eliminating excess, controlling prices of real estate and stocks and restraining shadow ranking, which are rebalancing policies related to structural transformation. This is the change from high growth rate in quantity to quality which is called the "New Normal".

Structural transformation and change to the "New Normal" led to the economic growth rate slowing down.[2] China's real economic growth rate was 9.6% in 2011, 7.7% in 2012, and 6.7% in 2016, and the annual average from 2020 to 2021 was 5.1% under the influence of Covid-19.

Among the three excess problems, overcapacity and excess production impact the Northeast economies directly. There are many fields related to overcapacity and excess production, such as steel, coal, cement, plate glass, electrolytic aluminum, chemicals, paper products, solar power, shipbuilding, coal thermal power, etc., some of them are manufactured by the state-owned enterprises in Liaoning Province and Heilongjiang Province.

From the perspective of main industrial products in Liaoning Province, drop in production of some products was very obvious from 2015 to 2018. Besides ferroalloy, rolled steel (2015–2016 drop in production, similarly hereinafter), coal (from 2012), cement (2014–2017), plate glass (2014–2015), chemical pesticides (2010–2016, except 2014), chemical medicines (2015–2018), agricultural chemical fertilizers (2013–2018), machine-made paper and paperboards (2011–2015), and metal-cutting machine tools (from 2012), spinning machines for cloth, yarns and raw silk (from 2015) also decreased sharply. Under such circumstances, the nominal value added of the secondary industry in Liaoning Province decreased by 14.5% from 2014 to 2016 as a period compared to the last three years.

Some main products also dropped in production in Heilongjiang Province. The overcapacity and excess production included pig iron, crude steel, rolled steel (2014–2016), cement (2014–2018, except 2016), plate glass (2011–2012), aluminous materials (2012), chemical pesticides (2011–2016, except 2013), proprietary Chinese medicine (2012–2017), agricultural chemical fertilizers (2013–2018, except 2015, 2016), paper products and paperboard (2011–2016, except 2013), machine tools (2012–2016), finished product sugar (2013–2016), special equipment for mine (2013–2017), railway passenger engines (2012–2016), mini-computers (2015–2017), large and medium tractors (2013–2017), small-sized tractors (2011–2016) also dropped sharply. Under such circumstances, the nominal value added of the

[2] The slowdown in growth was particularly noticeable in coal production areas and the Northeast China. See Taniguchi (2019).

secondary industry in Heilongjiang Province decreased by 32.4% from 2014 to 2017 as a period compared to the last four years.

As for Jilin Province, in terms of overcapacity and excess production, besides coke (especially 2015–2016), pig iron, crude steel, rolled steel (2015–2016), cement (2015–2018), plate glass (2015), paper products and paperboard (2012–2013), metal-cutting machine tools (2017–2018), caustic soda (2011–2016) also dropped sharply. However, the production of these goods were less than those of Liaoning Province, but motor vehicles which accounted for more than half of the sales (52% in 2020) of given scaled enterprises developed strongly until 2019, so the nominal value added in the secondary industry from 2015 to 2019 still increased by a small margin and presented increasing trend.

7.5.2 The Choices of Revitalizing the Northeast Economies

Some opinions on the Comprehensive Revitalization of Old Industrial Bases in Northeast China released in April 2016 showed that after implementing the strategy from 2003, the Northeast economies have got some results, but still existed some problems which should be settled, such as stagnation of marketization, lack of vigor for the state-owned enterprises, backward of private enterprises, slow fusion of technologies and economic development, unsuitable resource-oriented and heavy chemical industrial structures and traditional productive structures, city transformation facing difficulties, social security and livelihood pressure, etc. So this policy aimed to promote the Northeast China to become the base for advanced equipment manufacturing, strategic base for important technological equipment, national base for new raw materials, base for modern agriculture, R&D base for important technologies by means of new industrialization, computerization, urbanization and modernization of agriculture.

According to the comprehensive strategy of revitalizing the Northeast China, the three provinces made and released individually some strategies and policies in detail. For example, Jilin Province released the 14th Five-Year Plan, which emphasized the upgrading industries, strengthening industrial cooperation and enhancing modern agricultural manufacturing. By 2025, the goal is to realize an increase of labor productivity to over 6.5%, and the proportion of value added of core industries in digital economy to the regional GDP reaching 10%, and so on. To realize these goals, Jilin Province will develop the new energy vehicles, digitalization of manufacturing industry, electronic information industry, metallurgical and building materials industries, and at the same time, promote the digital technologies to be used in the ice and snow economy, the deep fusion of digital technologies and manufacturing, fusion of digital technologies and the substantial economy, and take AI technology as the new engine for regional economic development.

These ambitious goals are based on national digital strategies, such as the "Made in China 2025" plan from 2015 and AI development strategy and Internet Plus, and so on, which will be beneficial to promote the fourth industrial revolution through actively introducing advanced technologies. In this sense, though no doubts about these strategies and goals, we still have some other viewpoints about realizing them successfully.

Firstly, pay much attention to the differences among the three provinces as shown in section four, they should consider cooperation with each other according to the complementarities but not make their own similar strategies separately. So, the three provinces should try to build up the "hub-and-spoke" relationship.[3]

For instance, it is well known that Jilin Province has the stronger comparative advantage in manufacturing automobiles and thus can be set to be the hub of new energy vehicles, and other two provinces can be the spokes to undertake manufacturing parts and R&D. The same mode also goes for the industrial robots face to automobile industry.[4] Considering that the annual production of vehicles all over the world is 90 million, and most of them will be changed into electric vehicles and new energy vehicles, Jilin Province has no doubt to play a more important role as a hub of manufacturing new energy vehicles.

As a province with advantages in heavy industrial products, such as ironwork (including crude steel, rolled steel and pig iron), ethylene, machine tools, coke, etc., Liaoning Province should consider the long term decline of market share and the population dynamics (increase of aging and decrease of working-age population) and promote the development of IoT (Internet of things) and smart factory. Smart factory is the advanced factory that uses cutting-edge technologies including AI, Big data, cloud computing, Robotics, 3D printer, etc. and put the censor, actuator and embedded system into equipment, devices or terminals, which are taken as the CPS (cyber physical systems) interconnecting in the global network to drive. Liaoning Province can play the role of the hub of smart factory.

Heilongjiang Province that exists decreasing proportion of the secondary industry and increasing proportion of the primary industry should use the cutting-edge technologies, such as AI, Big data, cloud computing, Robotics, 3D printer, etc. to modernize agriculture on the one hand, on the other hand, use the experiences of resource-oriented manufacturing to promote the development of greening industries

[3] Our recommendations here are in line with the idea of place-based policies that have been attracting attentions in the United States in recent years. In general, place-based policies aim to expand employment opportunities and raise wages, targeting generally stagnant areas (see Neumark and Simpson, 2015). Our arguments are close to the following positions recommended by the Biden Administration's Council of Economic Advisers. That is to say, "a third common recommendation for successful place-based policies is to avoid one-size-fits-all solutions. Place-based policies can be designed so that the same measure will be applied to any eligible region; or, at the cost of additional complexity, measures can be differentiated to accommodate local conditions and the relative strengths, needs, and existing assets of individual communities." (The White House 2022, p.245).

[4] The automotive industry is the second largest customer of industrial robots after the electronics industry. The world robot installations in 2020 was 383,545 units, among them, the automotive industry accounted for 21% (79,848 units). China was the largest customer of industrial robots and accounted for 44% (168,377 units), but Japan and German are still the main manufacturing bases. See the International Federation of Robotics, *Executive Summary WR 2021 Industrial Robots* (https://ifr.org/img/worldrobotics/Executive_Summary_WR_Industrial_Robots_2021.pdf).

which can contribute to decarbonization and the related environmental protection industries. So Heilongjiang Province can be the hub of agriculture and environmental protection.

In order to build up and realize the relationship of "hub-and-spoke", infrastructures, such as digital telecommunications network, traffic network and logistics network are essential for hub-and-spokes and different inter-spokes, so these are important preconditions for intra- and extra- Northeast economies.

Secondly, adopt demand-side perspectives to promote the strategies and policies. Considering from demand-side is the successful experience from some typical electronic enterprises, such as Amazon, Google and Facebook, etc., and the lesson from constructing electronic government in Japan.[5] But in Japan, the successful example is, as the decreasing proportion of heavy chemical industry, the transformation of industries from thick, heavy, long and large to slim, light, short and small based on customers' demand. At the same time, manufacturing and marketing transformed from large to small production and sales, and provided customized or personalized products and services. These measures are not occasional, but the presentation of higher living standards, which can be regarded as the phenomenon of the transformation from supply-side to demand-side.

Thirdly, new strategies should promote according to the social changes, requirements and restraints. The most important factors are the population dynamics including aging, decreasing working-age and total population, and the goals of decarbonization and carbon neutrality. In addition, the fourth industrial revolution driven by the cutting-edged technologies, AI, Big data, cloud computing, robotics, 3D printer and innovations are all essential. These elements are essential premises for demonstrating regional characteristics based on a "hub-and-spoke" relationship. Of course, we should promote them from demand-side perspective.

7.6 Concluding Remarks

From the analysis above, we can make conclusions as follows.

Firstly, the Northeast economies went faster in aging and lower birth rate, decreasing total population caused by natural decrease compared to China as a whole. This led to an absolute and relative decrease of the working-age population (Sect. 7.2).

Secondly, the decrease of the working-age population and total population are not necessarily to impact negatively on economic growth, it is possible to keep a positive growth rate. In addition, there is a negative relationship between the compound annual growth rate of total population and the compound annual growth rate of real GDP per capita. The reasons are the increase of labor productivity and capital stock (Sect. 7.3).

[5] On the current situation and challenges of Electronic Government in Japan, see Taniguchi and Gao (2020). A particularly serious flaw is the emphasis on the supply side and the incomplete view of the demand side.

Thirdly, though exist the findings above, the growth rate of real GDP per capita of the Northeast economies is declining relative to the national average level, especially for Liaoning province and Heilongjiang Province with large decreasing margins. This means it is essential to make strategic policies to revitalize the Northeast economies by considering the characters of the three provinces (Sect. 7.3).

Fourthly, there are many differences in the characters of the Northeast three provinces from demand and supply. In demand, the structures of consumption and investment are different. In supply, the trends of the primary industry and the secondary industry are very different. The main industrial products and farm, livestock and aquatic products are also different. From this aspect, it is essential to consider the complementarities among these provinces when making strategic policies (Sect. 7.4).

Fifthly, the central government of China recognized the stagnation of the Northeast economies and made the strategy of revitalizing the Northeast china in 2003. With the promoting route of enlarging necessary volume, the Northeast economies created high growth rate in 2000s. The stimulus policy as the countermeasure of Lehman Shock in 2008 also contributed to the growth of the Northeast economies but brought about overcapacity and excess production in heavy chemical industry from state-owned enterprises. In order to resolve these problems, it is essential to carry out industrial transformation and change to the "New Normal" (Sect. 7.5).

Besides the opinions from the central government of China in 2016, we also put forward some suggestions as follows: (1) the significance of building up the complementary relationship among the three provinces based on their characters and designing "hub-and-spoke" for different industries in detail. (2) demand-side perspective should be emphasized. (3) under the circumstance of the population dynamics and the global goal of decarbonization and carbon neutrality, it is essential to consider the fourth industrial revolution driven by cutting-edge technologies and digital transformation.

This paper discusses the revitalizing of the Northeast economies, but does not concern about several important aspects. The first one is the improvement in the quality of human resource by means of education and training. The second one is the openness policies of the Northeast economies, especially the role of foreign investment in introducing advanced technologies, but the introduction of foreign investment was backward in the Northeast economies.[6] The third one is the effects of fiscal policy. In China, central government can implement inter-governmental transfer expenditure in dealing with insufficient financial resources and realizing balanced financial resources.[7] In the financial budget in 2020, the proportion of the inter-governmental transfer expenditure in the GDP of the Northeast economies were very high, reaching 28.4% in Heilongjiang Province, 20.0% in Jilin Province

[6] On the external trade in the Northeast, see Zhu (2014).

[7] On the relationship of the revitalization strategy in the Northeast China and inter-governmental fiscal transfer payments, see Zhu, Li and Zhang (2015).

and 11.6% in Liaoning Province, these proportions were only 17.1, 16.8 and 8.9% respectively in 2010.[8] The effects of these financial supports on the revitalizing of the Northeast economies will be the research topic in the future.

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[8] See the Ministry of Finance of the People's Republic of China, "Transfer Payments in General Public Budget from Central Government to Local Governments by region" (http://yss.mof.gov.cn/2020zyjs/202106/t20210629_3727251.htm).

Chapter 8
The Structure and Evolution of City System in the Philippines

Arianne Dumayas

Abstract The recent economic growth in the Philippines has been accompanied by a rising rate of urbanization. While some places are able to benefit from the economic expansion and increasing urbanization, others are left behind. To better understand the problem of widening spatial disparity and craft policies that would make urbanization more inclusive, it is vital to look at how cities are organized and how that affects socio-economic conditions. This study analyzes the structure of the city system within the provinces in the Philippines from 1990–2020. In general, the structure of the city system in provinces has remained almost unchanged for the past three decades. Cities or municipalities were able to preserve their sizes and rank in the system. This study also explores the link between the city system and socio-economic conditions. Provinces with a city system, where cities are geographically adjacent to one another and where the population is concentrated, typically have superior socioeconomic conditions. While provinces with a city system in which both population and cities are relatively dispersed, tend to have an inferior socio-economic condition. This study also classifies provinces based on the link between the city system and socio-economic conditions and outlines appropriate policy recommendations.

Keywords City system · Socio-economic development · Spatial inequality · Urbanization

8.1 Introduction

Half of the world's population now lives in urban areas and this trend is expected to continue rapidly. The relationship between urbanization and economic growth has been widely documented. In particular, Henderson (2000) pointed out that a simple correlation coefficient between the degree of urbanization and GDP per capita (log) is as high as 0.85. While urbanization is inevitable in the development process, it poses a struggle for the lagging areas, particularly in developing countries. The World

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Development Report 2009 argues that prosperity will not occur across geographical spaces at the same time, but this does not necessarily mean that lagging areas should be left behind (World Bank, 2009). Thus, policies that foster the growth of the leading areas and facilitate the integration or catch-up of lagging areas are essential.

While cities are seen as the primary engine of growth, they do not exist on their own and they are embedded in a wider network. Any development in one city would unavoidably impact the other cities. Thus, it is important to consider the overall structure of the system of cities as well as the general equilibrium nature of urban policy (Desmet and Rossi-Hansberg, 2014). The existing literature on the city system is often based on the case of developed economies and very few analyzed the urban system in the context of developing countries. However, the structure of the city system as well as urban development experiences can vary in different countries, particularly between developed and developing economies. Given the fact that urbanization has accelerated fast in developing economies, studies that focus on their case are indispensable. This paper aims to contribute to the understanding of the city system in developing countries by examining the case of the Philippines.

Inclusive growth has been the cornerstone of the development policy in the Philippines over the past years. Despite the impressive 6–7% annual economic growth rate in recent years, a huge disparity remains, particularly in terms of spatial inequality. The capital Metro Manila is a mega-city of 13 million population and accounts for almost 40% of the country's economic output. On the other hand, regions in Mindanao remain sparsely populated and account for about 1–3% of the total output. To address the widening spatial gap and make urbanization inclusive, it is imperative to understand the structure of the city system and how it relates to socio-economic conditions. In doing so, distinct types of city systems can be identified, and appropriate policy measures can be recommended.

This study has three main objectives. First, this study examines the structure of the city system at the subnational level, specifically, at the provincial level. Second, this paper analyzes the evolution of the structure of the city system in the provinces from 1990–2010. Third, this study explores the link between the structure of the city system and the level of socio-economic-development in the provinces. Moreover, this study classifies provinces based on the link between the city system and socio-economic conditions and outlines appropriate policy recommendations. This study is organized as follows: Sect. 8.2 presents related literature on the structure of the city system and its relationship with socio-economic development; Sect. 8.3 discusses the data and methodology; Sect. 8.4 examines the structure of the city system and its link with socio-economic conditions. Section 8.5 summarizes the study and outlines areas for further study.

8.2 Review of Related Literature

8.2.1 Spatial Concentration and City System

Central to the understanding of the city system is the rationale behind the concentration of economic activity in a geographical space. Marshall's theory of agglomeration is often referred to when explaining the existence of concentration of economic activity. According to Marshall (1920), there are three factors that attract the firms to cluster in the same location and in the process, fostering further expansion of a particular area: presence of skilled labor, availability of specialized inputs services, and knowledge of technological spillovers.

Meanwhile, the new economic geography (NEG) explains that the spatial configuration of economic activities is a result of two opposing forces: agglomeration (centripetal) forces, and dispersion (centrifugal) forces (Fujita, 2007). Agglomeration forces are basically factors that attract firms and people to a location, such as geophysical features (first-nature), increasing returns (second-nature), historical conditions, or public policies. Dispersion forces are essential factors that drive away firms and people such as congestion, high price of land and rent, slums, and environmental problems.

As pointed out earlier, cities are not standalone entities, thus it necessary to look at how cities relate to other cities in a system. The central place theory explains how cities are organized into a system based on size and functions (Christaller, 1933; Losch, 1940). The central place theory describes a hierarchy of locations in which there are few higher-order cities and low-order cities. The few higher-order cities typically have a larger population, more widely spaced, and provide more variety of variety and functions. Meanwhile, the low-order cities are smaller in size and perform limited functions.

On the other hand, there are several studies that challenge the validity of central place theory in the actual city systems (Camagni, 1993; Camagni, & Capello, 2004). Some functions that are traditionally performed by higher-order cities are also found in the lower-order cities. There are also horizontal linkages between similar cities. Given these new developments, new thinking such as the city network model has surfaced. The city network theory model emphasizes the importance of network integration with other cities to achieve increasing returns and scale economies (Camagni et.al, 2013). With economic efficiency gained through external cooperation with other cities, single cities can upgrade their functions, without expanding their individual sizes. Similar to the concept of city network theory is the concept of "borrowed size" from Alonso (1973). "Borrowed size" pertains to a small city that performs functions that are usually carried out by larger cities. Second-order cities who have access to the functions and networks of first-rank cities can offer high average location benefits (Camagni et.al, 2013).

8.2.2 Measurement of City System

There are several ways to quantify the city system and among the widely used methods are the primacy index and rank-size distribution. The definition and measurement of the primacy of the city varies. Primacy can be measured as the proportion of the city with the largest population to the second-largest city in a country (Jefferson, 1939). The city is defined as a primate city when ts ratio to that of the second city exceeds two. While this method is easy to measure, it is deficient as it does not consider the size distribution of the cites below the two largest. Thus, some studies extend the analysis to the proportion of the population of the first city to the next two or to an even larger number of cities (Rosen, 1980). Some studies measured primacy by looking at the share of the population of the largest city in reference to the total population (Moomaw, 1996). Meanwhile, some studies used the ratio of the largest city to the total urban population of a country (El-Shakhs, 1972).

Rank-size rule or Zipf's law (1949) describes a city system based on the size of the city and its rank in the system. This concept presents a regularity wherein the population size of a city is equal to the population of the largest city divided by the rank of the given city. Hence, the population of the second-largest city would be one-half of the largest and the population of the third-largest city would be one-third of the biggest city, and so on. Plotting the natural logarithms of the rank and of the city in the graph would yield a log-linear pattern. If the slope of the line is equal to 1, the size of cities perfectly fit to the rank-size rule. If the slope is > 1, the actual size of the largest city is bigger than predicted which means implies primacy and higher concentration of the population in the biggest city. If the slope of is < 1, the actual size of the middle-rank cities is higher than predicted which implies dispersion and relatively balanced population distribution.

The two prior techniques, while extensively used and somewhat simple to estimate, only study the population distribution and do not account for the spatial distribution of the cities. Ishikawa (2012) proposes a city system index that captures both the distribution of population and locations: coefficient of divergence (CD) of the population; and spatial converge of city distribution (SC). The CD component of the city index is based on Sheppard (1982), which is a hierarchical index based on the proportion of the total urban population in the largest city and weighted by the rank of the city. On the other hand, spatial convergence of city distribution is based on the average least distances. The low value of the city system index signifies a city system in which the population is concentrated on the primary cities and other cities geographically located close to the largest cities. The high value of the city system index indicates a city system in which there is a relatively even distribution of population among cities and cities are located relatively far from each other.

8.2.3 Structure of City System and Development

The link between the city system index and socio-economic performance has been examined using the case of different countries: Japan (Ishikawa, 2012), Germany (Ishikawa & Oh, 2015), and Japan and Sweden (Ishikawa & Wall, 2015). In the case of Japan (Ishikawa, 2012), there is an inverse relationship between the economic base and city system index. The economic base includes variables such as income per capita, the value of manufactured goods, unemployment rate, regional difference index of consumer prices, index of financial potential, starting salary of senior high school students, and salary of the female part-time worker. This implies that prefectures with an urban system, in which characterized where the population is concentrated in the biggest city and cities are located close to each other, are most likely to have a good economic condition. On the other hand, there is a positive relationship between the city system index and welfare (homes for the aged, rehabilitation facilities for physically disabled persons, child welfare institutions, welfare expenditure per capita, social welfare per capita, social welfare expenditure for aged person). This means that prefecture with relatively dispersed population and cities tend to have better welfare conditions. Meanwhile, social health which the aggregate value of all the variables (economic base, education, dwelling, health, welfare, and safety, and social unrest), is found to be positively correlated with the city system. This finding suggests that prefecture with city system characterized by relative dispersion of population and cities have better overall social conditions.

In the case of Germany (Ishikawa & Oh, 2015), there is also a negative correlation between various socio-indicators and city system indexes. Socio-economic indicators such as gross regional production, number of factories, income and expenditure, GDP per capita, number of full-time and part-time worker are found to have a negative relationship with the city system index. This means that prefectures in Germany where the population is concentrated in the biggest city and cities are located close to each other are relatively well-off than prefectures which is relatively dispersed. Similar finding is found in the case of Sweden (Ishikawa and Wall, 2016), where the city system index is negatively associated with gross regional product and the number of doctors. This implies that the concentrated urban system in Sweden tends to have higher economic output and better medical conditions.

8.3 Data and Methodology

8.3.1 Data

This study employs two sets of data. The first set of data is used for estimating the city system index: population of cities and municipalities (1990 and 2020) and GPS coordinates of cities and municipalities. As of June 2022, there are 81 provinces in

Table 8.1 List of data

Category	Variable	Years
1. City system structure		
Population	Population: City and municipalities	1990 and 2020
Distance	GPS coordinates	2015
2. Socio-economic development		
Category	*Variable*	*Years*
Economic	Annual average family income	2009
	Annual average family expenditure	2009
	Proportion of working population (15–64)	2010
	Poverty incidence	2009
	Unemployment rate	2009
	GINI index	2010
Education	Academic degree holder	2010
	Mean years of schooling	2008
	Expected years of schooling	2008
Governance	Total provincial income	2012
	IRA allotment	2012
	Social services expenditures	2012
	% SS expenditures to total expenditures	2012
Health	Life expectancy at birth (years)	2009
	Total health workers	2011
	Number of household with access to sanitary toilet	2011
	Number of household with access to safe water	2011
Infrastructure	Length of national roads	2013
	Length of national bridges	2013

Source Author's own construction

the Philippines. However, this study includes 79 provinces[1] and the capital, Metro Manila, or the National Capital Region (NCR). The second set of data is utilized for constructing the socio-economic index of the provinces. The variables are grouped into five categories: economic, education, governance, health, and infrastructure. Since these variables' publication years varied, this study used the most recent between 2009 and 2015. The Countryside in Figures and Provincial Quickstat publications from the Philippines Statistical Authority are the main sources of the data (PSA). The list of data used in this paper is shown in Table 8.1.

[1] This study did not include the following provinces: Compostela Valley used to be part of Davao del Norte until 1998; Dinagat Island which used to part of Surigao del Sur until 2012; Davao Occidental, the youngest province which was created in 2013.

8.3.2 Methodology

This study uses three different methods to quantify the city system in the provinces in the Philippines: Primacy Index, Rank-Size Rule, and City System Index. To measure the socio-economic development, this study constructs a socio-economic index.

8.3.2.1 Primacy Index

This study adopts two methods of estimating the primacy index: the share of the largest population (P1); and the two-city index which is the population ratio of the largest city compared to the second-largest city (P2).

The share of the largest city is calculated using the formula below (Eq. 8.1). The higher the value means the concentration of the population in the primary city.

$$P1 = \frac{Pop(largest)}{Population(total)} \tag{8.1}$$

The two-city index is estimated using the formula below (Eq. 8.2). If P2 > 2, the population is highly concentrated in the primary city. If P2 < 2, the population distribution is relatively dispersed.

$$P2 = \frac{Pop(City1)}{Pop(City2)} \tag{8.2}$$

8.3.2.2 Rank-Size Distribution

The rank-size rule is estimated first by looking at the relationship between population size and rank of the city.

$$Pr = \frac{P1}{r} \tag{8.3}$$

where Pr = population of the largest city ranked r, P = population of the largest city, and r = rank of the city R.

The logged values of the rank and size are then regressed using the formula below. The q coefficient provides information about the structure of the city system. The higher the value of q implies that primacy or concentration of the population in the biggest city. The lower the value of q, the more dispersed the population distribution.

$$LnPk = lnP1 - qLnk \tag{8.4}$$

where P1 is the population of the largest city, Pk is the population of the kth town by rank, and q is the coefficient which gives information about population distribution.

8.3.2.3 City System Index

This study utilizes Ishikawa (2012) city system index (CSI) to analyze the structure of urban system in the Philippines. The CSI has two components: Coefficient of Divergence (CD) of the population distribution towards the primary city; and Spatial Convergence (SC) of city distribution in a region.

The coefficient of Divergence (CD) indicates the distribution of urban population in a city system is derived as follows:

Suppose that there are N cities in a region and p_r represents the population share of a city for all urban populations in the region.

$$1 = \sum_{r=1}^{N} pr \tag{8.5}$$

In case that there is no prior information on the cities, it is rational to assume that every city has the same share, $p_r = 1/N$. This inference is derived by maximizing equation (Eq. 8.2) with reference to the equation (Eq. 8.1).

$$H = -\sum_{r-1}^{N} p_r L_N(p_r) \tag{8.6}$$

Since there is prior information about cities in the Philippines, the coefficient of divergence of the population can be established as follows: *r* indicates the rank of a city accordingly to its population size, and multiplying size, and multiplying the value of $\log_e$ *(r)* by its share as a weigh and them summing up these values and finally dividing it by N.

$$CD = \left(\frac{1}{N}\right) \sum_{r=1}^{N} p_r L_N(r) \tag{8.7}$$

If the population of the region is distributed equally between cities, the coefficient of the divergence is given by the equation below.

$$CD = N|^{-2} \sum_{r=1}^{N} L_N(r) \tag{8.8}$$

A low CD value suggests that the population is concentrated in a small number of cities or municipalities, whereas a high CD value suggests that the population is distributed fairly evenly throughout cities in the provinces.

Spatial Convergence (SC) which represents the spatial distribution of the city system is estimated as follows:

If there are N_i (i-1,2, 3…. N) cities in a region, of which land area is denoted by M. The distance from a city N_1 to the nearest city is denoted as d_1 or the least distance of the city N_1. The least distance or the nearest neighbor analysis is calculated for each city and then the average least distance is derived as below.

$$AD = \left(\frac{1}{N}\right)\sum_{i=1}^{N} d_i \tag{8.9}$$

The spatial convergence of the city distribution in a region is derived using the equation below. The smaller the value of SC indicates that the cities are geographically closer, whereas the higher the value of SC implies that cities are spatially dispersed.

$$SC = \frac{AD}{2\left(\frac{N}{M})^{0.5}\right)} \tag{8.10}$$

The values of CD and SC are then combined to construct the urban system index (USI). USI is expressed in the equation below, where α and β are both positive parameters and assumed at α = 20, and β = 0.5.

$$USI = ((\alpha CD)^2 + (\beta SC)^2)^{0.5} \tag{8.11}$$

The low value of the city system index signifies a city system in which the population concentrated on the primary cities and other cities geographically located close to the largest cities. The high value of city system index indicates a city system in which there is a relatively even distribution of population among cities and cities are located relatively far from each other.

8.3.2.4 Socio-Economic Index

Similar to other developing countries, data availability at the subnational level is quite problematic. This study attempts to provide a more holistic approach by collecting data that would adequately represent the socio-economic condition of the provinces.

The socio-economic index is computed using various variables that fall into five categories: economic, education, governance, health, and infrastructure.

These variables are standardized using Eq. 8.8,

$$S_{IVP} = \frac{(X_{IV} - AVE_{IV})}{ST_{IV}} \tag{8.12}$$

$$(I = a, b, e; V = 1, 2, 3, 4 \cdots n; P = P1, P2, P3 \cdots P80)$$

.

where X_{Iv} is the value of the indicator of I of a province P; AVE_{Iv} is the mean value; and ST_{Iv} is the standard deviation of the indicator I of variable E.

The score of the indicator I was obtained using Eq. 8.9,

$$S_{IV} = \left(\frac{1}{n}\right) \sum_{I=VP}^{In} S_{IVP} \tag{8.13}$$

The socio-economic index was computed based on equation (Eq. 8.10),

$$SEI_P = \left(\frac{1}{6}\right) \sum_{I=a}^{e} S_{IV} \tag{8.14}$$

The higher the value of the socio-economic index indicates that the provinces have relatively better socio-economic conditions, whereas the lower the value of the socio-economic index signifies unfavorable socio-economic conditions.

8.4 City System in the Philippines

8.4.1 Spatial Development in the Philippines

The Philippines is an archipelago located in Southeast Asia. It is composed of 7,107 islands which total to 300,000 square kilometers, the second biggest archipelagic country in the world. The Philippines is divided into three main islands: Luzon, Visayas, and Mindanao. As of 2022, the country is divided further into 17 regions,[2] 81 provinces, 146 cities, 1,488 municipalities, and 42,026 barangays. The provinces, cities, municipalities, and barangays are classified based on income. Meanwhile, cities were further classified as highly urbanized cities(HUCs), independent components, and component cities.[3]

[2] With the exception of regions, all other units are considered as official local governments units. Regions are used only for administrative management or statistic reference by the Executive branch.

[3] Highly Urbanized Cities (HUCs) are autonomous from the province and have a minimum population of 200,000 and latest annual income of PhP50 million; 2) Independent Component Cities (ICCs) are also autonomous and have charters that prohibit their residents in voting for provincial officials; and 3) Component Cities which do not meet the requirements for HUCs and ICCs and still considered a part of the provinces.

The Philippines is classified as a lower middle-income country by the World Bank with a gross domestic product (GDP) per capita of 3,412 dollars (constant 2015 US$). The Philippines have experienced an average of 5–7% growth over the past years, particularly between 2012–2019. The services, mainly through the information technology-business processing outsourcing, accounts for more than half of the economic output. As of 2020, the country has a total population 109 million inhabitants which makes it as the 13th largest country in the world in terms of population. Around 40 percent of the population lives in Metro Manila and its neighboring regions of Region IV-A (CALABARZON) and Region III (Central Luzon). The annual population growth rate as of 2020 is 1.63 percent, a bit lower than 1.72 percent during 2010–2015. The median age of the population is 24.3 years old.

Similar to the case of archipelagic countries, most villages have developed alongside the shorelines or the along riverbanks during the pre-colonial era. There was no central authority at that time and these villages function as independent political units composed of 30–100 families (Boquet, 2017). The arrival of the Spanish colonial rule would significantly alter the development of the pattern of settlements in the country. The Spanish government initially set up their base in Cebu but later moved to Manila in 1571 to better facilitate trade with the neighbors within South China. (Doeppers, 1972). The Philippines, like all other colonies, were primarily used by the Spanish empire as a source of raw materials. Because of this, the majority of the population and economic activity was concentrated in cities like Manila and the traditional agricultural districts of Visayas, Bicol, and Ilocos that were close to trade routes (Pernia, 1982). A hierarchy of settlements was established during the Spanish colonial period (1565–1898): (1) Capital City with Manila; (2) Provincial Centers (Ciudades and Villas)- center of military, political, and ecclesiastical control (Cebu, Naga, Nueva Segovia, all ciudades and villas in Panay and Fernandia(Vigan); (3) Central Church Villages or Cabeceras- focal points of activity and cultural change. Even after the change of colonial power (American: 1898–1946; and Japanese: 1944–195) and the transition to independence, this spatial pattern would continue throughout the next centuries.

During the post-war period in 1950s, nearly 70 percent of the population still lives in the rural areas. The Philippines experienced a severe balance of payments and foreign exchange crisis during this time, which led to the implementation of an import-substitution-industrialization (ISI) policy. Furthermore, the Filipino First Policy of the current administration has strongly encouraged economic nationalism. This shift toward ISI had a significant impact on the geographical development of the country since it allowed the capital-intensive industries in Metro Manila and Southern Luzon to expand quickly relative to resource-based industries (Sicat, 1968, cited in (Mercado, 2002). Consequently, this led to an increase in rural to urban migrations. However, from late 1960s onwards, the supply of jobs and adequate housing in urban areas could not keep pace with rapid population growth and this resulted to classic urban diseconomies such as congestion, slums, urban poverty, and pollution (Boquet, 2017). From late 1960s-1980s, there are several notable government policies that focused on the spatial aspects of development. These policies include the establishment of Regional Development Authorities(RDAs) to manage local development; the creation of the export processing zone in 1972; the organization of the provinces into regions based on geographical and cultural characteristics; and the formation of the National Capital Region in 1975, the only metropolitan area with governance functions.

The increase in the number of people living in urban areas would continue in 1990s-onwards. In particular, the level of urbanization would increase from 30 percent in 1960 to 47 percent in 1995. The number of newly established cities would significantly grow after the enactment of the Local Government Code (LGC) of 1991, an act which aims to empower the local governments units. Particularly, the rise in the internal revenue allotment (IRA) portion of the national taxes has encouraged some municipalities to convert into cities. The Philippines have implemented trade liberalization, privatization, and deregulation policy reforms to conform to the dominant market-oriented global landscape and to benefit from the country's rising economic integration to the global market. Specifically, the Special Economic Zones Act of 1995, which permitted private sector involvement in the creation and administration of special economic zones. Due to this act, there were more economic zones established, most of which were in the Southern Luzon provinces of Cavite, Batangas, and Laguna. From 2000 onward, the nation would witness the IT-BPO industry's astounding growth. Numerous IT-BPO companies have host locations in the highly urbanized regions of Metro Manila, Cebu, Baguio, Davao, and Davao.

8.4.2 Structure of City System in Provinces

Using different methods, this study uses a different method to analyze the structure of the city system in the Philippines. The results of the primacy index 1 or the share of the population of the largest to the total population in the province shows that the Davao City, the largest city in Davao del Sur has the most number of residents. Meanwhile, the biggest city in Pangasinan has the lowest share of the population. On average, the share of the largest city within a province is around 22 percent (Table 8.2).

Meanwhile, the results of primacy index 2 or the ratio of the population of the biggest city to the next biggest city indicates a similar finding, Davao City in Davao Del Sur is the most primate city in the country. On other hand, North Cotabato have the lowest primacy ratio. On average, the average ratio of the primary city to next biggest city is 2 and there is wide variation among provinces as evidenced by a standard deviation of 1.354. The results of the analysis of the rank-size reveals that same finding as well, Davao del Sur emerged as the most concentrated province in the Philippines. Meanwhile, Zamboanga Sibugay is considered as with the most dispersed city system. The average q coefficient stood at 0.775 and there is relatively variation among the provinces. The estimation of the CSI shows that Davao del Sur has the most concentrated city system in the Philippines. On the other hand, Guimaras has the most dispersed city system. The average value of CSI among the provinces is around 2.050.

Table 8.2 Top 10 highest and lowest[4]

Primacy Index 1		Primacy Index 2		Rank-Size q		CSI	
Province	Primacy index 1 (2020)	Province	Primacy index 2 P1/P2 2020	Province	Rank-size q zipf 2020	Province	CSI(2020)
Concentration							
Davao del Sur	0.7231	Davao del Sur	9.4330	Davao del Sur	1.4408	Davao del Sur	0.9414
Kalinga	0.5272	Misamis Oriental	5.3285	Benguet	1.2647	Leyte	1.0706
Batanes	0.5054	Lanao del Norte	4.9454	Laguna	1.2441	Maguindanao	1.1445
Agusan del Norte	0.4904	Surigao del Norte	4.7486	Kalinga	1.2317	Misamis Oriental	1.2927
Zamboanga del Sur	0.4819	Iloilo	4.6455	Cavite	1.2294	Lanao del Sur	1.2967
Benguet	0.4430	Zamboanga del Sur	4.6435	Rizal	1.1987	Laguna	1.3517
Camiguin	0.4428	Agusan del Norte	4.6408	Palawan	1.1883	Bohol	1.3903
Misamis Oriental	0.4322	Lanao del Sur	4.1101	Agusan del Norte	1.0982	Isabela	1.3949
South Cotabato	0.4169	Palawan	3.5941	Davao del Norte	1.0860	Pangasinan	1.4179
Lanao del Norte	0.3344	South Cotabato	3.5687	Batanes	1.0829	Ilocos Sur	1.4332
Dispersion							
Pangasinan	0.0649	North Cotabato	1.0044	Zamboanga Sibugay	0.3463	Guimaras	3.5321

(continued)

[4] For conformity, the top highest for CSI value is reversed as the low value indicates concentration.

Table 8.2 (continued)

Primacy Index 1		Primacy Index 2		Rank-Size q		CSI	
Province	Primacy index 1 (2020)	Province	Primacy index 2 P1/P2 2020	Province	Rank-size q zipf 2020	Province	CSI(2020)
Bohol	0.0753	Antique	1.0205	Compostela Valley	0.3705	Tawi-Tawi	3.5102
Ilocos Sur	0.0870	Camarines Norte	1.0225	Apayao	0.3974	Palawan	3.3711
Isabela	0.0932	Aurora	1.0268	Sarangani	0.416	Sarangani	3.3243
Negros Oriental	0.0936	Mountain Province	1.0274	Sultan Kudarat	0.4328	Marinduque	3.3169
Camarines Sur	0.1011	Compostela Valley	1.0347	Marinduque	0.4558	Apayao	3.1754
Antique	0.1063	Nueva Vizcaya	1.0372	Ifugao	0.4686	Batanes	3.1515
North Cotabato	0.1109	Sarangani	1.0387	Guimaras	0.4794	Aurora	3.1439
Masbate	0.1150	Marinduque	1.0474	Capiz	0.5052	Siquijor	3.0412
Compostela Valley	0.1224	Cavite	1.0580	Antique	0.51	Quirino	2.9886

Source Author's own construction

While variation in results is expected due to the difference in measurements, some similarities can be observed. In particular, as noted earlier, all four methods points to Davao Del Sur having the most concentrated city system structure. Davao del Sur is home to Davao City, the largest city in terms of land area and 3rd most populous city in the Philippines. While Davao City is geographically located in the province of Davao del Sur, as it is a highly urbanized city, it has its own independent local government. Misamis Oriental is another province that is found by all analyses as highly concentrated. Similar to the case of Davao del Sur, Misamis Oriental is also home to a highly urbanized city, Cagayan de Oro which is considered to be a major economic center of Northern Mindanao. Meanwhile, similarities are also found among provinces with relatively dispersed city systems. In particular, Sarangani, Marinduque, Compostela Valley, and Aurora are found to be highly dispersed using the three methods of primacy index 2, rank-size rule, and CSI. These provinces are all far from the capital and relatively economically-developed areas in the region.

However, the analysis also reveals some strikingly different results. In particular, the provinces of Bohol and Pangasinan are found in top 10 highest of the CSI ranking but the biggest city of both provinces have the lowest share of the total population. Pangasinan located in Northern Luzon is the most populous provinces in 2020, while Bohol, an island province in Visayas, ranks as the 17th most populous provinces. The low share of the population of the biggest city can be explained by the fact that both provinces have a high number of cities and municipalities.[5] Bohol have 1 component city and 47 municipalities, while, Pangasinan have 1 independent city, 4 components cities, and 44 municipalities.

Different outcomes can be seen in the cases of the island provinces of Palawan and Batanes. These two provinces are found in the top 10 lowest CSI ranking which means relatively dispersed city system, but they are also found to be among the top 15 highest rank-size rule and primacy index 2 which signifies a highly-concentrated city system. Palawan is the biggest province in the Philippines with a land area of 14,650 sq.km, while Batanes is the smallest province with 209 sq.km. While both provinces are significantly different in terms of land area, both provinces are among the most sparsely populated provinces. Palawan ranks third with a population density of 64 persons per sq.km and Batanes ranks twelve with 93 persons per sq.km. This results highlight the importance of the inclusion of the spatial dimension in the analysis. The inclusion of geographical distance in the analysis provides a more accurate representation of the city system. The estimation of the city system without geographical dimension is most likely biased towards the cities with big population.

8.4.3 Evolution of City System

The evaluation of the share of the largest city to the total population of the provinces from 1990–2020 reveals an increasing trend. The average increase in the share of the

[5] The average number of cities per province is 1.3 and the municipalities per city is 18.

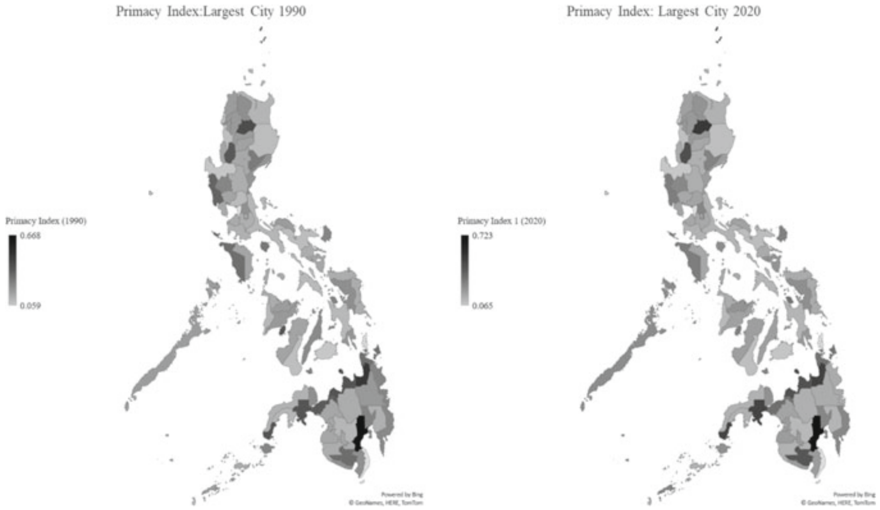

Fig. 8.1 Evolution of primacy index: Largest city share. *Source* Author's own construction

largest city is 9% from 1990–2020. The provinces with the largest increase share of the largest city include Bulacan (86%), Tawi-Tawi (59%), Sorsogon (48%), Palawan (41%), and Batanes (33%). On the other hand, some provinces have seen decline in their share of their largest city: Surigao del Sur (−39%), Guimaras (−28%), Agusan del Sur (−21%), Cebu (−19%), and Zambales (−16%). There are several possible explanations for the decline of the primacy city: faster growth in smaller cities than the biggest cities such as in the case of Cebu and Zambales which both have a metropolitan area; or gerrymandering, the practice of creation new political units such as provinces or cities in order to gain an advantage in the election and extend political power. For example, the province of Dinagat Island is carved out from the province of Surigao del Sur in 2012 (Fig. 8.1).

The analysis of primacy index 2 or the ratio of the biggest city to the second biggest city from 1990–2020 also shows an increasing dominance of the largest city. In general, the ratio of the biggest city to the second largest city increased to 12%. The provinces which experienced the biggest increase in the ratio of their biggest city to the second biggest city include: Palawan (126%), Tawi-Tawi (120%), Bulacan (98%), Batanes (98%), Maguindanao (58%), and Sorsogon (58%). Meanwhile, the provinces in which the ratio of the biggest city to the second biggest city include: Surigao del Sur (−47%), Zambales (−44%), Cebu (−43%), Agusan del Sur (−19%), and Marinduque (−19%) (Fig. 8.2).

Meanwhile, the examination of the rank-size rule distribution suggests growth in secondary cities or municipalities from 1990–2020. However, the average percent change is relatively low at −2%. The provinces which experienced an increase in the q-coefficient include Mountain Province (59%), Kalinga (38%), Cavite (36%), Biliran (35%), and Sorsogon (23%). On the other hand, provinces with the

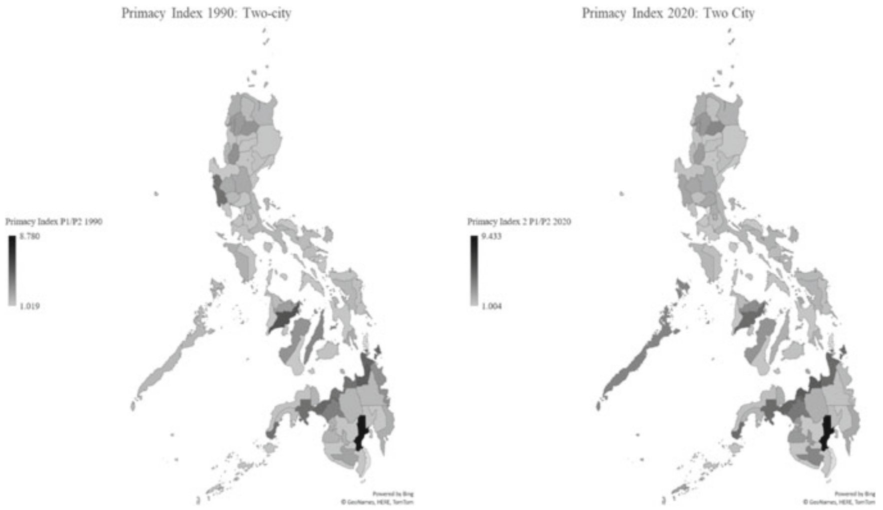

Fig. 8.2 Evolution of primacy index: Two-city. *Source* Author's own construction

highest decline in q-coefficient include Basilan (−88%), Maguindanao (−84%), Davao Del Norte (−76%), Ifugao (−74%), and North Cotabato (−55%). The three provinces of Basilan, Maguindanao, and Tawi-tawi are part of the Bangsamoro Autonomous Region in Muslim Mindanao(BARMM), which experienced a series of reorganizations in cities and municipalities (Figs. 8.3 and 8.4).

The assessment of the city system index (CSI) indicates almost a change from 1990–2020 with only an average percent change of −1%. This suggests that the cities or municipalities have maintained their population size and retain their rank

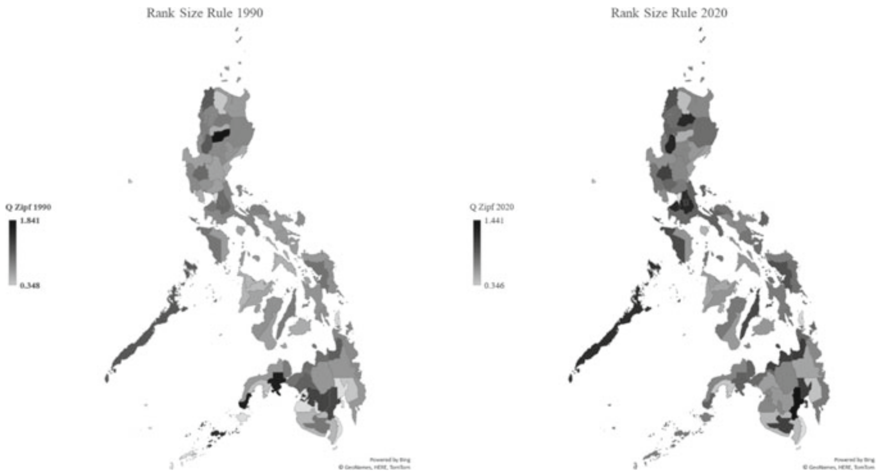

Fig. 8.3 Evolution of rank-size-rule. *Source* Author's own construction

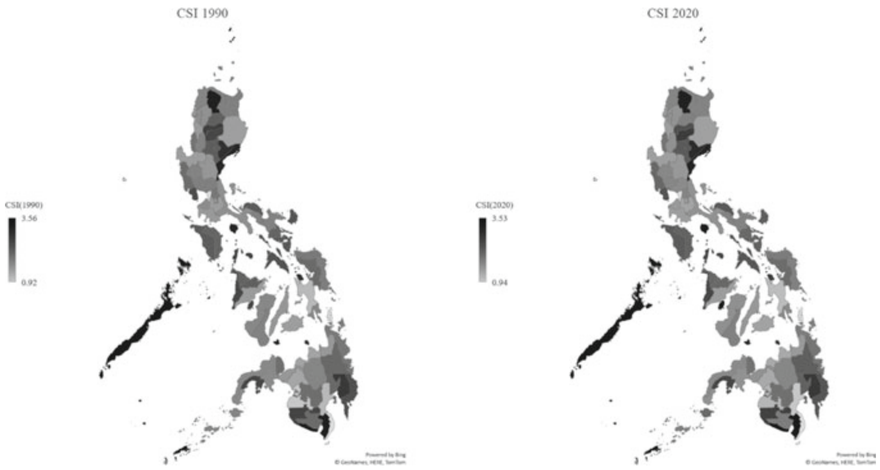

Fig. 8.4 Evolution of city system index. *Source* Author's own construction

in the system. The primary cities have remained big, while small cities or municipalities have not expanded significantly. The provinces with the biggest decline in CSI which means the city system is becoming more concentrated include Kalinga (−19%), Davao del Sur (−14%), South Cotabato (−11%), Mountain Province (−9%), Benguet (−9%), and Cavite (−9%). On the other hand, provinces with increasing CSI or provinces which are becoming more dispersed include Guimaras (38%), Maguindanao (25%), Metropolitan Manila (25%), and Basilan (20%) (Table 8.3).

8.4.4 Relationship Between City System and Socio-Economic Index

A simple correlation analysis is conducted to check the relationship between CSI and specific socio-economic indicators. The correlation values can range from 1 (perfectly positive linear relationship) to −1 (perfectly negative relationship). As expected, most indicators have a significant negative relationship with CSI. According to the findings, provinces with low CSI or a dense urbanization pattern are more likely to have excellent socioeconomic conditions. Provinces with a higher CSI or a more dispersed city system, on the other hand, tend to have adverse socioeconomic conditions (Table 8.4).

As compared to the earlier studies, the result of this study is similar to the case of Sweden and Germany where the city system index is negatively correlated with indicators such as GDP per capita, number of factories, number of full-time and part-time workers, and number of doctors. On the other hand, in the case of Japan, the overall social health estimate has a positive relationship with the city system.

Table 8.3 Highest and lowest change

Primacy index 1		Primacy index 2		Rank-size rule		CSI	
Province	Primacy 1% change (%)	Province	Primacy 2% change (%)	Province	Rank-size % change (%)	Province	CSI %change (%)
Concentration							
Bulacan	86	Palawan	126	Mountain Province	59	Kalinga	−19
Tawi-Tawi	59	Tawi-Tawi	120	Kalinga	38	Davao del Sur	−14
Sorsogon	48	Bulacan	98	Cavite	36	South Cotabato	−11
Palawan	41	Batanes	83	Biliran	35	Mountain Province	−9
Batanes	33	Maguindanao	58	Sorsogon	23	Benguet	−9
South Cotabato	31	Sorsogon	58	Laguna	22	Cavite	−9
Maguindanao	29	South Cotabato	55	Rizal	21	Rizal	−8
Biliran	28	Metropolitan Manila	54	Pampanga	21	Biliran	−8
Bohol	27	Biliran	42	Bataan	21	Batanes	−8
Kalinga	26	Northern Samar	33	Masbate	20	Bulacan	−7
Province	Primacy %Change	Province	%Change	Province	Rank-Size %Change	Province	CSI %change
Dispersion							
Surigao del Sur	−39	Surigao del Sur	−47	Basilan	−88	Guimaras	38
Guimaras	−28	Zambales	−44	Maguindanao	−84	Maguindanao	25
Agusan del Sur	−21	Cebu	−43	Davao del Norte	−76	Metropolitan Manila	25
Cebu	−19	Agusan del Sur	−19	Ifugao	−75	Basilan	20

(continued)

Table 8.3 (continued)

Primacy index 1		Primacy index 2		Rank-size rule		CSI	
Province	Primacy 1% change (%)	Province	Primacy 2% change (%)	Province	Rank-size % change (%)	Province	CSI %change (%)
Zambales	−17	Marinduque	−19	Tawi-Tawi	−74	Marinduque	6
Marinduque	−16	Mountain Province	−14	North Cotabato	−55	Agusan del Sur	6
Lanao del Norte	−9	Iloilo	−13	Sulu	−49	Ifugao	6
Sarangani	−8	Pampanga	−13	Lanao del Sur	−49	Davao del Norte	5
Nueva Vizcaya	−7	Occidental Mindoro	−12	Zamboanga del Sur	−48	Lanao del Norte	4
Aurora	−6	North Cotabato	−11	Marinduque	−26	Sulu	4

Source Author's own construction

Table 8.4 Correlation of city system index and socio-economic index

Variables	Correlations
Income (family)	−0.135
Expenditure (Family)	−0.104
% of Working population	−0.179*
Poverty rate	−0.051
Unemployment rate	0.217**
Gini index	0.024
Number of degree holders	−0.436**
School years (mean)	−0.183*
School years (expected)	0.111
Provincial income	−0.419**
IRA Allotment	−0.477**
Social services (SS) expenditure	−0.443**
% of SS to total expenditure	−0.128
Life expectancy	−0.303**
Number of health workers	−0.503**
Family with sanitary toilet	−0.510**
Family with safe water access	−0.509**
Length of national roads	−0.429**
Length of bridges	−0.423**

**$p < 0.01$ level (2-tailed), * $p < 0.05$ level (2-tailed)
Source Author's own construction

This variation in the result is expected due to possible differences in country-specific conditions.

Based on the relationship between SEI and CSI, there are four distinct types of provinces than can be identified (Figs. 8.5 and 8.6). Type 1 Provinces: High SEI, Low CSI, or provinces with the good socio-economic condition but highly concentrated city system. Type 2 Provinces: High SEI, High CSI, or provinces with good socio-economic condition but relatively dispersed city system. Type 3 Provinces: Low SEI, High CSI, or provinces with inferior socio-economic conditions but dispersed city system. Type 4: Low SEI, Low CSI, or provinces with poor socio-economic conditions but highly concentrated city systems. Various policy suggestions might be offered based on the type of the province. High or low index category is distinguished based on the average. An index value higher than average is classified as high, index value lower than average is categorized as low.

For the Type 1 provinces, there are two subgroups that can be identified. The first subgroup is the provinces located adjacent to Metro Manila such as Batangas, Cavite, Rizal, and Laguna. The second subgroup is the provinces that have metropolitan areas such as Cebu, Davao, Iloilo, Negros Occidental, and Pangasinan. For Type 1

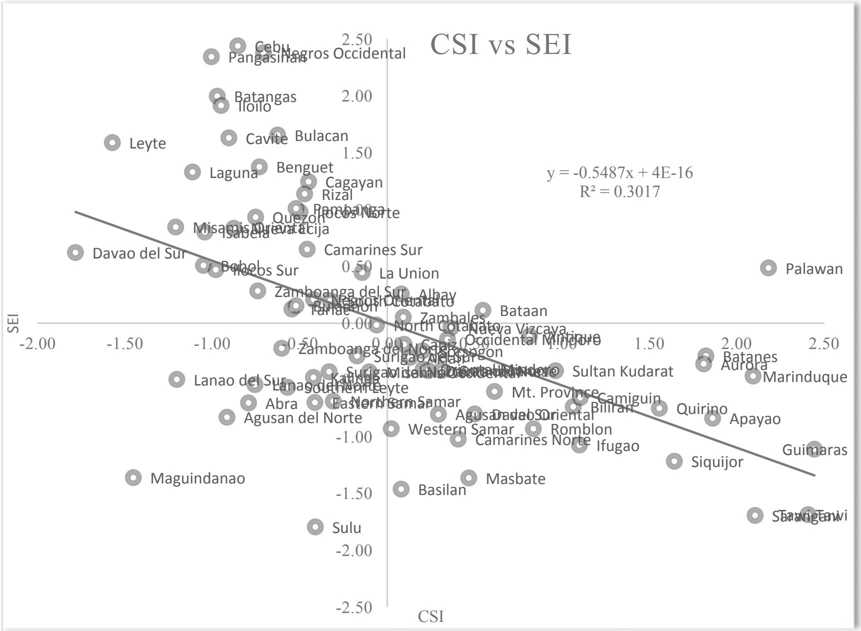

Fig. 8.5 Relationship between city system index and socio-economic index. *Source* Author's own construction

provinces, policies that can sustain economic density and manage possible congestion problems should be promoted. Type 1 provinces can also be considered as good alternative locations and hold potential to absorb economic activities or investments that might be driven out from the capital. The Philippines government has already taken into consideration the development of these secondary centers and has implemented policy measures. The Digital Cities Program, a public and private sector effort which aims to develop second and third-tier cities to host IT-BPO investments. With regard to the metropolitan areas, there is no established metropolitan governance system except for the Metro Manila Development Authority (MMDA). Provinces with metropolitan areas should also consider establishing an intergovernmental network that would facilitate planning and management (Ortega et. al., 2015).

There are very few provinces that can be categorized as Type 2 provinces: Albay, Bataan, Palawan, and Zambales. For type 2 provinces, policies that can maintain good socio-economic conditions or expand economic density or functions through a network should be encouraged. Following the logic of city network theory, these provinces have the potential to "borrow size" in which they can perform functions traditionally carried out by large and dense provinces if they are linked to other provinces. Connectivity to other provinces can be enhanced mainly through infrastructure development or intergovernmental cooperation.

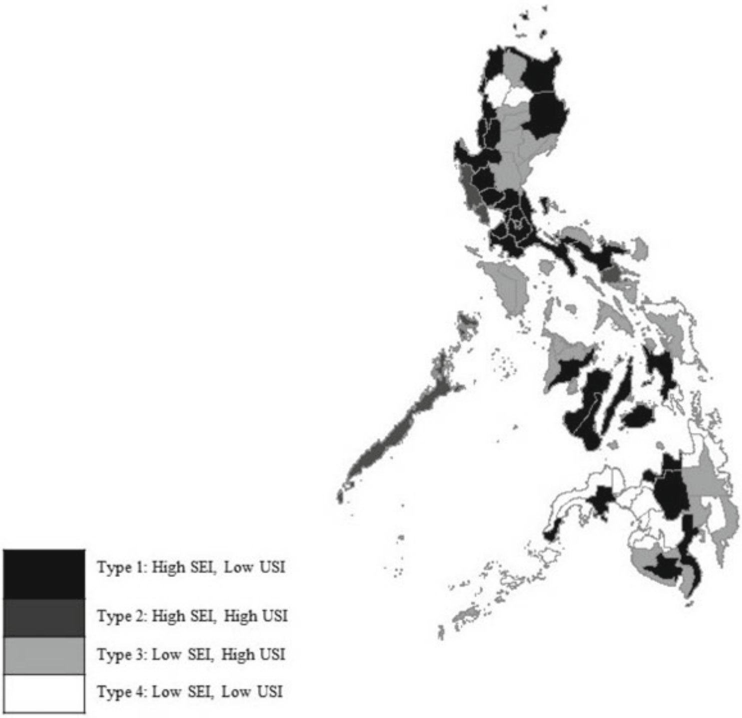

Fig. 8.6 Types of provinces

For type 3 provinces, there are two distinct subgroups that can be identified under type 3 category: island provinces such as Masbate, Sarangani, Tawi-tawi, Siquijor, and Guimaras; and landlocked provinces such as Apayao, Ifugao, and Mt. Province. Most of the provinces under this category are also often found at the bottom of the ranking in some socio-economic indicators. For type 3 provinces, policies that can create economic mass and overcome geographical distance should be promoted. The policy framework of the World Development Report 2009 for lagging areas is applicable to this category. Based on the framework, these provinces should prioritize "spatially-blind" policies such as effective land market, education and health programs, safe water, and sanitation. In the case of the Philippines, the provision of several basic social services is devolved to local government such as health, education, local infrastructure, and environmental management. However, there is an apparent mismatch between the cost of devolved functions and the availability of resource funding, thus further posing development hurdles for type 3 provinces. In particular, provinces were assigned with 37 percent of the cost but were given only 23 percent of the IRA; municipalities 38.5 percent of the total cost and 34 percent of IRA share, cities, 5.7 of the total cost and 23 percent of IRA share (Manasan, 2007).

There are various proposals that call for the re-evaluation of IRA to reflect a more equitable intergovernmental transfer.

Type 4 provinces have unfavorable socio-economic conditions but a highly concentrated urban system. The majority of the provinces are in Mindanao: Basilan, Maguindanao, Lanao del Sur, Agusan del Note, and Sulu. With the exception of Agusan del Norte, all of these provinces are located in Bangsamoro Autonomous Region in Muslim Mindanao (BARMM). BARMM is the only autonomous region in the country, however, prolonged period of conflicts poses significant development challenges. Similar to type 3 provinces, many of these provinces have consistently fare poorly in several socio-economic indicators. For type 4 provinces, policies that can improve the socio-economic condition and manage density and congestion should be prioritized. The WDR 2009 policy framework for densely populated lagging areas is useful for this category. The policy framework recommends spatially blind institutions such as basic social services and spatially-connective infrastructure such as infrastructure and information and communication services.

8.4.5 Summary and Conclusion

This study shows the structure of the urban system in provinces from 1990–2020 using different techniques. The evaluation of the share of the largest city to the total population of the provinces from 1990–2020 reveals an increasing trend with an average increase in the share of the largest city of 9%. The analysis of primacy index 2 or the ratio of the biggest city to the second biggest city from 1990–2020 also shows an increasing dominance of the largest city with an average increase 12%. Meanwhile, the examination of the rank-size rule distribution suggests growth in secondary cities or municipalities from 1990–2020 but the average percent change is relatively low at −2%. The assessment of the city system index (CSI) indicates almost a change from 1990–2020 with only an average percent change of −1%.

This study also establishes the link between the city system and socio-economic conditions. Provinces with a city system in which the population and cities are concentrated tend to have better socio-economic conditions. While provinces with an urban system in which population and cities are dispersed are likely to have an inferior socio-economic condition. This study also outlines policy recommendations based on the relationship between the urban system and socio-economic conditions.

Given the limitation of the current study, future tasks and research areas can be identified. First, this study only employs data from the 1990s-2020, longer time frame can be considered to better capture the transformation in both the urban system and socio-economic conditions. Second, this study provides a description the structure of the city system in the Philippines, however, it would be noteworthy to conduct a study which examines the possible determinants of the city system structure. Third, this study focuses on only one country, a comparative study between or among countries can also be carried out. For example, a comparative study between countries that share some similarities, like the island nations of the Philippines and Indonesia.

Fourth, the link between the urban system and resiliency can also be explored. The study of resiliency is a relevant topic, particularly in the context of an island nation like the Philippines, which are highly susceptible to natural calamities. And lastly, the dynamics between the city system and economic zones can also be examined. Economic zones are often as a regional development tool in many countries and have implications on the structure of the urban system.

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Chapter 9
Roles of Education in Expenditure Inequality between Urban and Rural Areas: Indonesia, the Philippines, and India

Mitsuhiro Hayashi

Abstract This study selects Indonesia, the Philippines, and India among Asian developing countries and, based on household survey data, examines the determinants of urban–rural disparities in per capita consumption expenditure in these three countries, with a focus on education, using the Blinder–Oaxaca decomposition method. In both Indonesia and India, inequality in per capita consumption expenditure, as measured by the Theil index, tended to expand during the observation period. In the Philippines, inequality in per capita expenditure improved over the period, although the level of inequality still remains high. The share of inequality between urban and rural areas is relatively lower than that of inequality within urban and rural areas, due to the use of the conventional Theil decomposition method. However, the gaps between urban and rural areas are not small enough for their impact to be ignored, when using Elbers' alternative decomposition approach as a supplementary tool for the conventional Theil decomposition method. This study therefore attempts to decompose the differences in mean per capita consumption expenditure between urban and rural areas into several household features, including education, using the Blinder–Oaxaca decomposition method. As a result, in Indonesia, the Philippines, and India, differences in educational endowments appear to have been a key determinant of urban–rural disparity, accounting for approximately 30–60% of the urban–rural expenditure gap. In addition, differences in job sectors (agricultural sector *vs* non-agricultural sector) also contribute to the expenditure gap, albeit to a lesser extent.

Keywords Expenditure inequality between urban and rural areas · Roles of education · Blinder–Oaxaca decomposition method · Indonesia · The Philippines · India

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9.1 Introduction

Studies on inequality in developing countries have actively been conducted by the World Bank, the Asian Development Bank (ADB), and the United Nations University-World Institute for Development Economics Research (UNU-WIDER); the studies published include that of the World Bank (2005), Ravallion (2016), ADB (2012), Zhuang (2010), and Kanbur and Venables (2005). Most of these studies analyzed inequality in developing economies, based on either cross-country data or aggregate data, which are easy to obtain and process.

However, there are only a limited number of studies on spatial inequality in a certain country—with a focus on location groups (e.g., urban and rural areas)—using time series and nationwide household survey data, which are not easy to obtain and process. Among them are Yusuf et al. (2014), Balisacan and Fuwa (2004), Cain et al. (2008), and Gustafsson et al. (2008).

As distinguished development economists such as Lewis (1954), Harris and Todaro (1970), and Kuznets (1955) pointed out, as the social and economic inequalities observed between urban and rural areas have been very large, it may be a critical challenge for developing countries to solve this problem, from the perspective of ensuring fairness across population groups. ADB (2012) emphasizes that the widening income disparity between urban and rural areas in Asian countries in recent years should be addressed directly. However, even though spatial inequality is such an important issue, this field has not been much studied until recently, due to types of data and/or decomposition methods.

Considering this gap in the research, the current study aims to investigate the spatial socio-economic inequalities in developing countries. This study selects Indonesia, the Philippines, and India as its research target countries, based on the following criteria: (1) these countries each have a large population size, which is helpful for the effective use of research results; (2) these countries have adequate spatial expanses, considering that this is suitable for a spatial analysis; and (3) there is the availability of household survey data, which makes the execution of the study possible. Using time series and nationwide household survey data of these three countries, the study focuses on inequality between urban and rural areas and examines the role of education in urban–rural disparity, with reference to my previous studies such as Hayashi et al. (2014, 2015), and Hayashi and Kalirajan (2018).

Indonesia, the Philippines, and India have achieved steady economic development, with an average annual growth rate—in real GDP per capita—of 3.8%, 2.8%, and 5.1%, respectively, for 2000–2010, despite the outbreak of the Lehman shock. Among Asian countries, Indonesia, the Philippines, and India are large countries, with their populations being approximately 240 million, 94 million, and 1.2 billion, respectively, in 2010.

This study attempts to clarify how much influence education has had on the urban–rural gap in consumption expenditure in each of the above three countries. Specifically, the Blinder–Oaxaca decomposition method is adopted to analyze the impact of various household characteristics—such as the number of family members, gender, age, education, and production sector—on inequality between urban and rural areas, in terms of per capita household consumption expenditure, using nationwide household survey data in the three countries at two-time points.

The remainder of this study is organized as follows. Section 9.2 describes the data and methods used in this study, while Sect. 9.3 gives an overview of urban–rural disparity in Indonesia, the Philippines, and Indonesia. In Sect. 9.4, the role of education in urban–rural inequality is analyzed, using the Blinder–Oaxaca decomposition method. Finally, Sect. 9.5 presents the main findings, along with some policy implications.

9.2 Data and Method

This study explored the determinants of the urban–rural disparity in per capita consumption expenditure in Indonesia, the Philippines, and India, respectively; then, the determinants in those three countries were compared. To accomplish these aims, the study used household survey data of each country, as indicated in Table 9.1, decomposed consumption expenditure data into several determinants, and then compared these determinants.

Considering Indonesia, this study used the *Susenas* (the *Survei Sosial Ekonomi Nasional* or the National Socio–Economic Survey) panel data on expenditure in 2008 and 2010, compiled by the Central Bureau of Statistics in Indonesia (BPS). The *Susenas* panel dataset includes approximately 61,000 households, of which 23,700 are in urban areas and 37,300 are in rural areas. The share of urban households—estimated using sampling weights—was around 47% in 2008, a proportion that remains constant during the study period.[1] To adjust for spatial differences in prices at a point in time and spatial differences in inflation rates, this study converted current price expenditures into expenditures at 2008 constant prices by using current price provincial urban and rural poverty lines in 2008 and 2010.[2]

With regard to the Philippines, we used household data from the Family Income and Expenditure Survey (FIES) in 1997 and 2006, compiled by Philippine Statistics

[1] Sampling weights are used for calculations to adjust overestimation or underestimation of sections of the population.

[2] Cameron (2002) notes that the BPS official figures and most studies in the literature do not control for the regional cost of living differences when calculating inequality figures. According to this work, spatial differences in prices are considered in different official poverty lines used in urban and rural areas by province, although the urban poverty line tends to be inflated, relative to the rural poverty line.

Authority (PSA).[3] The Family Income and Expenditure Survey datasets in those two years include around 38,500–39,600 households, of which 45–60% are in urban areas and 40–55% are in rural areas. To analyze inequality changes in real terms, the study converted current price expenditures into expenditures at 2000 constant prices by using the 2000 consumer price index (CPI) calculated by the PSA.

In the case of India, our study used household consumption expenditure data from the National Sample Survey (NSS), collected and compiled by the National Sample Survey Office (NSSO) under the Indian Ministry of Statistics and Programme Implementation.[4] Specifically, the study used the NSS 55th Round Survey (July 1999–June 2000) and 68th Round Survey (July 2011–June 2012). The NSO datasets in those two rounds include around 102,000 to 120,000 households, of which approximately 40% are in urban areas and 60% are in rural areas. The shares of urban households estimated using sampling weights are roughly 27% in 1999/2000 and 31% in 2011/12.

To adjust for spatial differences in prices at a point in time and spatial differences in inflation rates, the study converted current price expenditures into constant

Table 9.1 Household survey data in Indonesia, The Philippines, and India

	Indonesia	The Philippines	India
Household survey data used in this study	National Socio–Economic Survey (*Susenas*): Panel dataset	Family Income and Expenditure Survey (*FIES*)	National Sample Survey (*NSS*)
Organization responsible for household survey	Statistics Indonesia (BPS)	Philippine Statistics Authority (PSA) (former NSO)	National Sample Survey Office (NSSO)
Years of dataset used in this study	2008 and 2010	1997 and 2006	1999/2000 and 2011/12
Number of households surveyed	Approx. 61,000	Approx. 39,500 (1997)	Approx. 120,000 (1999/2000)
		Approx. 38,500 (2006)	Approx. 102,000 (2011/12)
Share of households (Urban:Rural, %)	Approx. 39:61 (2008, 2010)	Approx. 59:41 (1997)	Approx. 41:59 (1999/2000, 2011/12)
		Approx. 45:55 (2006)	
Deflator and base year	Provincial urban and rural poverty lines	Provincial CPI	Urban and rural poverty lines of each state/union territory
	2008 constant prices	2000 constant prices	2011/12 constant prices

Source Prepared by the author

[3] The Philippine Statistics Authority (PSA) was established in 2013 by integrating the former National Statistics Office (NSO), the National Statistical Coordination Board, Bureau of Agricultural Statistics and Bureau of Labor and Employment Statistic.

[4] As for the history, implementation method and problems of National Sample Survey, see Mukhopadhaya et al. (2011) and Tsujita (2006).

price expenditures by using current price provincial urban and rural poverty lines in 1999/2000 and 2011/12. Based on the poverty line in the urban area of Delhi (National Capital Territory) in 2011/12, per capita household expenditure at 2011/12 constant prices with consideration of spatial differences was calculated and utilized.[5]

To explore the determinants of the urban–rural disparity in mean per capita consumption expenditure, this study used household survey data for the three countries and performed a Blinder–Oaxaca decomposition analysis, which was popularized by Blinder (1973) and Oaxaca (1973).[6]

In the equation below, let Y_U and Y_R be the natural log of per capita expenditure of urban and rural households, respectively. Given the linear regression model,

$$Y_k = \boldsymbol{X}_k{}' \boldsymbol{\beta}_k + e_k \quad E(e_k) = 0 \quad k = U, R$$

where X_k is a vector of explanatory variables, $\boldsymbol{\beta}_k$ includes the parameters associated with $\boldsymbol{X}_k$, and e_k is the error term, which contains unobserved factors. Moreover, we let $\hat{\boldsymbol{\beta}}_k$ be a vector of the least-squares estimates for $\boldsymbol{\beta}_k$ ($k = U, R$), obtained separately from the urban and rural samples, and $\overline{\boldsymbol{X}}_k$ be the estimate for $E(\boldsymbol{X}_k)$. Then, the estimated urban–rural difference in mean per capita expenditure is expressed as a twofold decomposition:

$$\widehat{D} = \overline{Y}_U - \overline{Y}_R = (\overline{\boldsymbol{X}}_U - \overline{\boldsymbol{X}}_R)' \hat{\boldsymbol{\beta}}^* + \left(\overline{\boldsymbol{X}}_U{}' (\hat{\boldsymbol{\beta}}_U - \hat{\boldsymbol{\beta}}^*) + \overline{\boldsymbol{X}}_R{}' (\hat{\boldsymbol{\beta}}^* - \hat{\boldsymbol{\beta}}_R) \right)$$

where $\hat{\boldsymbol{\beta}}^*$ is a vector of the least-squares estimates for the slope parameters and the intercept, obtained from the pooled sample of urban and rural households (Neumark, 1988). The first term in the above equation is the part of the urban–rural difference in mean per capita expenditure that is explained by urban–rural differences in the explanatory variables (endowments or quantity effect), and the second term is the unexplained part. Based on the above equation, we decomposed the differences in mean per capita household expenditure between urban and rural areas into several components, including educational differences.

[5] Poverty lines in 2011/12 were calculated using only Tendulkar methodology, while those in 1999/2000 were calculated using only Lakdawala methodology. However, poverty lines in 2004/05 were calculated using both methodologies. Therefore, based on poverty lines in 2011/12, those in 1999/2000 are adjusted by connecting both series in 2004/05. For details on poverty lines in India, see Planning Commission (2014).

[6] For a comprehensive review of the Blinder–Oaxaca decomposition method and its applications, please see Jann (2008).

9.3 Urban–Rural Disparity in Indonesia, the Philippines, and India: Overview

Tables 9.2, 9.4, and 9.6 present figures on mean monthly per capita household expenditure and the shares of population and expenditure in Indonesia, the Philippines, and India, respectively. The data are presented in terms of urban and rural areas and educational attainment and at two-time points. Tables 9.3, 9.5, and 9.7 report the results of urban–rural decomposition of per capita expenditure inequality by using the Theil T, in each of the three countries and at two-time points.

Table 9.2 indicates that, in Indonesia, the mean expenditure per capita in urban areas is 1.7 times higher than in rural areas. While the majority of the country's population resides in rural areas, urban areas occupy a larger share of expenditure, around 60%. In both urban and rural areas, the mean per capita household expenditure increases as the level of education of the household head rises. However, there is a striking contrast between urban and rural areas in terms of educational attainment levels. The proportion of households of which household heads have received higher education is considerably larger in urban areas than in rural areas. More than 40% of rural households are headed by individuals with no schooling or incomplete primary school education.

Table 9.3 presents the results of the urban–rural decomposition of per capita expenditure inequality in Indonesia. These figures indicate an upward trend in inequality in Indonesia as a whole over the period. Inequality within urban and rural areas is more significant than inequality between urban and rural areas, in terms of both value and contribution, as measured by the Theil T. Urban areas have significantly higher within-group inequality than rural areas.

Clearly, between-area inequality is unremarkable, in comparison with within-area inequality. However, an alternative Theil index decomposition proposed by Elbers et al. (Between-area [B′] in Table 9.3) indicates that observed inequality between the two areas accounts for more than 26% of the maximum attainable between-area inequality, given the current distribution of per capita household expenditures, the relative sizes of urban and rural areas, and their ranking in terms of mean per capita expenditure.[7] This implies that the contribution of urban–rural inequality may be larger than we thought it was when using the conventional Theil decomposition approach.

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[7] Elbers et al. (2008) propose an alternative measurement approach for the contribution of the between-group inequality component. The between-group component depends on the number of groups, the relative sizes of the groups, and the differences in mean per capita expenditures among the groups. Therefore, care should be taken when comparing decomposition results based on different spatial groupings (Shorrocks and Wan, 2005). Even when the same spatial grouping is used, decomposition results would not be comparable if the relative sizes of the groups are different. To rectify the problem, Elbers et al. (2008) suggest that between-group inequality should be assessed against the maximum between-group inequality attainable, given the number and relative sizes of the groups, rather than against the overall inequality that is used in the conventional approach for the contribution of the between-group inequality component.

Table 9.2 Mean per capita household expenditure and shares of population and expenditure by groups: Indonesia

	2008			2010		
	Mean per capita expenditure[a]	Population share (%)	Expenditure share (%)	Mean per capita expenditure[a]	Population share (%)	Expenditure share (%)
Urban and rural areas						
Urban	510,191	47.1	60.3	571,949	47.1	60.5
Rural	298,795	52.9	39.7	331,722	52.9	39.5
Total	398,390	100.0	100.0	444,802	100.0	100.0
Educational attainment in urban and rural areas[b]						
Urban						
No education	330,823	20.5	13.3	372,462	20.5	13.4
Primary	384,322	22.8	17.2	428,090	23.5	17.6
Lower secondary	462,898	15.2	13.7	501,139	15.1	13.2
Upper secondary	585,135	30.3	34.8	663,559	29.9	34.6
Tertiary	956,729	11.2	21.0	1,097,547	11.0	21.2
Total	510,191	100.0	100.0	571,949	100.0	100.0
Rural						
No education	258,143	41.6	36.0	286,206	40.4	34.8
Primary	284,482	33.3	31.7	312,083	34.5	32.5
Lower secondary	328,159	11.5	12.6	365,641	11.5	12.7
Upper secondary	402,351	10.9	14.6	448,411	10.8	14.5
Tertiary	557,075	2.7	5.1	637,377	2.8	5.5
Total	298,795	100.0	100.0	331,722	100.0	100.0

Notes [a]The average monthly per capita household consumption expenditure for each group at 2008 constant prices (Indonesian Rupiah)
[b]Classified based on educational attainment level of household head
Source Calculated based on *Susenas* 2008 and 2010

In the Philippines, as shown in Table 9.4, urban areas have higher mean household expenditure per capita than rural areas, in both 1997 and 2006. These numbers suggest a reduction in urban–rural inequality in mean expenditure per capita during the ten-year period; however, the mean expenditure per capita in urban areas is more than twice as large as in rural areas in 2006. While more than half of the country's population resides in rural areas, urban areas account for around two-thirds of consumption

Table 9.3 Inequality decomposition by urban and rural areas: Indonesia

	2008			2010		
	Theil *T*		Gini	Theil *T*		Gini
	Value	Contribution (%)[a]		Value	Contribution (%)[a]	
Urban and rural areas						
Urban	0.242	57.8	0.361	0.264	60.0	0.377
Rural	0.180	28.3	0.300	0.177	26.3	0.313
Within-area (A)	0.218	86.1		0.230	86.3	
Between-area (B)[b]	0.035	13.9		0.036	13.7	
Total (C) = (A) + (B)	0.253	100.0	0.362	0.266	100.0	0.376
Between-area (B′)[c]	0.035	28.5		0.036	26.8	
Max between-area[d]	0.123	100.0		0.136	100.0	

Notes [a]The percentage contribution of each inequality component to overall inequality
[b]Between-area inequality is assessed by using a conventional approach (see note 7)
[c]Between-area inequality is assessed by using an alternative approach (see note 7)
[d]This is obtained as the maximum between-area inequality attainable, given the numbers and relative sizes of the groups (see text in note 7)
Source Calculated based on *Susenas* 2008 and 2010

expenditure. Mean expenditure per capita increases monotonically with the education attainment of the household heads in both urban and rural areas. However, the educational attainment level of household heads is very different between urban and rural areas. The proportion of households of which the household heads have received higher education is significantly larger in urban areas than in rural areas.

In Table 9.5, it is shown that, over the study period, inequality in terms of mean expenditure per capita in the Philippines has improved, as a whole; however, it still remained at a high level. Inequality within urban and rural areas is more significant than inequality between urban and rural areas, judging from both value and contribution measured by the Theil *T*. Looking within urban and rural areas, urban inequality is considerably higher than rural inequality.

Urban–rural inequality accounts for slightly <20% of overall inequality. When using the alternative Theil index decomposition method, inequality between urban and rural areas can explain around 40% of overall inequality. This suggests that urban–rural inequality in the Philippines is severe.

Table 9.6 illustrates the mean per capita household expenditures and the shares of population and expenditure in India in 1999/2000 and 2011/12. Urban areas have higher mean expenditure per capita than rural areas. The shares of population and expenditure are larger in rural areas than in urban areas. Although the center of the country—in terms of the size and share of population—is still in rural areas, the shares of population and consumption expenditure have been shifting from rural to urban areas over the period. This implies the advancement of dynamic urbanization and the expansion of inequality between urban and rural areas in India.

Table 9.4 Mean per capita household expenditure and shares of population and expenditure by groups: The Philippines

	1997			2006		
	Mean per capita expenditure[a]	Population share (%)	Expenditure share (%)	Mean per capita expenditure[a]	Population share (%)	Expenditure share (%)
Urban and rural areas						
Urban	31,248	47.6	67.9	48,535	49.6	67.8
Rural	13,417	52.4	32.1	22,633	50.4	32.2
Total	21,898	100.0	100.0	35,477	100.0	100.0
Educational attainment in urban and rural areas[b]						
Urban						
No education	17,167	15.6	8.6	27,607	14.2	8.0
Primary	19,602	18.5	11.6	30,676	14.1	8.9
Lower secondary	21,170	11.3	7.6	33,836	12.2	8.5
Upper secondary	30,844	39.8	39.3	47,764	43.4	42.8
Tertiary	69,510	14.8	32.9	95,837	16.1	31.8
Total	31,248	100.0	100.0	48,535	100.0	100.0
Rural						
No education	10,736	38.3	30.7	16,510	35.1	25.6
Primary	12,140	27.9	25.2	19,271	23.5	20.1
Lower secondary	12,729	10.8	10.2	20,817	12.5	11.5
Upper secondary	17,243	19.5	25.1	28,079	23.9	29.6
Tertiary	33,620	3.5	8.8	60,158	5.0	13.2
Total	13,417	100.0	100.0	22,633	100.0	100.0

Notes [a]The average monthly per capita household consumption expenditure for each group at 2000 constant prices (Philippine Peso)
[b]Classified based on educational attainment level of household head
Source Calculated based on *FIES* 1997 and 2006

The mean per capita household expenditure increases monotonically with the education of the household heads in both urban and rural areas. However, the mean per capita household expenditure is higher in urban areas than in rural areas, even at the same educational attainment level; this tendency can be clearly seen in groups of higher-educated people. Furthermore, the proportion of households in which household heads have received higher education is considerably larger in urban areas than in rural areas.

Table 9.5 Inequality decomposition by urban and rural areas: The Philippines

	1997			2006		
	Theil T		Gini	Theil T		Gini
	Value	Contribution (%)[a]		Value	Contribution (%)[a]	
Urban and rural areas						
Urban	0.453	65.0	0.456	0.343	59.5	0.427
Rural	0.253	17.2	0.368	0.281	23.1	0.387
Within-area (A)	0.389	82.2		0.323	82.6	
Between-area (B)[b]	0.084	17.8		0.068	17.4	
Total (C) = (A) + (B)	0.473	100.0	0.470	0.391	100.0	0.455
Between-area (B′)[c]	0.084	40.2		0.068	37.5	
Max Between-area[d]	0.209	100.0		0.182	100.0	

Notes [a]The percentage contribution of each inequality component to overall inequality
[b]Between-area inequality is assessed by using a conventional approach (see note 7)
[c]Between-area inequality is assessed by using an alternative approach (see note 7)
[d]This is obtained as the maximum between-area inequality attainable, given the numbers and relative sizes of the groups (see note 7)
Source Calculated based on *FIES* 1997 and 2006

Table 9.7 presents the results of the urban–rural decomposition of per capita expenditure inequality in India in 1999/2000 and 2011/12. These figures show an upward trend of inequality in India as a whole during the period. In India, similar to the other two countries, inequality within urban and rural areas is more salient than inequality between urban and rural areas, in terms of both value and contribution, as measured by the Theil T. Moreover, urban areas have higher within-group inequality than rural areas.

During the observation period, the value of between-area inequality rose to 0.035, and its contribution to total inequality increased to 14%, as measured by the Theil T. In addition, an alternative decomposition measure indicates that inequality between urban and rural areas accounts for nearly a quarter of the maximum attainable between-area inequality in 2011/12. India should therefore address inequality between urban and rural areas urgently.

As described earlier, urban areas have higher mean household expenditures per capita than rural areas in all three countries. While the centers of the three countries in terms of population are still on rural areas, population and consumption expenditure have been flowing into urban areas.

Common in these three countries, in both urban and rural areas, mean per capita household expenditure increased as the level of education attained by household heads rose. However, mean per capita household expenditure was shown to be higher in urban areas than in rural areas, even in the same educational attainment level; this tendency becomes clear in the groups of higher-educated people. Additionally, the

Table 9.6 Mean per capita household expenditure and shares of population and expenditure by groups: India

	1999/2000			2011/12		
	Mean per capita expenditure[a]	Population share (%)	Expenditure share (%)	Mean per capita expenditure[a]	Population share (%)	Expenditure share (%)
Urban and rural areas						
Urban	2,236	27.2	36.9	3,205	31.3	43.8
Rural	1,430	72.8	63.1	1,873	68.7	56.2
Total	1,649	100.0	100.0	2,290	100.0	100.0
Educational attainment in urban and rural areas[b]						
Urban						
No education	1,524	31.6	21.6	1,890	23.7	14.0
Primary	1,764	11.6	9.1	2,261	10.8	7.6
Lower secondary	1,897	14.2	12.0	2,469	14.5	11.1
Upper secondary	2,534	26.0	29.5	3,414	30.4	32.4
Tertiary	3,740	16.6	27.8	5,421	20.6	34.9
Total	2,236	100.0	100.0	3,205	100.0	100.0
Rural						
No education	1,271	65.1	57.9	1,610	52.7	45.2
Primary	1,486	11.4	11.8	1,802	13.2	12.7
Lower secondary	1,605	11.1	12.5	1,982	15.1	16.0
Upper secondary	1,946	9.9	13.5	2,390	15.4	19.7
Tertiary	2,456	2.5	4.3	3,292	3.6	6.4
Total	1,430	100.0	100.0	1,873	100.0	100.0

Notes [a]The average monthly per capita household consumption expenditure for each group at 2011/12 constant prices (Indian Rupee)
[b]Classified based on educational attainment level of household head
Source Calculated based on *NSS* 1999/2000 and 2011/12

proportion of households in which household heads had received higher education is larger in urban areas than in rural areas.

As measured by the Theil T, in Indonesia and India, the overall inequality in terms of per capita household expenditure increased between two-time points. In the Philippines, inequality in mean expenditure per capita was slightly reduced, although it still remained at a high level. When using the conventional Theil index decomposition method, the share of inequality between urban and rural areas was shown to be

Table 9.7 Inequality decomposition by urban and rural areas: India

	1999/2000			2011/12		
	Theil *T*		Gini	Theil *T*		Gini
	Value	Contribution (%)[a]		Value	Contribution (%)[a]	
Urban and rural areas						
Urban	0.258	46.4	0.354	0.275	49.0	0.385
Rural	0.139	42.7	0.270	0.162	37.0	0.285
Within-area (A)	0.183	89.1		0.211	86.0	
Between-area (B)[b]	0.022	10.9		0.035	14.0	
Total (C) = (A) + (B)	0.205	100.0	0.317	0.246	100.0	0.351
Between-area (B′)[c]	0.022	19.2		0.035	24.0	
Max Between-area[d]	0.116	100.0		0.143	100.0	

Notes [a]The percentage contribution of each inequality component to overall inequality
[b]Between-area inequality is assessed by using a conventional approach (see note 7)
[c]Between-area inequality is assessed by using an alternative approach (see note 7)
[d]This is obtained as the maximum between-area inequality attainable, given the numbers and relative sizes of the groups (see note 7)
Source Calculated based on *NSS* 1999/2000 and 2011/12

relatively lower than that of inequality within urban and rural areas. However, when using the alternative Theil index decomposition, the share of inequality between urban and rural areas increased substantially in Indonesia, the Philippines, and India.

This suggests that the gaps between urban and rural areas are not necessarily small enough for their impact to be ignored. Our study focuses on and examines the role of educational differences in urban–rural inequality in these three countries.

9.4 Accounting for Urban–Rural Disparity in Indonesia, the Philippines, and India: The Blinder–Oaxaca Decomposition Method

The preceding section provides an overview of the urban–rural inequality in consumption expenditure in each of the three countries. Previous studies on inequality in Asian economies point out that household income or expenditure disparities are generated by unequal access to education.[8] The current section thus analyzes the

[8] Studies that associate inequality with household features, including education are, for example, ADB (2007, 2012), and OECD (2011).

degree of impact of various household characteristics, including differences in educational attainment on urban–rural inequality in per capita consumption expenditure, using the Blinder–Oaxaca decomposition method.

Specifically, we decomposed differences in mean per capita household expenditure between urban and rural areas into the following common components of household features, as the determinants of the urban–rural inequality in each of the three countries:

(i) household size;
(ii) gender of household head (female = 0; male = 1);
(iii) age of household head;
(iv) squared age of household head;
(v) years of education of household head; and
(vi) job sector of household head (agriculture/mining = 0; non-agriculture/mining = 1).

Note that variable (v), the number of years of education, is calculated according to the following, in each of the three countries.

In Indonesia, household heads' years of education are calculated as (1) no schooling (0 years); (2) incomplete primary school (3 years); (3) general and Islamic primary schools (6 years); (4) general and Islamic junior high schools (9 years); (5) general, Islamic, and vocational senior high schools (12 years); (6) diploma I and II (13 years); (7) diploma III (15 years); (8) diploma IV (bachelor's degree) (16 years); and (9) master's or doctoral degree (18 years).

In case of the Philippines, the length of education is calculated as (1) no schooling (0 years); (2) incomplete elementary education (3 years); (3) elementary education (6 years); (4) incomplete secondary education (8 years); (5) secondary education (10 years); (6) incomplete tertiary education (12 years); and (7) tertiary education including postgraduate education (14 years).

As for India, based on Cain et al. (2008), the number of years of education is calculated in the following way: (1) illiterate (0 years); (2) literate through non-formal schooling (i.e., NFEC [Non-formal Education Courses], ALC [Adult Literacy Centers], EGS [Education Guarantee Scheme], TLC [Total Literacy Campaign], and [other]) (1 year); (3) literate, but incomplete primary education (3 years); (4) primary education (5 years); (5) middle schools/lower secondary education (8 years); (6) secondary education (10 years); (7) higher secondary education (12 years); (8) diploma/certificate courses (12 years); (9) undergraduate education (15 years); and (10) postgraduate education (17 years). For details on the education system in India, refer to National Sample Survey Office (2015).

Tables 9.8, 9.9, and 9.10 indicate the results of the Blinder–Oaxaca decomposition of urban–rural differences in mean per capita expenditure in Indonesia, the Philippines, and India, respectively, at two-time points.

Table 9.8 shows that, in Indonesia, the mean of the natural log of per capita expenditure in 2008 is 12.973 for urban households and 12.482 for rural households,

Table 9.8 Blinder–Oaxaca decomposition of urban–rural differences in Mean per capita household consumption expenditure: Indonesia[a]

	2008			2010		
	Coefficient	Standard errors	Contribution (%)[b]	Coefficient	Standard errors	Contribution (%)[b]
Prediction (urban)	12.973	0.004		13.071	0.004	
Prediction (rural)	12.482	0.003		12.574	0.003	
Difference (urban–rural)	0.492	0.005	100.0	0.496	0.005	100.0
Explained	0.226	0.003	46.0	0.239	0.004	48.2
Household size	−0.008	0.001	−1.7	−0.012	0.001	−2.4
Gender of household head	0.000	0.000	0.0	0.000	0.000	0.0
Age of household head	−0.017	0.003	−3.5	−0.007	0.003	−1.4
Square of age of household head	0.015	0.002	3.0	0.008	0.003	1.6
Years of education of household head	0.175	0.003	35.5	0.181	0.003	36.5
Household job sector (agriculture vs. non–agriculture)	0.062	0.002	12.7	0.069	0.002	13.9
Unexplained	0.265	0.005	54.0	0.257	0.005	51.8

Notes [a]The Blinder–Oaxaca decomposition technique used here is a twofold decomposition method
[b]The percentage contribution of each factor to the urban–rural expenditure gap
Source Calculated based on *Susenas* 2008 and 2010

yielding an urban–rural expenditure gap of 0.492. The same figures for 2010 are almost at the same level. The Blinder–Oaxaca decomposition method can divide this expenditure gap into two parts. The first part—that is, the explained part (endowments or quantity effect)—reflects the increase in mean per capita expenditure if rural households had the same endowments as urban households, assuming that urban and rural households have the same coefficients, obtained from the pooled sample of urban and rural households. The second part is a residual or unexplained part that captures all potential effects of differences in unobserved variables. In the table, the increases of 0.226 in 2008 and 0.239 in 2010 indicate that differences in endowments

Table 9.9 Blinder–oaxaca decomposition of urban–rural differences in Mean per capita household consumption expenditure: The Philippines[a]

	1997			2006		
	Coefficient	Standard errors	Contribution (%)[b]	Coefficient	Standard errors	Contribution (%)[b]
Prediction (urban)	9.896	0.005		10.445	0.006	
Prediction (rural)	9.278	0.005		9.768	0.004	
Difference (urban–rural)	0.617	0.007	100.0	0.676	0.007	100.0
Explained	0.341	0.005	55.2	0.322	0.005	47.6
Household size	0.003	0.002	0.5	0.008	0.003	1.2
Gender of household head	0.003	0.001	0.4	0.005	0.001	0.7
Age of household head	0.000	0.005	0.0	−0.014	0.003	−2.1
Square of age of household head	0.002	0.003	0.3	0.009	0.002	1.3
Years of education of household head	0.201	0.004	32.6	0.206	0.004	30.4
Household job sector (agriculture vs. non–agriculture)	0.132	0.003	21.4	0.109	0.003	16.1
Unexplained	0.276	0.007	44.8	0.354	0.006	52.4

Notes [a]The Blinder–Oaxaca decomposition technique used here is a twofold decomposition method
[b]The percentage contribution of each factor to the urban–rural expenditure gap
Source Calculated based on *FIES* 1997 and 2006

(household size, gender, age, education, and job sector) as a whole account for 46% and 48%, respectively, of the urban–rural expenditure gap.[9]

[9] The estimated urban–rural difference in mean per capita expenditure can also be decomposed into the three terms, as follows (threefold decomposition):

$$\widehat{D} = \overline{Y}_U - \overline{Y}_R = (\overline{\boldsymbol{X}}_U - \overline{\boldsymbol{X}}_R)'\hat{\boldsymbol{\beta}}_R + \overline{\boldsymbol{X}}_R{}'(\hat{\boldsymbol{\beta}}_U - \hat{\boldsymbol{\beta}}_R) + (\overline{\boldsymbol{X}}_U - \overline{\boldsymbol{X}}_R)'(\hat{\boldsymbol{\beta}}_U - \hat{\boldsymbol{\beta}}_R) \text{ or}$$
$$\widehat{D} = \overline{Y}_U - \overline{Y}_R = (\overline{\boldsymbol{X}}_U - \overline{\boldsymbol{X}}_R)'\hat{\boldsymbol{\beta}}_U + \overline{\boldsymbol{X}}_U{}'(\hat{\boldsymbol{\beta}}_U - \hat{\boldsymbol{\beta}}_R) + (\overline{\boldsymbol{X}}_U - \overline{\boldsymbol{X}}_R)'(\hat{\boldsymbol{\beta}}_U - \hat{\boldsymbol{\beta}}_R)$$

The first term reflects the mean increase in rural households' per capita expenditures if they had the same characteristics as urban households (endowments effect), while the second term represents the increase in rural households' per capita expenditures when applying the urban households' coefficients to the rural households' characteristics. The third component is the interaction term. Differences in endowments as a whole account for 37% of the urban–rural expenditure gap, while differences in coefficients account for 39%, in 2008. As shown in the results, based on the twofold

Table 9.10 Blinder–Oaxaca decomposition of urban–rural differences in Mean per capita household consumption expenditure: India[a]

	1999/2000			2011/12		
	Coefficient	Standard errors	Contribution (%)[b]	Coefficient	Standard errors	Contribution (%)[b]
Prediction (urban)	7.535	0.003		7.748	0.003	
Prediction (rural)	7.203	0.002		7.508	0.002	
Difference (urban–rural)	0.332	0.003	100.0	0.240	0.004	100.0
Explained	0.262	0.003	79.0	0.164	0.002	68.4
Household size	0.042	0.001	12.5	0.044	0.001	18.3
Gender of household head	0.000	0.000	0.1	0.001	0.000	0.3
Age of household head	−0.010	0.001	−3.1	−0.008	0.001	−3.1
Square of age of household head	0.001	0.001	0.3	0.000	0.001	0.1
Years of education of household head	0.195	0.002	58.6	0.128	0.002	53.6
Household job sector (agriculture vs. non–agriculture)	0.035	0.002	10.6	−0.002	0.001	−0.8
Unexplained	0.070	0.003	21.0	0.076	0.003	31.6

Note [a]The Blinder–Oaxaca decomposition technique used here is a twofold decomposition method
[b]The percentage contribution of each factor to the urban–rural expenditure gap
Source Calculated based on *NSS* 1999/2000 and 2011/12

In the explained part, the components related to household size, gender, and age have only a marginal effect. The most significant component is education, followed by the job sector component. Educational attainment differences measured by the length of education of the household head are the largest contributor to differences in mean per capita expenditure between urban and rural areas. This education component accounts for approximately 36% of the urban–rural expenditure gap. Differences in the job sector also explain 13–14% of the gap. Non-agricultural jobs or off-farm opportunities in rural areas would have an effect on reducing the gap between urban and rural areas. This result suggests that urban–rural disparity is largely associated with educational attainments and job sectors.

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decomposition, differences in educational attainment and job type play an important role in the urban–rural expenditure gap. In the cases of the Philippines and India, similar results are obtained when using the threefold decomposition.

Table 9.9 exhibits the results of the decomposition of urban–rural differences in mean per capita household expenditure in the Philippines. The mean of the natural log of per capita expenditure in 1997 is 9.896 for urban households and 9.278 for rural households, yielding an urban–rural expenditure gap of 0.617. These levels in 2006 are not much different from those in 1997. The increases of 0.341 in 1997 and 0.322 in 2006 show that differences in endowments (household size, gender, age, education, and job sector) as a whole account for 55% and 48%, respectively, of the urban–rural expenditure gap.

In the Philippines, similar to Indonesia, the components associated with household size, gender, and age do not play a prominent role in the explained part. Most noticeable is the education attainment component, followed by the job sector component. Educational differences have the largest influence on differences in mean per capita household expenditure between urban and rural areas. This education attainment component accounts for approximately 30–33% of the urban–rural expenditure gap. Differences in the job sector also explain around 16–21% of the gap. This result implies that educational attainments and job sectors have a large impact on urban–rural disparity in the Philippines.

According to Table 9.10, the mean of the natural log of per capita expenditure in India in 1999/2000 is 7.535 for urban households and 7.203 for rural households; these yield an urban–rural expenditure gap of 0.332. Likewise, those in 2011/12 are 7.748 for urban households and 7.508 for rural households, yielding an urban–rural expenditure gap of 0.240. The increases of 0.262 in 1999/2000 and 0.164 in 2011/12 demonstrate that differences in endowments (household size, gender, age, education, and job sector) as a whole account for around 79% and 68%, respectively, of the urban–rural expenditure gap.

In India, while the gender and age components do not play a major role in the explained part, the education component is the most influential. Similar to the other two countries, educational differences are the primary factor of differences in mean per capita expenditure between urban and rural areas. This education component accounts for approximately 54–59% of the urban–rural expenditure gap. Next to the education component, the household size and job sector component have a large effect on urban–rural inequality in India. However, the contribution of the job sector to the urban–rural expenditure gap decreases markedly in 2011/12. This change could also be explained by a recent increase in non-agricultural jobs and off-farm business opportunities in rural areas.

The results of the analyses of the three countries using the Blinder–Oaxaca decomposition method suggest that the household components of educational attainments and job sectors make a large contribution to differences in per capita consumption expenditure between urban and rural areas.

9.5 Conclusions

This study selects Indonesia, the Philippines, and India among Asian developing countries and, based on household survey data, examines the determinants of urban–rural disparities in per capita consumption expenditure in these three countries, with a focus on education, using the Blinder–Oaxaca decomposition method. The results of the analysis and the implications drawn from them are summarized as follows.

Indonesia, the Philippines, and India have achieved steady economic development, with an average annual growth rate in real GDP per capita of 3.8%, 2.8%, and 5.1%, respectively, between 2000 and 2010. Among Asian countries, Indonesia, the Philippines, and India are large countries, with populations in 2010 of approximately 240 million, 94 million, and 1.2 billion, respectively.

In all three countries, urban areas have higher mean per capita consumption expenditure than rural areas. Moreover, the shares of population and consumption expenditure tend to shift from rural to urban areas over the period. Common in all three countries, the mean per capita household consumption expenditure increased monotonically with the education attainment of the household heads in both urban and rural areas. However, the proportion of households of which household heads had received higher education is considerably larger in urban areas than in rural areas.

In both Indonesia and India, inequality in per capita consumption expenditure, as measured by the Theil index, tended to expand during the observation period. In the Philippines, inequality in per capita expenditure improved over the period, although the level of inequality still remains high. The share of inequality between urban and rural areas is relatively lower than that of inequality within urban and rural areas, due to the use of the conventional Theil decomposition method. However, the gaps between urban and rural areas are not small enough for their impact to be ignored. Furthermore, when using Elbers' alternative decomposition approach as a supplementary tool for the conventional Theil decomposition method, the share of inequality between urban and rural areas increased substantially, in all three countries.

This study therefore attempts to decompose the differences in mean per capita consumption expenditure between urban and rural areas into several household features, including education, using the Blinder–Oaxaca decomposition method. As a result, in Indonesia, the Philippines, and India, differences in educational endowments appear to have been a key determinant of urban–rural disparity, accounting for approximately 30–60% of the urban–rural expenditure gap.

In addition, differences in job sectors (agricultural sector vs. non-agricultural sector) also contribute to the expenditure gap, albeit to a lesser extent. As indicated in Tables 9.2, 9.4, and 9.6, in these three countries, while the proportion of households of which the household heads have completed tertiary education is about 10–20% in urban areas, it is merely around 2–5% in rural areas. In rural areas, the share of the population engaged in agriculture—an industry with low productivity and high risks—is large. It can be assumed that the differences between urban and rural areas in terms of access to education and employment opportunities in industries with high productivity and value added would become a major factor, causing the urban–rural disparity in household consumption expenditure.

As countermeasures, it seems that the expansion of education in quantity, improvement in agricultural productivity, and the creation of employment opportunities in non-agricultural sector could contribute to the reduction of urban–rural disparity in per capita consumption expenditure in Indonesia, the Philippines, and India. An important issue would be whether these three countries, in which more than 40% of household heads in rural areas have not received primary education and agriculture sector with low productivity is a key industry, can expand the provision of education services to people in rural areas, create educational opportunities for them through social policy tools—such as a conditional cash transfer program—and enhance their income-earning capacity in either the agricultural or non-agricultural sectors.

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Chapter 10
Examination of Regional Production Activity Using City System and Regional Connection Indexes

Toshiharu Ishikawa

Abstract The agglomeration economy is changing with the progress of the globalized economy. In addition to the place-based economy, the connection economy has exerted its influence on firms' activities. This paper divides the connection economy into the city system economy and the regional connection economy and devises two indexes to indirectly measure their influence. Using these two indexes, the paper classifies 47 prefectures in Japan into four categories and considers the impact of connection economies on regional production activities. This study clarifies the following two points. The 47 prefectures in Japan are arranged with regularity according to the strength of the connection economy. Prefectures that largely enjoy the connection economies have large economic activities and factory scales in their territories becomes smaller. On the other hand, prefectures with low connection economies have larger factory scales in order to enjoy more place-based economies. It can be said as follows. The agglomeration economy continues to have a significant impact on the composition of firms' activity in each region.

10.1 Introduction

Agglomeration economy has had a decisive influence on the locations of the factories since the Industrial Revolution. From around 1900, the influence of agglomeration economy on economic society in general began to be widely recognized

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in the academic realm, and its analysis progressed.[1] Especially, research on the place-based agglomeration economy progressed in detail. Then, as the economic activity became wider and the production activity expanded, the firms' organization of production drastically changed. Along with this trend, the spatial formation of the agglomeration places that is a strong base of the production activities of the firms was also restructured. Also, the contents of the agglomeration economy changed significantly. In addition to the place-based agglomeration economy, the connection economy created by the connection among the agglomeration places has increased its influence on firms' activities. As a result, these days, the city system, which is constructed by the plural agglomeration places, and the connection between the city systems have become to have economic influence and they have provided a kind of economic infrastructure for the firms' activities.

The regional economics has successfully advanced theoretical research on the mechanism by that the connection between the cities influences regional economy. While, the progress of the analysis of the impacts of the connections within a city system and between the city systems on the firms' activities is currently in its infancy stage because the economic effects of these impacts are quite complex. This paper focuses effects of the city system and regional connection on production activity. Using two indexes that may represent the degree of the economic effect of the city system and the regional connection, the analysis tries to examine the effects of these connections on the production activities in the regions. This paper attempts to take the analysis one step further by examining the connection economy that functions in the regional production economy.

10.2 Classification of Agglomeration Economy and Connection Economy

10.2.1 Agglomeration Economy and Connection Economy

A factory enjoys various internal and external economy. These economies interact each other and influence factory's production. Some of the economies are created by the factory itself and by the surrounding districts. Other of the economies come from outside these districts and other regions. These economies are broadly divided into agglomeration economy and connection economy. The former is a place-based agglomeration economy that is sticked to a place and it is classified into mass production economy, large-scale economy, localization economy, and urbanization economy. The latter is generated by relationships between the places, and it is divided to the city system economy and regional connection economy. Let us reexamine the basic contents of the place-based agglomeration economy.

[1] Weber (1909) made the first systematic analysis of agglomeration from a location theory perspective.

10.2.1.1 Mass Production Economy and Large-Scale Economy

Since the mass production economy and the large-scale economy are generated within a factory, they are classified into the internal economy. They are examined in detail in microeconomics. The mass production economy is successfully represented by the average cost reduction by optimizing the production scale of a factory. And the large-scale economy is represented by the reduction of the average cost that results from optimizing the factory size. These internal economies have the locational influence of agglomerating factories' production activity into a certain place.

10.2.1.2 Localization Economy and Urbanization Economy

Localization economy arises from the agglomeration of the same kind of the factories in a certain place. An urbanization economy arises from the agglomeration of different kinds of the factories in place. Both come from outside a factory and they are regarded as an external economy. The essential nature of the localization economy is that spatial concentration of the factories of the same type generates many auxiliary factories and reduces the firms' production costs.

Then, the substantive economy of urbanization arises from a wide variety of production and infrastructure, and its unique economy arises from the availability of a wide variety of labor forces. This economy contributes to reduce the firms' various kinds of costs.

Localization and urbanization economies have the same locational influence as well as the internal economies: They agglomerate the factories and spatially concentrate production activity into a certain place. It should also be noted here that the internal and external economy interact and affect the production activity of a factory. This interaction contributes to create a new form of production activity within an agglomeration, and they lead to the new formation of economic organization in the region.[2] Agglomeration economies have the power to concentrate production activity to factory and region[3].[4]

[2] Changes in the field of corporate economy due to agglomeration are considered by Porter (1998).

[3] The detailed and systematic consideration of the agglomeration economy was started by Weber (1909). Khalili-Muther-Bordenhorn (1974) has shown that the internal economy tends to drive the factories to a market place.

[4] The importance of the socio-economic role of agglomeration-forming regions in the era of global economy extends to the field of technological innovation. Fratesi-Senn (2010) can be helpful in this regard.

10.2.2 City System Economy and Regional Connection Economy

This subsection explains the basic contents of the connection economy. A factory requires the production infrastructure to produce goods. Workers in the factory need living infrastructure to sustain their lives. Thus, agglomeration of the factories is inevitably formed at a place within the city area. As the production activity of the firms expands and sophisticates, it becomes difficult to efficiently perform the firms' production activity within a city. It is more efficient that the factory's production activity are fragmented and fragmented activities are carried out individually by the several cities. This forms economic connection between the cities and this connection provides the firms' production with a kind of external economy. The external economy is different from the place-based agglomeration economy, and this economy arises from the connection between the cities. This economy is named the city system economy in this analysis, and it is defined the economy created by the connection between the cities within a city system in a region.[5]

10.2.2.1 City System Economy

In a region where there is high social homogeneity, the cities are closely related to each other and form interdependence between them through a city system. From the city system the factories may enjoy various kinds of benefits. The city system combined the multiple cities generates high integration in the production activity and forms a labor market. It establishes high accessibility between the factories and forms a high division of labor and complementary relationships between them. These high integrations and various relationships have various positive effects on the factories operating in each city. This analysis considers these positive effects as a city system economy.[6]

Let us use three cases to explain the city system economy. Case 1) Suppose the following situation: there is one city system in a region, and there are three scales of the cities that make up the city system, large, medium, and small. A factory locates at the large city and it enjoys a large-scale economy in the production. Then, if the factory sells its products to the medium and small cities, the factory can enjoy more large-scale economy than the case selling only at the large city. Because this factory sells the goods at low price in the region, it can prevent the existence of the factories with low efficiency and high production cost in the region and it enables to provide the goods at a low price to all consumers in the region. Because the city system in a region has a relatively homogeneous economic environment, it is easy

[5] As shown by the following section, according to the same logic, the regional connection economy is generated by the connection between the regions that contain a city system.

[6] With the globalization of economic activities, studies on the functions of urban system economies have begun. Camagni et al. (2016) advances this consideration by incorporating a dynamic viewpoint.

to establish relationships that facilitate product movement between the cities and achieve an efficient production organization within the city system. This production organization established in the city system is advantageous for the factories located in the large city and the consumers in the region. Case 2) The city system promotes the vertical division of labor by that the factories in each city can utilize a large-scale economy and specialization economy, and the entire manufacturing processes can be done efficiently: If the multiple cities of the same size would individually produce the same kind of product, they cannot sufficiently enjoy a large-scale economy. By performing the vertical division of labor in production processes between the cities that form the city system, the factories in each city can adequately enjoy the large-scale economy. Case 3) There is no firm in the each of small cities that can perform the complex and large-scale financial activity. Therefore, if a small city exists in isolation, the factories in this small city cannot enjoy a high economic function. However, if the small city belongs to the city system, it has a cooperative relationship with a large city, it is possible to smoothly utilize the advanced economic functions in the large city. As a result, the factories in small cities can carry out some large-scale activities. The easy accessibility and the complementary relationships formed by the high degree of integration in a city system provides many benefits to the factories located in the cities forming the city system. In sum, small cities can exert some advanced economic functions through the city system. These benefits are considered a city system economy.

10.2.2.2 Regional Connection Economy

The spatial scope of the factories' activity in the global economy is not limited to a city system but expands to have connections with other city systems in other regions. The connections between the regions create the regional connection economy. By connecting between the regions that are at various distances, the factories can enjoy regional connection economy. Although this regional connection economy is similar to the city system economy, its spatial dimension is broader than the city system, and its economy goes beyond the category of the city system economy.[7]

Let us explain the regional connection economy using the following examples: (1) There is a firm in region manufactures goods. The firm can greatly benefit from a large-scale economy in its factory and it sells its product to promising markets in other regions. When selling products to other regions, the firm considers the transportation distance and time to the targeted region. According to the distribution cost, the firm may open an agent, a sales office, or a branch factory in the targeted region. In addition, if necessary, part of the production process is separated and a branch factory in charge of that process is built in the region. Spatial expansion of the firm's sales activity brings stable securing of a large demand for the products and contributes greatly to the overall firm activity. And this sales organization becomes

[7] The analysis of Meeteren et al. (2016) is also useful for considering the regional connection economy.

to form the strong relationships between the regions. Excellent and stable sales organization provides various benefits with the factories.

(2) When labor wage rates and land costs rise in the region where the firm locates, the firm fragments the production process and disperse some of the processes to local areas or developing countries. These processes are connected by logistic and information connection. Such a production organization greatly reduces the production costs of firms and contributes to the enhancement of the international competitiveness of the firms. And this production organization also contribute to form close economic connection between the regions concerned. By the connection between them the movement of the goods manufactured by the individual firms and the flows of passengers such as diverse engineers and workers begin to grow quite large. With such movements, useful information in other regions acquired by the advanced firms is disseminated to among many firms surrounding the advanced firms, and many relationships are built and deepened between the regions. Stable connections between the regions make a great contribution to both of sales and production activity of the firms.

(3) As various relations between regions deepen, the firm's production activity also progresses. Especially, the horizontal division of labor is progressed: There are differences between the regions in technology and raw materials used in production, these differences enable product differentiation between the regions. And, in particular, the factories can utilize superior production technology developed in other regions in some of the production processes. Compared with the vertical division of labor, the horizontal division of labor requires less close proximity between the production processes, and there are few troublesome in the conducting production even when they are distant from each other. Connections between the regions can create the horizontal division of labor and become a pillar that supports the firms' activity. This further deepens the alliance between the regions.

(4) As the firms' production activity spatially expands to other heterogeneous regions, the firms become to need the support functions to smoothly carry out the production activity. The regions are required by the firms to have professional support functions in the fields of legal, tax, public relations, and consulting. These business service functions are better provided by the companies operating on a global scale that is located in the large cities. Connecting with other regions with the large cities, therefore, the region can provide the firms with superior professional service functions. This situation creates regional connection and it provides a regional connection economy.

The followings are considered as main factors to make up the regional connection economy, securing a large demand for the products, obtaining intermediate goods at low cost, promoting horizontal division of labor, and using excellent professional support functions.

10.2.3 Conceptual Arrangement of Agglomeration Economy and Connection Economy

From a spatial perspective, this subsection describes the agglomeration economy and the connection economy in a unified manner using Fig. 10.1. Economies of mass production and large-scale production are generated within a factory; these economies are closely related at the factory's site that is shown by the center of Fig. 10.1. Localization economy is created in a district where the same kind of factories are spatially concentrated. And urbanization economy is generated in a region where various kinds of the factories are agglomerated. These economies adhere to certain place and region. They are depicted surrounding the center of Fig. 10.1. It is said that economies of mass production and large-scale production, and the economies of localization and urbanization have the property of being close to a place and a territory. They are associated with progressively larger geographical land, from a site to a region.

On the other hand, although the connection economy is based on the places where the production activity is spatially concentrated, it is generated by the collaboration between such the places. The degree of impact of the connection economy depends on the place's capacity that is shown by the number of connections with other places and the degree of collaboration with other places. This connection economy can be divided into the two categories, the city system economy, and the regional connection

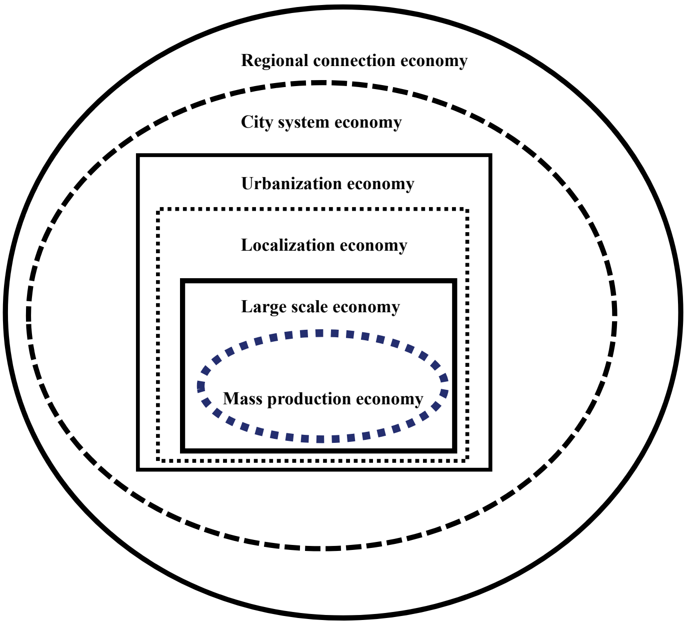

Fig. 10.1 Agglomeration economy and connection economy

economy. The city system economy is mainly created from high accessibility and complementarity among economic agents based on the high economic coherence. This coherence is based on a city system formed in a homogeneous region. While, the regional connection economy is mainly generated by the connection between the heterogeneous regions. It has, thus, a wider spatial range than a region where a city system exists. The regional connection economy is depicted by the outermost circle in Fig. 10.1. Lastly, it should be notified that these agglomerations and the connection economy interact each other and they influence the activity of the factories and the firms.[8]

10.3 Impact of Connection Economy on Production Activity

10.3.1 A Procedure for Analysis of Impact of Connection Economy on Production Activity

Empirical analysis is indispensable for deepening the study of agglomeration and the connection economy. As Weber (1909) suggested, however, empirical analysis of localization and urbanization economies has a lot of difficulties because these economies have strong sociality. The progress of analysis, therefore, has been taking a long time. Naturally, the analysis of the influence of the connection economy on the firms' production is still at the beginning of analysis.[9]

This subsection provides a kind of a clue to proceed the analysis of the influence of the connection economy on the production activity of the firms. To this aim this subsection takes an empirical analysis using data from the 47 prefectures in Japan. The analysis focuses on two kinds of the connection economy, city system economy, and regional connection economy. And this subsection devices the indexes as a proxy that have the potential to represent the influence of these two economies. The proxies are City System Index and Regional Connection Index. These indexes are derived from the economic data of the 47 prefectures in Japan. And, by these two indexes, the 47 prefectures are classified into 4 groups, and characteristics of the production activity of each group are examined.

[8] See Ishikawa (2019) for a theoretical analysis of the relationships between agglomeration economies. From the interrelationships, Porter (1998) provides an interesting insight about innovation created by the firms.

[9] Burger and Meijers (2016) gives a systematic look at city connection externalities.

10.3.2 Derivation of City System Index

The City System Index CSI is used as a proxy to reveal the effect level of the city system economy on production activity in a region (Ishikawa, 2016). This index is derived from two viewpoints as follows. One viewpoint is concerned with cities' population distribution within a city system. In order to describe the divergence of the cities' population distribution toward the primary city of the city system, the coefficient of the divergence CD was shown by Sheppard (1982). This coefficient is utilized to build half part of the City System Index. Let us obtain the coefficient of the divergence CD.

Suppose that there are N cities in a region, and p denotes the population share of a city for all cities' population within a city system. The value of CD obtained by Eq. (10.1) is considered as the coefficient of divergence of cities' population distribution to the largest city in a city system,

$$CD = (1/N) \sum_{x=1}^{N} p_x L_N (r) \tag{10.1}$$

where r is the rank of a city by population share order, and it is converted into a logarithmic value. CD is utilized as an index that indicates characteristic of the distribution of cities' population. As the divergence the distribution of the cities' population toward the largest city of the city system becomes larger, the value of CD lowers.

The second viewpoint is concerned with the location pattern of the cities within a city system. A city system's character can be captured by the location pattern of the cities. It offers a concept of the spatial convergence of the cities' locations within a city system. The spatial convergence of the cities' locations SC, within a city system is obtained by using Poisson distribution. The SC is used to build the other half part of the CSI. Assume that there are N_i (i = 1, 2, 3…N) cities in a region of which the land area is M. The distance from a city N_1 to the nearest city is denoted as d_1. This distance is named as the least distance of the city N_1. The least distance is obtained for each of the cities N_i (i = 1, 2, 3…N), and the average least distance AD of the cities is derived as Eq. (10.2).

$$AD = (1/N) \sum_{i=1}^{N} d_i \tag{10.2}$$

The spatial convergence of cities distribution within a city system in a region SC is expressed by Eq. (10.3),

$$SC = AD/(1/2(N/M)^{0.5})) \tag{10.3}$$

As the cities locate more closely each other, SC becomes smaller. The SC's value is used to specify a spatial characteristic of the city system.

The values of both CD and SC become smaller as the divergence of the distribution of cities' population to the largest city progresses and the spatial convergence of the cities distribution is higher. Hence, combining these two values, an index is built to reveal characteristic of a city system, City System Index CSI is derived by Eq. (10.4).

$$CSI\ ((\alpha\, CD)^2 + (\beta\, SC)^2)^{0.5} \tag{10.4}$$

where α and β are positive parameters. As mentioned above, the low value of CSI means that the structure of the city system has concentrating characteristics in terms of the cities' population distribution and the location of the cities. While, the high value of the CSI means that the structure of the city system has leveling characteristics. CSI can be used as an index that indicates the characteristics of the city system in the region.

Let us concretely obtain the values of the City System Index CSI based on data on the population and location of the cities in each of the 47 prefectures in Japan. The third column in Table 10.1 shows the CSI for each of the 47 prefectures using the data of 47 prefectures in Japan.[10,11] (The parameters in the Eq. (10.4) are assumed as $\alpha = 20$ and $\beta = 1$ in this analysis). And the second column of Table 10.1 shows the number assigned to each prefecture.

10.3.3 Derivation of Regional Connection Index

The regional Connection Index RCI is derived by a method of the network analysis. In order to simplify the derivation of the Regional Connection Index, the Japanese case used in the above derivation of the CSI is used to the explanation. The Regional Connection Index is an index showing the degree of connectivity between a prefecture concerned and other prefectures. This index is considered as a proxy to reveal the effect level of the regional connection economy on production activity in the region. In the derivation, data of the passenger flow amount between the prefectures and the amount of its own prefecture are adopted.[12,13] The derivation procedure of RCI is as follows (Ishikawa, 2019).

First, we obtain passenger flow amount $A_{i,j}$ (i, j = 1,2, … 47) from a prefecture i to each j of the 47 prefectures, including passenger flow within its own prefecture. And, each passenger flow is divided by the total passenger flow amount of the 47prefectures, and the passenger flow ratio $a_{i,j}$ (i, j = 1, 2, … 47) is derived. And

[10] Data source is Chiiki keizai soran (2019).

[11] It can be considered that a city system exists in each of 47 prefectures.

[12] See Von Wouter et al (2005), the network analysis has made great progress in recent years.

[13] Data source is Chiiki keizai soran (2019). RCI is derived using four items other than passenger flows.

Table 10.1 City system and regional connection indexes of 47 prefectures

Prefec	No	CSI	RCI	Prefec	No	CSI	RCI
Hokkaido	1	1.5325	305	Mie	24	2.7643	218
Aomori	2	3.0892	347	Shiga	25	2.6756	270
Iwate	3	3.2298	376	Kiyoto	26	2.2535	415
Miyagi	4	2.3012	438	Osaka	27	1.2892	450
Akita	5	3.151	225	Hiyogo	28	2.2265	241
Yamagata	6	2.3449	311	Nara	29	2.2103	222
Fukushima	7	2.7192	282	Wakayama	30	4.3667	65
Ibaraki	8	1.9486	206	Tottori	31	4.2606	127
Tochigi	9	2.1339	228	Shimane	32	3.7509	313
Gunma	10	2.5702	246	Okayama	33	2.7574	326
Saitama	11	1.6851	165	Hiroshima	34	2.5905	479
Chiba	12	2.1704	165	Yamanashi	35	3.646	109
Tokyo	13	1.2008	480	Tokushima	36	4.1194	200
Kanagawa	14	1.8164	253	Kagawa	37	2.3134	321
Niigata	15	2.143	445	Ehime	38	2.536	270
Toyama	16	1.9671	343	Kochi	39	3.7353	298
Ishikawa	17	3.5271	494	Fukuoka	40	1.7398	387
Fukui	18	3.0731	378	Saga	41	3.039	203
Yamanashi	19	2.3523	285	Nagasaki	42	2.8465	311
Nagano	20	2.139	400	Kumamoto	43	3.045	342
Gifu	21	2.2844	338	Oita	44	3.2104	281
Shizuoka	22	2.4623	403	Miyasaki	45	3.344	267
Aichi	23	1.5726	463	Kagoshima	46	2.8953	390
				Okinawa	47	2.4394	402

then, we obtain the ratios of the following four items: (b_1) (Gross Regional Product of each prefecture)/(Gross Domestic Product of Japan), (b_2) the ratio of (the passenger flow amount within the prefecture)/(the passenger flow amount of Japan), (b_3) the ratio of (the passenger flow amount from a prefecture to other 46 prefectures)/(the passenger flow amount of Japan), (b_4) the ratio of (the passenger flow amount of a prefecture)/(the passenger flow volume of Japan).

Second, using the elements $a_{i,\,j}$ (i, j = 1, 2, … 47) and the elements $b_{i,j}$ (i = 1, 2, 3, 4, j = 1, 2, … 0.47), we create the 51-by-47 matrix X that is shown by the matrix (5).

$$X = \begin{pmatrix} a_{1,1} & \cdots & a_{1,47} \\ \ldots & \ldots & \ldots \\ a_{47,1} & \ldots & a_{47,47} \\ b_{1,1} & \ldots & b_{1,47} \\ \ldots & \ldots & \ldots \\ b_{4,1} & \cdots & b_{4,47} \end{pmatrix} \tag{10.5}$$

In elements $a_{i,j}$ (i, j = 1,2, … 7) and $b_{i,j}$ (i = 1, 2, 3, 4, j = 1,2, … 0.47), if its value is close to 0, the value of the element is positively set to 0, and the value of the element having another numerical value is set to 1. By this procedure, the 51-by-47 matrix X is composed of elements 0 and 1.

Third, we build the matrix X' of the 47-by-51 by transposing the matrix X that is composed by 0 and 1, and we compute X·X' to create the 47-by-51 matrix X^* that is shown by the matrix (6).

$$XX^{'} = X* = \begin{pmatrix} ac_{1,1} & \cdots & ac_{1,47} \\ \ldots & \ldots & \ldots \\ ac_{47,1} & \ldots & ac_{47,47} \\ bc_{1,1} & \ldots & bc_{1,47} \\ \ldots & \ldots & \ldots \\ bc_{4,1} & \cdots & bc_{4,47} \end{pmatrix} \tag{10.6}$$

Finally, summing up the values of the elements ac_j (j = 1,2,…47) in each of the 47 rows in the matrix (6), we derive the Regional Connection Index of each of the 47 prefecture. The fourth column in Table 10.1 shows the RCI for each of the 47 prefectures.

By using the values of CSI and RCI shown in Table 10.1 a basic production property of each prefecture can be suggested.

10.3.4 Characteristics of City System Index and Regional Connection Index

Before the derivation of a production environment of each prefecture of the 47 prefectures by two indexes of CSI and RCI, it is useful to know the characteristics of these two indexes. Figure 10.2 shows the relationship between the CSI and the Gross Regional Product (GRP) values, which are shown logarithmically in the figure, of the prefectures. As shown in Fig. 10.2, the GRP decreases as the CIS increases. The CSI is closely related to the GRP of each prefecture; the City System Index is related to the scale of prefecture's economic activity.

While, the Regional Connection Index is related to the scale of the socio-economic role of the prefectures and the distance from the prefecture in question to the specific

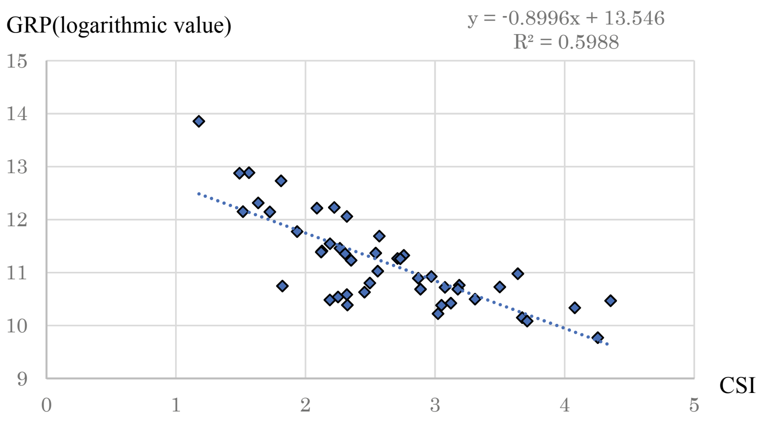

Fig. 10.2 Relationship between CSI and GRP. *Data source* Chiiki keizai soran (2019)

prefectures that play a large socio-economic role in the nation. Figure 10.3 shows the locations of the prefectures with high RCI by coloring. This figure is depicted by the standardized values of the RCI that are shown in Table 10.2.

Figure 10.3 shows the following points. All prefectures that play a large socio-economic role in the nation and in the local area have high RCI and they are dispersed

Fig. 10.3 Location of prefectures with high regional connection index (RCI > 0.5)

Table 10.2 Standardized values of CSI and RCI of 47 prefectures

Prefec	No	CSI	RCI	Prefec	No	CSI	RCI
Hokkaido	1	−1.4569	−0.0192	Mie	24	0.1934	−0.88462
Aomori	2	0.6341	0.4135	Shiga	25	−0.0702	−0.35577
Iwate	3	0.8076	0.6635	Kyoto	26	−0.5842	1.03846
Miyagi	4	−0.4266	1.2596	Osaka	27	−1.5093	1.375
Akita	5	0.6955	−0.7885	Hiyogo	28	−0.5194	−0.63462
Yamagata	6	0.3851	0.02759	Nara	29	−0.5562	−0.81731
Fukushima	7	0.1399	−0.2596	Wakayama	30	2.3597	−2.28846
Ibaraki	8	−0.9003	−0.9712	Tottori	31	2.1984	−1.73077
Tochigi	9	−0.6218	−0.7596	Shimane	32	1.4544	0.05769
Gunma	10	−0.5385	−0.5385	Okayama	33	0.1745	0.18269
Saitama	11	−1.3654	−1.3654	Hiroshima	34	−0.0383	1.65385
Chiba	12	−0.07022	−1.3654	Yamaguchi	35	1.3784	−1.89423
Tokyo	13	−1.9211	1.6635	Tokushima	36	1.9822	−1.03846
Kanagawa	14	−1.0735	−0.5288	Kagawa	37	−0.4295	0.11538
Niigata	15	−0.6464	1.3269	Ehime	38	−0.1298	−0.36538
Toyama	16	−0.8928	0.3462	Kochi	39	1.4916	−0.07692
Ishikawa	17	1.1968	1.7692	Fukuoka	40	−1.1872	0.88462
Fukui	18	0.6040	0.6827	Saga	41	0.5613	−1.01923
Yamanashi	19	−0.3783	−0.2115	Nagasaki	42	0.2978	0.02885
Nagano	20	−0.4033	0.9038	Kumamoto	43	0.4914	0.33654
Gifu	21	−0.3387	0.2596	Oita	44	0.7793	−0.26923
Shizuoka	22	−0.4783	0.9038	Miyazaki	45	0.9625	−0.58654
Aichi	23	−1.4110	1.4712	Kagoshima	46	0.3633	0.66346
				Okinawa	47	−0.2575	0.72115

throughout Japan, Tokyo, Osaka, Miyagi, and Fukuoka. Some prefectures, Aomori, Fukui, Kagoshima, etc., which are located quite far away from the Tokyo and Osaka also have high RCI.

Then, Fig. 10.4 shows the locations of the prefectures with low RCI by coloring. Figure 10.4 is depicted using the standardized values of the RCI. It shows that some of the prefectures with low RCI such as Saitama, Kanagawa, and Nara, are adjacent to the prefectures with large economic scale. And other prefectures with low RCI are located in the area a little far from Tokyo and Osaka. It can be said that prefectures adjacent to metropolitan areas and those located on the outer periphery of metropolitan areas have low RCI.

Fig. 10.4 Location of prefectures with low regional connection index (RCI < −0.5)

10.3.5 Classification of Regional Production Activity by Two Connection Indexes

Characteristics of production activity can be categorized into four groups by the two indexes, CSI and RCI. Figure 10.5 conceptionally shows the four states of enjoyment of two connection economies in the region by the quadrants, A, B, C, and D. It is also possible to classify the 47 prefectures into four groups.

Let us classify the 47 prefectures in Japan into the 4 quadrants by the CSI and the RCI. According to the procedures shown in the previous subsection, the values of CSI and RCI are derived for each of the 47 prefectures. And the values are transformed into the standardized values that are shown in the second and the third column of Table 10.2. Figure 10.6 shows the locations of the 47 prefectures and the number assigned to each prefecture.

Four quadrants formed by the CSI and the RCI are shown by Fig. 10.7. In Fig. 10.7, the horizontal axis represents the CSI and the vertical axis represents the RCI. The coordinate of each prefecture is indicated by the number of that prefecture. Figure 10.7 shows important facts: Quadrant A includes all prefectures that play a major socio-economic role in Japan as a whole and in local areas. Quadrant B includes many prefectures which are adjacent to Tokyo and Osaka prefecture. Quadrant C contains many prefectures located on the outer fringes of Tokyo and Osaka

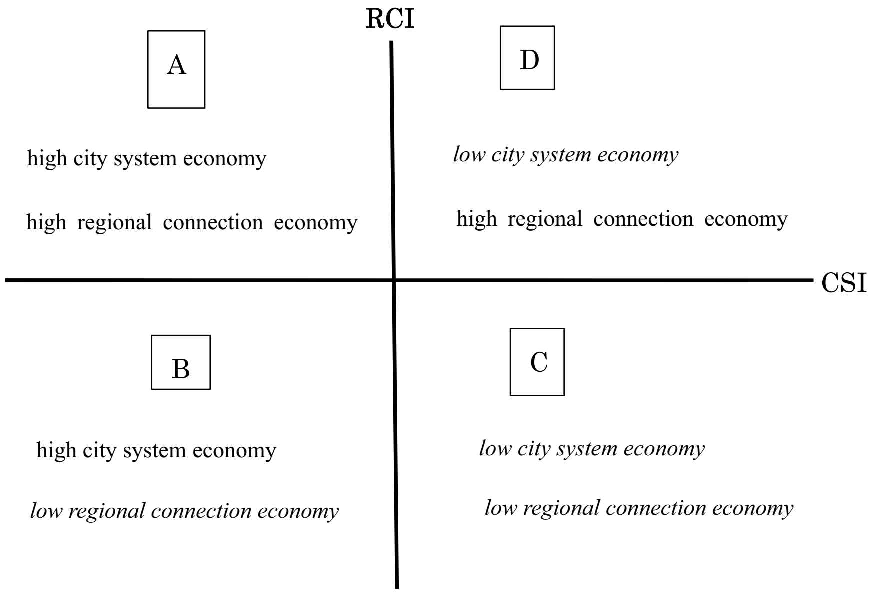

Fig. 10.5 Four conceptional groups of state of enjoyment of connection economies in region

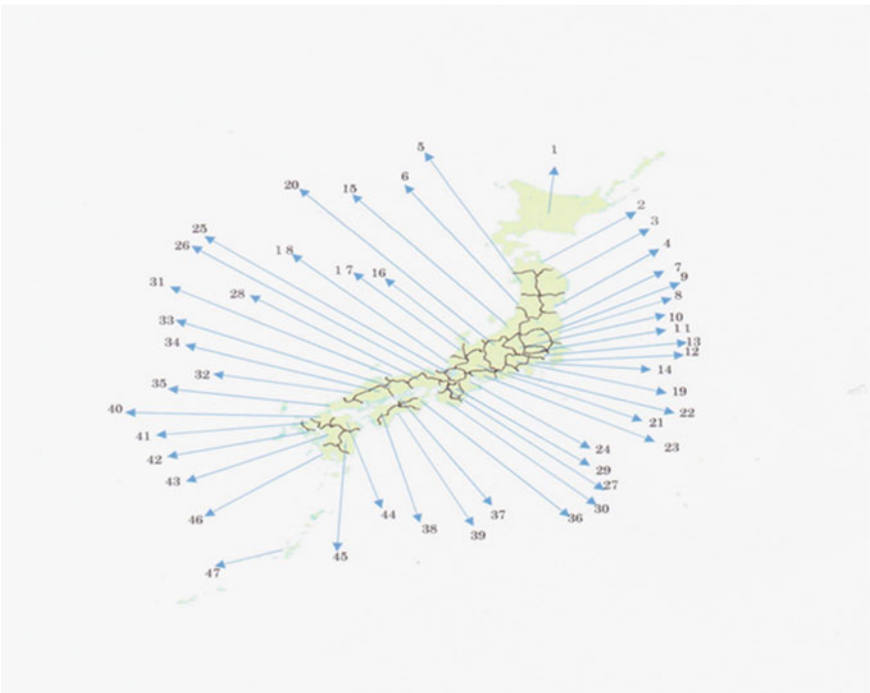

Fig. 10.6 Locations of 47 prefectures and their assigned numbers

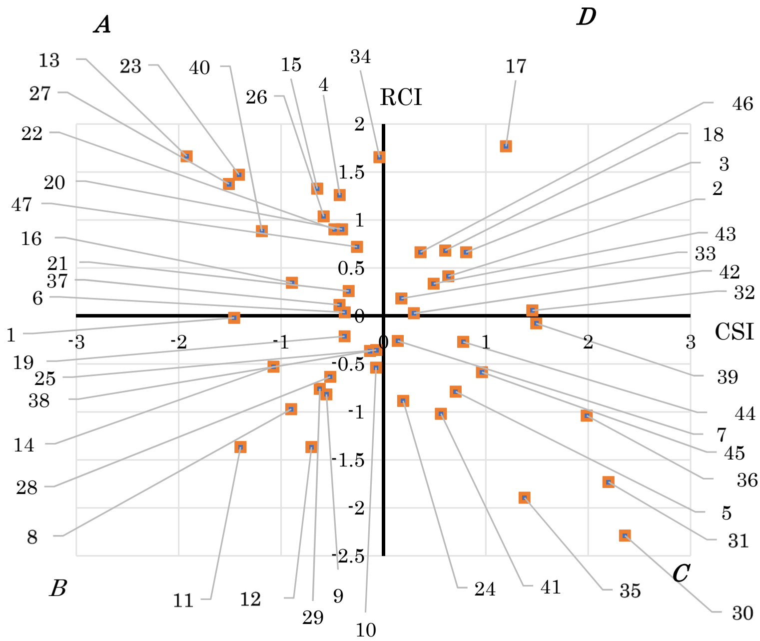

Fig. 10.7 Coordinates formed by CSI and RCI for 47 prefectures in Japan. *Source* Ishikawa (2019)

metropolitan areas. Quadrant D contains prefectures that deviate from the Tokyo and Osaka prefecture. It can be said that the spatial economic distance from Tokyo and Osaka prefecture decisively influence in the distribution of the prefectures in the four quadrants, A, B, C, and D.

The classification of the prefectures shown in Fig. 10.7 is made by the City System Index and the Regional Connection Index. These indexes are constructed from simple general materials for each prefecture, and they are effective in classifying the production activity of each prefecture into four categories. It is considered that these indexes useful to proceeds the analysis of the effects of agglomeration economies in production activity in regions.

10.4 Classification of Prefectures in Each Quadrant Based on Two New Regional Connection Indexes

This section proceeds the analysis based on the materials of machine industry of each prefecture. In the analysis in this section, two new regional connection indexes are devised from a firm-level perspective. And this analysis uses these indexes to further classify the prefectures into four categories in each of the quadrant, A, B, C, and D. The first one of the newly introduced regional connection index is the regional connection index PCI based on the locations of the branch factory owned by the firms. The second one is the regional connection index SCI based on the locations of the sales office of the firms. Methods for deriving these indexes are explained in the next subsection.

10.4.1 Derivation of Regional Connection Indexes Based on Branch Factories and Sales Offices

This subsection explains how to derive RCI and SCI for each of the 47 prefectures in Japan. The index PCI is derived based on the location of the branch factory owned by a firm. First, 152 firms belonging to the machine industry are arbitrarily selected.[14] And find out the number of branch factories of each firm and the prefecture where they are located. The main factory is also counted as a branch factory. Then, give the number of branch factories to the prefecture where the firm has the branch factories, and give 0 to the prefecture where the firm does not have a branch factory. These procedures are conducted for each of the 152 firms. As a result, a matrix X of 152 rows and 47 columns is created and it is shown in the form of a matrix (7).

$$\boldsymbol{X} = \begin{bmatrix} \boldsymbol{A}_{1,1} & \boldsymbol{A}_{1,j} & \boldsymbol{A}_{1,47} \\ \cdots & \cdots & \cdots \\ \cdots & \boldsymbol{A}_{i,j} & \cdots \\ \cdots & \cdots & \cdots \\ \boldsymbol{A}_{152,1} & \boldsymbol{A}_{152,j} & \boldsymbol{A}_{152,47} \end{bmatrix} \tag{10.7}$$

$$i = 1, \cdots 152, \; j = 1, \cdots 47$$

$A_{i,j}$ is the number of the factories that firm *i* has located in prefecture *j*. Correlation analysis about the matrix between the 47 prefectures is performed based on this matrix, and a correlation matrix X_C of 47 rows and 47 columns is obtained. This correlation matrix is shown in the form of a matrix (8), and each element $C_{i,j}$ (*i, j* = 1, …. 47) shown in matrix (8) indicates the correlation coefficient between the prefectures.

$$Xc = \begin{bmatrix} \boldsymbol{C}_{1,1} & \boldsymbol{C}_{1,j} & \boldsymbol{C}_{1,47} \\ \cdots & \cdots & \cdots \\ \cdots & \boldsymbol{C}_{i,j} & \cdots \\ \cdots & \cdots & \cdots \\ \boldsymbol{C}_{47,1} & \boldsymbol{C}_{47,j} & \boldsymbol{C}_{47,47} \end{bmatrix} \tag{10.8}$$

[14] The materials are based on Kaishiya-Shikiho (Data book on stock listed companies, in Japanese, 2017).

$$i = 1, \cdots 47, j = 1, \cdots 47$$

A partial correlation matrix is derived from the correlation matrix represented by matrix (8). A value of 0 is positively given to an element having an extremely low value in this partial correlation matrix. Based on the derived partial correlation matrix, the correlation matrix between the 47 prefectures is estimated. The partial correlation matrix is derived again from this correlation matrix. And repeat this process to find the correlation matrix with the most elements having a value of 0.. And then, replace the non-zero value of the elements of this correlation matrix with 1, and set the values of all the elements to 1 or 0. As a result, a matrix X_L composed of elements $L_{i,j}$ (i, j = 1, ... 47) having a value of 1 or 0 is obtained, and it is shown in the form of matrix (9).

$$XL = \begin{bmatrix} \boldsymbol{L}_{1,1} & \boldsymbol{L}_{1,j} & \boldsymbol{L}_{1,47} \\ \cdots & \cdots & \cdots \\ \cdots & \boldsymbol{L}_{i,j} & \cdots \\ \cdots & \cdots & \cdots \\ \boldsymbol{L}_{47,1} & \boldsymbol{L}_{47,j} & \boldsymbol{L}_{47,47} \end{bmatrix} \quad (10.9)$$

$$i = 1, \cdots 47$$

Finally, the element L_j having a value of 1 is added to each of the 47 prefecture i to obtain the total value represented by Eq. (10.10). The total shows the regional index PCI derived based on the branch factories for each prefecture.

$$\text{PCI}\boldsymbol{i} = \sum_{j=1}^{j=47} \boldsymbol{L}_{i,j} \quad (10.10)$$

$$i = 1, \cdots 152$$

Next, let us derive the index SCI based on the location of the sales office owned by a firm. It is created as follows. Once again, 152 firms belonging to the machine industry are arbitrarily extracted. Find out the number of sales offices of each firm and the prefecture where they are located. The head office is also included in the sales office. Then, the number of sales office is given to the prefecture where the firm places these offices, and 0 is given to the prefectures that the firm does not have sales office. The same procedures are conducted for each of the 152 firms. The following derivation work is the same as the derivation procedure of PCI. The regional connection index SCI based on the location of the sales office is derived for each prefecture.

10.4.2 Conceptual Classification of Regions by Two New Regional Connection Indexes

By the derived PCI and SCI indexes production and sales activities of manufacturing firms in regions are divided into four categories. And it is possible to conceptually infer the characteristics of production and sales activities of the firms in regions. Figure 10.8 divides the characteristics of production and sales activities of the firms into four quadrants, *a, b, c,* and *d* by PCI and SCI. Conceptional characteristics of the production and sales activities of the firms belonging to each quadrant can be suggested from Fig. 10.8.

The typical conceptional characteristics of the manufacturing firms in each quadrant are inferred as follows.

(1) Firms in the quadrant *a* tend to carry out production activity in a vertical division of labor within the prefecture. Manufactured products tend to be sold outside the prefecture in the market by using sales offices.
(2) Firms in the quadrant *b* tend to carry out production activity in a vertical division of labor within the prefecture. Manufactured products tend to be sold inside and outside the prefecture without using sales offices.
(3) Firms in the quadrant *c* tend to carry out production activity in a horizontal division of labor between regions. Manufactured products tend to be sold inside and outside the prefecture without using sales offices.
(4) Firms in the quadrant *d* tend to carry out production activity in a horizontal division of labor between regions. Manufactured products tend to be sold outside the prefecture in the market by using sales offices.

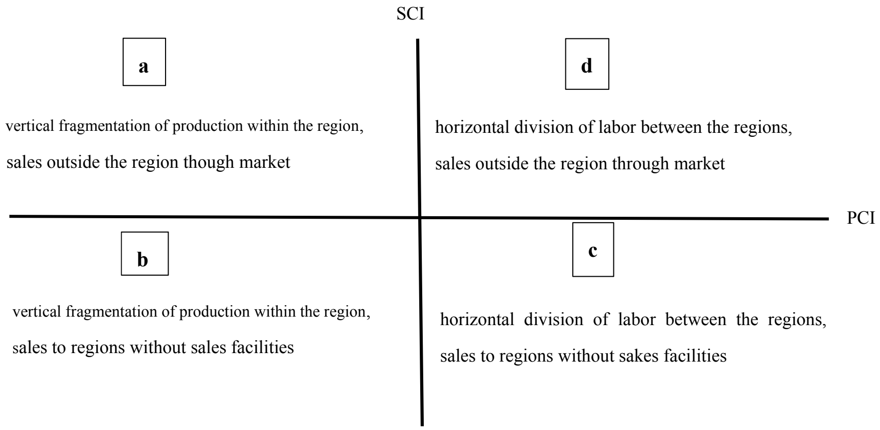

Fig. 10.8 Conceptional classification of production and sales activities by PCI and SCI

10.4.3 Classification of 47 Prefectures by Two New Regional Connection Indexes

This subsection shows the regional connection indexes PCI and SCI of the 47 prefectures in Japan and classify the type of their production and sales activity in each of the four quadrants into small four groups. Table 10.3 shows the PCI and SCI values of the 47 prefectures and their standardized values.

Let us classify the prefectures belonging to each quadrant A, B, C, and D into the small group a, b, c, and d, respectively. Figure 10.9 shows how the 15 prefectures belonging to quadrant A are divided into four small quadrants Aa, Ab, Ac, and Ad. Similarly, Figs. 10.10, 10.11, and 10.12 show how prefectures belonging to quadrants B, C, and D are divided into the small quadrants a, b, c, and d, respectively.

Figure 10.9 shows that all prefectures that play a major socio-economic role in Japan as a whole and in local areas belong to quadrant Ac. These representative prefectures have relationships with many other prefectures through branch factories, but few through sales offices.

Figure 10.10 shows that most of the prefectures adjacent to the prefectures with large economic scale belong to quadrants Bb and Bc**.** These prefectures do not have relationships with many other prefectures through sales offices.

Figure 10.11 descries that most of the prefectures that exist on the outer periphery of the metropolitan areas of Tokyo and Osaka belong to the quadrants Ca and Cd. These prefectures have relationships with many other prefectures through sales offices.

Figure 10.12 indicates that the prefectures far from the prefectures with large economic scale are evenly distributed in the quadrants Da, Db, and Dd. In the quadrant Dc, there is no prefecture.

The prefectures belonging to each of the 16 quadrants are shown in Table 10.4. And Table 10.5 shows the distribution ratios of the prefectures in each of the 16 quadrants.

The 47 prefectures are classified into the 4 categories *a, b, c*, and *d* by the regional connection index based on branch factories and sales offices of the machinery firms. This industry is not a standard criteria that covers all industries. But, the machine industry is a leading industry in Japan and create a relatively large number of cooperative relationships between the prefectures. The two new indexes are considered to be a powerful measure for estimating the degree of connection between the prefectures in Japan.

10.5 Extraction of Production Characteristics of Prefectures in Each of Four Quadrants

The 16 classifications of the 47 prefectures are considered to successfully represent the general production characteristics of the prefectures. This classification may proceed the analysis of the industrial economy of the 47 prefectures. However, the

Table 10.3 Regional connection indexes based on branch factories and sales offices (2017)

Prefec	PCI	Standardized PCI	SCI	Standardized SCI
Hokkaido	5	0.4519	9	−0.6616
Aomori	4	0.0188	13	0.0544
Iwate	0	−1.7135	9	−0.6616
Miyagi	4	0.0188	8	−0.8407
Akita	5	0.4519	14	0.2335
Yamagata	4	0.0188	19	1.1287
Fukushima	5	0.4519	19	1.1287
Ibaraki	2	−0.8473	12	−0.1245
Tochigi	2	−0.8473	12	−0.1245
Gunma	5	0.4519	12	−0.1245
Saitama	5	0.4519	8	−0.8407
Chiba	2	−0.8473	13	0.0544
Tokyo	8	1.7511	9	−0.6616
Kanagawa	7	1.3181	7	−1.0197
Niigata	7	1.3181	11	−0.3036
Toyama	9	2.1843	20	1.3077
Ishikawa	*0*	−1.7135	*7*	−1.0197
Fukui	4	0.0188	15	0.4125
Yamanashi	3	−0.4142	8	−0.8407
Nagano	1	−1.2804	12	−0.1245
Gifu	4	0.0188	23	1.8449
Shizuoka	3	−0.4142	9	−0.6616
Aichi	6	0.8850	10	−0.4826
Mie	3	−0.4142	16	0.5916
Shiga	2	−0.8473	7	−1.0197
Kyoto	2	−0.8473	15	0.4125
Osaka	7	1.3181	6	−1.1988
Hiyogo	10	2.6173	10	−0.4826
Nara	*4*	0.0188	*0*	−2.2730
Wakayama	2	−0.8473	14	0.2335
Tottori	4	0.0188	22	1.6658
Shimane	2	−0.8473	21	1.4868
Okayama	2	−0.8473	12	−0.1245
Hiroshima	5	0.4519	7	−1.0197
Yamaguchi	8	1.7512	12	−0.1245
Tokushima	5	1.7511	21	1.4868

(continued)

Table 10.3 (continued)

Prefec	PCI	Standardized PCI	SCI	Standardized SCI
Kagawa	5	0.4519	15	0.4125
Ehime	1	−1.2804	11	−0.3036
Kochi	2	−0.8473	2	−1.9150
Fukuoka	4	0.0188	7	−1.0197
Saga	3	−0.4142	14	0.2335
Nagasaki	7	1.3181	17	0.7706
Kumamoto	2	−0.8473	18	0.9497
Oita	3	−0.4142	22	1.6658
Miyasaki	3	−0.4142	14	0.2335
Kagoshima	2	−0.4142	24	2.0239
Okinawa	4	0.0188	7	−1.0197

Data Kaishiya-Shikiho (2017)

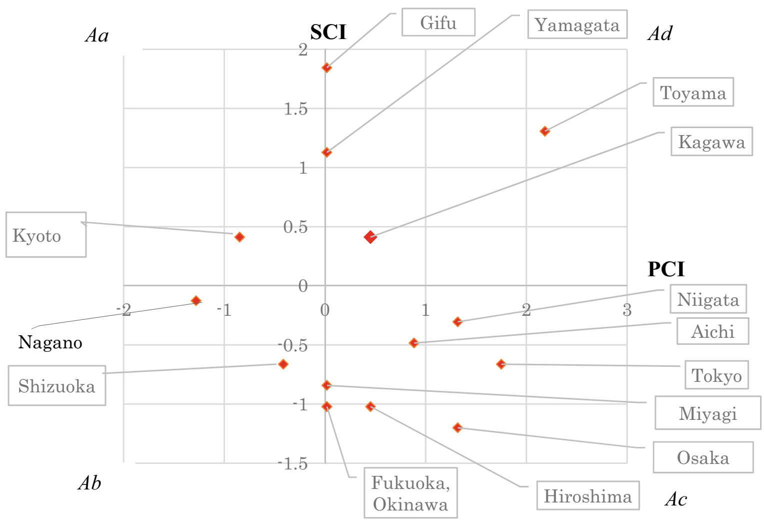

Fig. 10.9 Classification of prefectures in A quadrant

detailed analysis of the obtained results is too large in scale to the analysis in this paper. This section conducts an industrial economic survey of the prefectures that belong to the basic quadrants A, B, C, and D respectively.

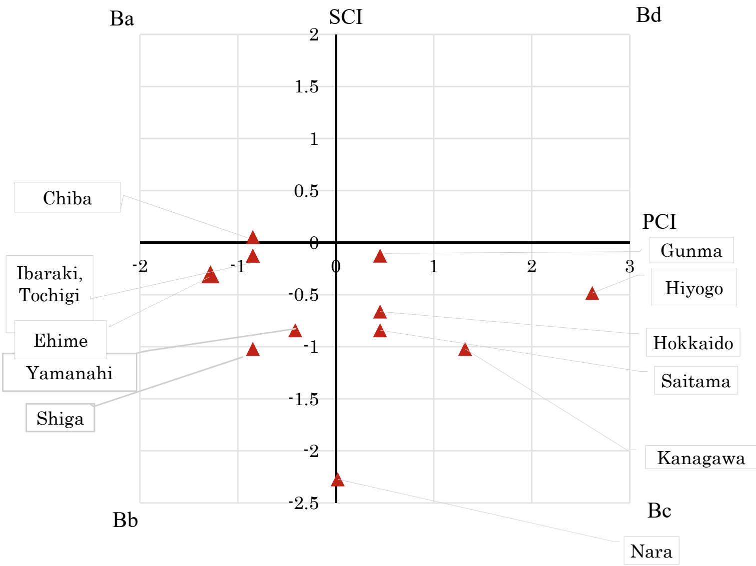

Fig. 10.10 Classification of prefectures in B quadrant

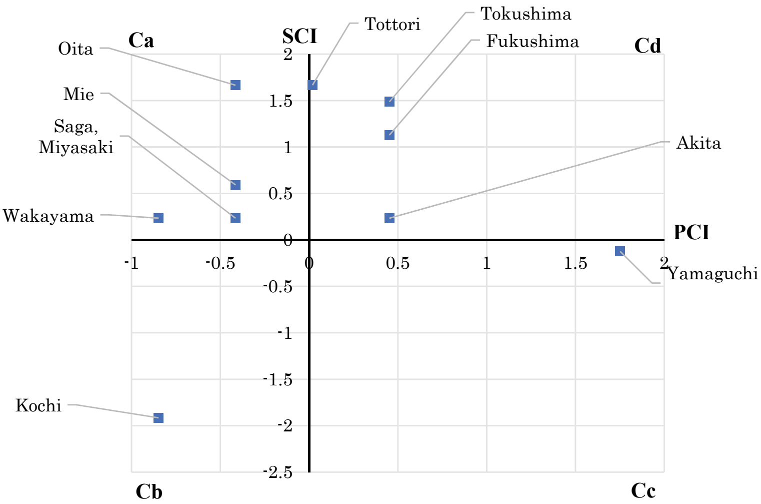

Fig. 10.11 Classification of prefectures in C quadrant

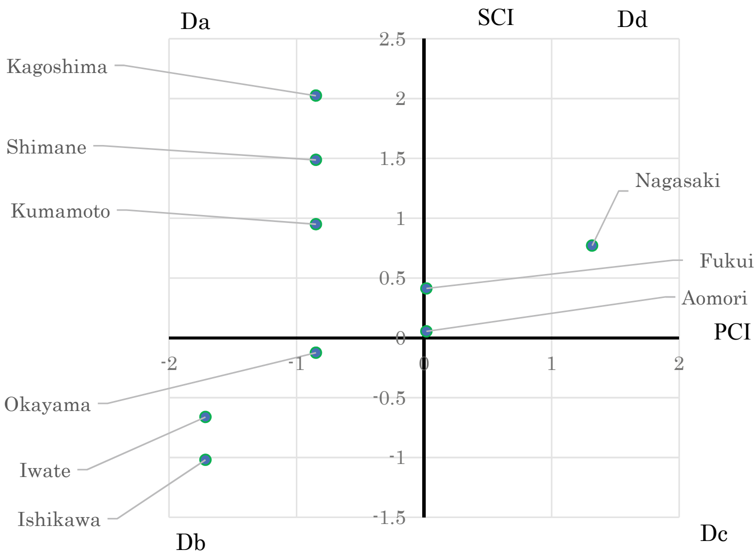

Fig. 10.12 Classification of prefectures in D quadrant

Table 10.4 Prefectures in 16 quadrants

Aa	Kyoto							
Ab	Nagano	Shizuoka						
Ac	Miyagi	Tokyo	Niigata	Aichi	Osaka	Hiroshima	Fukuoka	Okinawa
Ad	Yamagata	Toyama	Gifu	Kagawa				
Ba	Chiba							
Bb	Ibaraki	Tochigi	Yamanashi	Shiga	Ehime			
Bc	Hokkaido	Gunma	Saitama	Kanagawa	Nara	Hiyogo		
Bd	–							
Ca	Mie	Wakayama	Saga	Oita	Miyasaki			
Cb	Kochi							
Cc	Yamaguchi							
Cd	Akita	Fukushima	Tottori	Tokushima				
Da	Shimane	Kumamoto	Kagoshima					
Db	Iwate	Ishikawa	Okayama					
Dc	–							
Dd	Aomori	Fukui	Nagasaki					

Table 10.5 The distribution ratios of number of prefectures in each quadrant

A	Percent	*B*	Percent	*C*	Percent	*D*	Percent
Aa	6.7	Ba	8.3	Ca	45.5	Da	33.3
Ab	13.3	Bb	41.7	Cb	9.1	Db	33.3
Ac	53.3	Bc	50	Cc	9.1	Dc	0
Ad	26.7	Bd	0	Cd	36.4	Dd	33.3

10.5.1 Difference in Production Scale of Factory Between Four Quadrants

It may be generally inferred that the factories in the prefectures with a high level of two connection economies, city system economy, and regional connection economy, employ production methods that utilize these economies as much as possible. The production scale of the factories, therefore, tends to small and to specialize in the specific processes. On the other hand, the factories in prefectures with a low level of the economies adopt production methods that make maximum use of internal economies, mass production, and large-scale economy. Thus, the factories' scale tends to be large. To verify this inference, this subsection derives the specialization coefficients for the three factory's scales, small, medium, and large based on the data on the number of the employees of the factories in the prefecture. And it shows the factory's scale in the prefectures in each quadrant.

The factory's scale is divided into the three categories, small factory (1 to 3 employees), medium factory (3 to 99 employees), and large factory (300 or more employees). And specialization coefficient for each factory's scale is derived for each prefecture. And then, according to the coefficient value, the 47 prefectures are ranked in each category respectively. The results are shown in Table 10.6.

As shown in Table 10.6, the specialization coefficient of the small factory is quite high in Tokyo, Kyoto, and Okinawa that are in the quadrant A and also Ishikawa prefecture in the quadrant D. The specialization coefficient of the medium factory is the highest in Iwate that is in quadrant D and also Tottori in the quadrant C. The specialization coefficient of the large-scale factory is quite high in Yamaguchi in the quadrant C and also Shiga in the quadrant B. These rankings may generally support the inference regarding the factory scale in each quadrant.

Then, Table 10.7 shows the number of the prefectures in the top ten in each rank by the specialization coefficient for the three scales. Table 10.7 indicates important facts: In 15 prefectures in the quadrant A, 6 prefectures, 40% of 15 prefectures, are in the top 10 in the ranking of the specialization coefficient of the small factory. And in 12 prefectures in the quadrant B 4 prefectures are in the top 10 in the ranking of the specialization coefficient of the large-scale factory. And then, there are 11 prefectures in the quadrant C, none of them is in the top 10 in terms of the specialization coefficient

Table 10.6 Specialization coefficients by factory size in 47 prefectures and their ranking

	Small factory (1-3workers)		Medium factory (33–99 workers)		Large factory (more than 300 workers)	
Rank	Prefecture	Spatialization quotient	Prefecture	Spatialization quotient	Prefecture	Spatialization quotient
1	Tokyo	1.43	Iwate	1.62	Yamaguchi	2.17
2	Kyoto	1.25	Tottori	1.61	Shiga	2.03
3	Okinawa	1.18	Miyagi	1.42	Ibaraki	1.62
4	Ishikawa	1.14	Shiga	1.42	Mie	1.48
5	Yamanashi	1.12	Yamaguchi	1.40	Kumamoto	1.47
6	Niigata	1.11	Toyama	1.35	Saga	1.44
7	Fukui	1.10	Yamagata	1.34	Miyagi	1.42
8	Nara	1.09	Fukushima	1.32	Kanagawa	1.42
9	Gifu	1.07	Ibaraki	1.28	Tochigi	1.40
10	Osaka	1.06	Aomori	1.28	Oita	1.38
11	Wakayama	1.05	Hokkaido	1.28	Tottori	1.38
12	Kagoshima	1.03	Oita	1.28	Toyama	1.34
13	Saitama	1.01	Akita	1.27	Okayama	1.34
14	Nagasaki	1.00	Kumamoto	1.25	Hiroshima	1.33
15	Gunma	0.97	Okayama	1.24	Yamagata	1.32
16	Nagano	0.97	Chiba	1.23	Aichi	1.31
17	Kagawa	0.96	Miyasaki	1.17	Iwate	1.31
18	Tokushima	0.96	Fukuoka	1.16	Shizuoka	1.29
19	Tochigi	0.96	Niigata	1.15	Hiyogo	1.28
20	Hiyogo	0.94	Mie	1.14	Fukushima	1.26
21	Aichi	0.93	Shizuoka	1.13	Chiba	1.23
22	Saga	0.92	Hiroshima	1.12	Fukuoka	1.18
23	Mie	0.92	Ehime	1.12	Gunma	1.16
24	Kanagawa	0.92	Saga	1.12	Aomori	1.11
25	Aomori	0.91	Tochigi	1.12	Nagano	1.10
26	Yamagata	0.90	Hiyogo	1.11	Miyasaki	1.01
27	Miyasaki	0.90	Nagano	1.0	Ehime	0.99
28	Ehime	0.89	Shimane	1.0	Niigata	0.94
29	Shizuoka	0.89	Gunma	1.05	Tokushima	0.89
30	Okayama	0.88	Kagawa	1.02	Saitama	0.88
31	Fukushima	0.88	Kochi	1.02	Kagawa	0.84
32	Akita	0.88	Kanagawa	1.02	Nagasaki	0.81
33	Shimane	0.88	Aichi	0.98	Yamanashi	0.80

(continued)

Table 10.6 (continued)

	Small factory (1-3workers)		Medium factory (33–99 workers)		Large factory (more than 300 workers)	
34	Fukuoka	0.87	Kagoshima	0.94	Akita	0.78
35	Kochi	0.87	Yamanashi	0.92	Ishikawa	0.74
36	Ibaraki	0.86	Saitama	0.90	Gifu	0.73
37	Shiga	0.86	Wakayama	0.89	Hokkaido	0.71
38	Chiba	0.85	Nara	0.88	Shimane	0.69
39	Oita	0.83	Tokushima	0.87	Fukui	0.64
40	Hiroshima	0.83	Gifu	0.87	Kagoshima	0.61
41	Kumamoto	0.82	Nagasaki	0.81	Kyoto	0.61
42	Toyama	0.82	Fukui	0.77	Nara	0.60
43	Hokkaido	0.81	Ishikawa	0.74	Osaka	0.45
44	Yamaguchi	0.78	Osaka	0.73	Wakayama	0.33
45	Miyagi	0.77	Okinawa	0.66	Tokyo	0.28
46	Iwate	0.74	Kyoto	0.63	Okinawa	0.16
47	Tottori	0.69	Tokyo	0.45	Kochi	0.05

Source Kensei (Japanese Data book, 2019)

of the small factory. While, in the ranking of the specialization coefficient of the large-scale factory, 4 prefectures, 36% of them, are in the top 10. Finally, the prefectures in the quadrant D are distributed evenly between the three scales, it is a feature in the quadrant D.

The suggested inference of the factory scale of each quadrant may be generally supported by the facts shown in Tables 10.6 and 10.7: In the prefectures where the two types of the connection economies can be fully enjoyed, the factories tend to be small. In the prefectures where the connection economies are not enjoyed so much, the factory scale tends to be large. And the distribution of the factory scales in the prefectures where one of the two types of connection economies is not abundantly enjoyed tends to be uniform rather than extreme.

Table 10.7 Number of prefectures in the top 10 in specialization coefficient of factory scale

Quadrant (number of prefectures)	Small factory	Medium factory	Large factory
A (15)	*6*	3	1
B (12)	2	2	*4*
C (11)	*0*	3	*4*
D (9)	2	2	1

10.5.2 Characteristics of Production Activity in Prefectures in Each Quadrant

This subsection clarifies characteristics of production activity of the prefectures in each quadrant by survey of some economic items. The survey here focuses on two economic indicators; the manufactured product shipment value *S* per person that is shown in the fourth column in Table 10.8, the ration of gross value added *V* per person in manufacturing industry, which is shown in the third column in Table 10.8, to the value of *S*, V/ S, which is shown the fifth column in Table 10.8.

Using the manufactured product shipment value *S* per person in each prefecture in Table 10.8, let us form the five ranks regarding the value of S in descending order of the value for each quadrant. The five ranks are shown by the top row in Table 10.9. Table 10.9 shows the number of the prefectures belonged to each rank. In the quadrant A, the number of the prefectures is evenly distributed in each rank. In the quadrant B, 9 out of 12 prefectures are in the rank 1st and 2nd. In the quadrant C, 4 prefectures are in the rank 1st, and 4 prefectures are also included in the lower ranks of 4th and 5th. It shows a bipolar distribution. In the quadrant D, 8 out of 9 prefectures are in the rank 4th. Table 10.9 clarifies that the prefectures belong to the four quadrants have different characteristics of production each other. Especially, the quadrant B and the quadrant D have contrasting characteristics.

Using the ratio V/S of each prefecture, let us form the five ranks regarding the value of V/S in descending order of the value for each quadrant. Table 10.10 shows the number of the prefectures that belonged to each of the five ranks.

The comparison of the results shown in Tables 10.9 and 10.10 is interesting. In the quadrant A, the distribution of the prefectures into the five ranks are not greatly changed. In the quadrant B, the numbers of the prefectures in the rank 1st and rank 2nd in Table 10.9 are significantly reduced from 9 to 3 in Table 10.10. In the quadrant C, the distribution of the numbers of the prefectures is changed from a bipolar in Table 10.9 to leveled in Table 10.10. In the quadrant D, the numbers of the prefectures in the rank 1st and rank 2nd in Table 10.9 increase from 1 to 5 in Table 10.10. And it is also interesting that in the quadrants B and D, the difference in between the ranking of the manufactured product shipment value *S* per person and that of the V/S ratio is large. It can be said that these survey results show the characteristics of the production activity of the prefectures that are divided into the four quadrants.

10.5.3 Similarity and Dissimilarity in Production Activity Between Prefectures

From the considerations in the previous sections and the values of the manufacture product shipment of the prefectures shown in the second column of Table 10.8, it is possible to derive similarities and differences in the production activities of

Table 10.8 Values of basic economic indicators of the prefecture

Prefec	Manufactured product shipment value (million yen)	Gross value added per person in manufacturing industry (10000 yen) V	Manufactured product shipment value per person (10000 yen) S	(V/S) ratio
Hokkaido	6,535,855	1130	3842	0.2941
Aomori	1,702,308	1252	3088	0.4054
Iwate	2,366,978	853	2800	0.3046
Miyagi	4,017,070	1204	3607	0.3337
Akita	1,224,139	869	2056	0.4226
Yamagata	2,550,977	951	2644	0.3596
Fukushima	4,915,726	1169	3272	0.3572
Ibaraki	12,037,605	1555	4599	0.3381
Tochigi	8,802,168	1598	4463	0.358
Gunma	9,050,380	1747	4415	0.39563
Saitama	12,760,252	1256	3318	0.3785
Chiba	12,668,824	1485	6160	0.2411
Tokyo	8,374,172	1261	3111	0.4053
Kanagawa	17,477,226	1545	4982	0.3101
Niigata	4,779,168	1063	2642	0.4023
Toyama	3,811,625	1235	3149	0.3921
Ishikawa	2,807,217	1200	2940	0.4081
Fukui	2,039,261	1205	2814	0.4282
Yamanashi	2,442,647	1433	3479	0.4118
Nagano	5,879,432	1197	3115	0.3842
Gifu	5,373,371	1059	2752	0.3848
Shizuoka	16,372,042	1551	4130	0.3755
Aichi	46,048,253	1811	5583	0.3243
Mie	10,898,556	1707	5673	0.3008
Shiga	7,371,769	1621	4589	0.3532
Kyoto	5,322,102	1574	3840	0.4098
Osaka	16,685,899	1273	3782	0.3365
Hyogo	15,445,672	1520	4437	0.3425
Nara	1,845,142	1150	3172	0.3625
Wakayama	2,648,002	1550	5037	0.3077
Tottori	704,352	834	2249	0.3708
Shimane	1,085,615	1109	2825	0.3925
Okayama	7,788,634	1507	5484	0.2747

(continued)

Table 10.8 (continued)

Prefec	Manufactured product shipment value (million yen)	Gross value added per person in manufacturing industry (10000 yen) V	Manufactured product shipment value per person (10000 yen) S	(V/S) ratio
Hiroshima	10,342,775	1626	4881	0.3331
Yamaguchi	6,303,285	1945	6734	0.2888
Tokushima	1,698,480	1985	3767	0.5269
Kagawa	2,491,700	1231	3715	0.3313
Ehime	4,094,964	1421	5391	0.2635
Kochi	558,495	838	2278	0.3678
Fukuoka	9,215,929	1253	4238	0.2956
Saga	1,815,391	1207	3145	0.3837
Nagasaki	1,628,207	1017	2827	0.3597
Kumamoto	2,712,683	1185	3079	0.3848
Oita	4,269,713	1625	6803	0.2388
Miyazaki	1,565,730	1113	2957	0.3763
Kagoshima	2,054,700	1019	2955	0.3448
Okinawa	544,069	806	2310	0.3489

Data source Chiiki keizai soran (2019)

Table 10.9 Five ranks by product shipment per person and number of prefectures in each group

Quadrant	1st–10th	11–20th	21–30th	31–40th	41–47th
A	2	4	3	1	4
B	3	6	3	0	0
C	4	0	3	1	3
D	1	0	0	8	0

Table 10.10 Five ranks by (V/S) ratio and number of prefectures in each group

Quadrant	1st–10th	11–20th	21–30th	31–40th	41–47th
A	3	4	2	5	1
B	2	1	4	2	3
C	2	3	2	2	2
D	3	2	2	1	1

Table 10.11 Similarity and dissimilarity between quadrants by items

Item	Quadrant	Quadrant
Manufactured product shipment value in prefecture	High A, B	Low C, D
Specialization quotient for small factory	High A, D	Low B, C
V/S ratio	High D	Low B

each quadrant. The results of the consideration are summarized in Table 10.11. The similarity and dissimilarity in production activity between the quadrants are shown in Table 10.11.

The following results can be derived from Table 10.11. First, the shipment value of the manufactured product of prefecture is high in the quadrants A and B where the CSI related with the economic scale of the prefecture is low, while its value of prefecture is low in the quadrants C and D where the value of CSI is high.

Second, the factory scale of the prefecture in the quadrant A is small because the factories effectively enjoy the two economies of the city system and the regional connection as well as the economies of localization and urbanization. And the factory scale of the prefecture in the quadrant D is also small because the factories enjoy the regional connection economy that is reflected by high RCI. On the other hand, the factory scale of the prefecture in the quadrant C where the two economies of the city system and the regional connection are less, the factory scale is large to enjoy the internal large-scale economy. The same thing could be said for the quadrant B.

Third, because the prefectures in the quadrant D are away from the prefectures with large-scale economy, the shipment value of the manufactured product of the prefecture is relatively low. These prefectures tend to interact between the firms within the prefecture in order to make their regional economy as active as possible. The result of the interaction is indicated by the high gross added value per person in manufacturing industry. In the context here, it is indicated by the high (V/S) value in the quadrant D. It could be said that in these prefectures the level of vertical transaction between the firms within the prefecture is high to make their economy active.

To inspect the third result, let us examine the ratio V/S in the quadrant D from a different view point: One effective way to increase the ratio V/S is to decrease the ratio of the raw material costs to the product manufacturing costs. It is, thus, a useful way to inquire the ratio of the freight flow within the prefecture to the total freight flow in each prefecture. Because if this ratio is high, the raw material cost may be low, as a result, the ratio V/S becomes high. Table 10.12 shows the ratio of the freight flow within the prefecture itself to the total freight flow. As shown in Table 10.12, the average freight flow ratio within the prefecture itself in the quadrant D is 78 percent that is the highest of the four quadrants. A high freight flow ratio within prefecture tends to procure raw materials within the prefecture and reduce the production costs. The high freight flow ratio within prefecture may be one of factors to keep the ratio V/S high in the quadrant D.

Table 10.12 Average rate of freight flow within prefecture for each quadrant

Quadrant	Average freight flow rate within prefecture, %
A	72
B	63
C	68
D	*78*

Data source Chiiki keizai soran (2019)

10.6 Summary and Conclusions

This paper firstly explains the agglomeration economy that has a great influence on regional economic activity even in an era when the globalized economy has progressed considerably. Then, the paper focuses on the connection economy and considers its influence on production activity: As the connection economy, two connection economies are taken up. One is the city system economy that is created by a city system composed of the cities located in a region, the other is the regional connection economy that is created by the connection between the regions. It is considered that the degree of economy created by the city system may be represented by the city system index CSI and that of the regional connection economy is represented by the regional connection index RCI. In addition, the paper devises the indexes PCI and SCI that are derived from firm's branch factories and sales offices to express the degree of the regional connection economy. Using these the connection indexes, the paper first classifies the regional economy into the 4 quadrants and then divides them into 16 quadrants and it derives production characteristics of the firms in the 47 prefectures in Japan. As a result of the examination, it can be obtained that the four quadrants formed by two indexes CSI and RCI have obvious characteristics: Quadrant A includes all prefectures that play a major socio-economic role in Japan and in local areas. Quadrant B contains many prefectures located adjacent to Tokyo and Osaka prefecture. Quadrant C contains many prefectures located on the outer fringes of Tokyo and Osaka metropolitan area. Quadrant D contains prefectures that are away from the Tokyo and Osaka prefecture. The spatial economic distance from Tokyo and Osaka decisively influences in distribution of the prefectures in Japan. In addition, the following spatial economic characteristics are clearly shown. Prefectures that play a major socio-economic role in Japan have high RCI and high PCI and have low CSI and low SCI. In most prefectures near prefectures with large economic scale, both RCI and SCI are low. Conversely, most prefectures on the outskirts of the sphere of the large-scale economic prefectures have low RCI and high SCI. The prefectures that are away from Tokyo and Osaka have high RCI and low CSI.

It is not possible to draw operable and functional conclusions by only categorizing the regional economy by the indexes used in this analysis. This kind of categorization, however, can contribute to show the entrance and direction of a clearer economic analysis of how and to what extent the economies of the city system and connection between the regions influence regional production activity.

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