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Do service sectors need another core sector to improve their productivity?

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Do service sectors need another core sector to improve their productivity?

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Abstract

This paper demonstrates whether large core sectors (the specialized sectors or manufacturing sectors) in the local economy improve the productivity of local non-tradable service sectors and then increase employment using Japanese micro-data. The demand-size of service sectors are determined by the size of the local economy and the size of the local economy is determined by the core sectors. The core sectors are mostly tradable sectors and their demand-size is not limited by the local market size because their goods can supply other regions. The large demand-size of service sectors induces heightened competition and it improves their productivity by Darwinian selection or efficiency increases within firms.

As a result, a 1% larger volume of added value in the specialized sectors in the previous estimation period, a 1% increase in the change in that added value, and a 1% larger volume of added value in the manufacturing sectors in the previous period increase the productivity of the service sectors by approximately 4~5 %, 4% and 2.5%, respectively. An increase of a hundred thousand dollars of added value in the specialized sectors increases the employment by 45 employees in the local service sectors. Furthermore, this paper supports efficiency increases within firms as a mechanism.

Keywords: productivity of service sectors, employment in the service sectors, local economy, manufacturing sectors, specialized sectors

JEL code: D24, O47, J21, R11

1. Introduction

Improving the productivity in service sectors is important in developed countries as service sectors account for quite a large share of the economy in terms of added value as well as employment. In the early literature, "Baumol's diseases" was postulated, which means that "increasing income level induces enriches the proportion of service sectors whose productivity level is relatively-low, and slow down the economic growth (Baumol, 1967)". However, some researchers are finding that some service sectors increase their productivity and contribute to the entire economic growth (Bosworth and Triplett, 2007; Maroto-Sanchez and Cuadrado-Roura, 2009).

One characteristic of service sectors is different from other sectors. That characteristic is "non-tradable". The goods and services in the service sectors are consumed in the same place where these goods and services are supplied[1]. In contrast, goods in manufacturing sectors can be traded outside the regions where these manufacturing goods are produced. Therefore, the volume of demand for service sectors is determined by the size of the local economy, e.g., volume of value added, residents' income level and population size. This characteristic makes improving the productivity in service sectors more important when people consider the regional economy.

The differences in regional economies within the country as well as within the region, such as the European Union, is one of the concerns in the U.S., Japan, EU and other countries because relatively weaker people are kept close to home, and the difference in regional economies creates a difference in living standards among individuals.

The difference in regional economies mainly depends on the local service sectors because its share is quite large everywhere. Service sectors are the non-tradable sectors and their demand sizes are determined by the local economy. In contrast, demand sizes of tradable sectors are not limited by the size of local economies because their goods and services can be demanded from outside the local market. If some

[1] Some service sectors such as computer software, information and technology sectors can trade their goods and services outside the region where these goods are produced. This paper determines that the service sectors indicate the non-tradable service sectors such as retail, hospitals, drinking and eating places.

innovative tradable sectors or manufacturing sectors, or "core sectors" in most regions, are active, lead to more employment, and pay high wages, they demand more goods and services in the local service sectors. The local service sectors become more active. Therefore, some innovative tradable or manufacturing sectors determine the demand size of local service sectors and the local service sectors determine the level of regional economy.

Furthermore, especially in Japan, people discuss a "trickle-down effect" where the benefits from the economic policy for international trade and large firms spread to the domestic small and medium firms that supply goods and services for local residents. Some people criticize that this economic policy does not benefit small and medium firms and argue that improving the domestic local sectors such as nursing and retail trade by themselves is important. However, is it possible that these local firms grow by themselves?

This paper demonstrates whether large/active core sectors in the local economy improve the productivity of local non-tradable service sectors and then increase employment in those service sectors using Japanese micro-data. "Core sectors" are 1) specialized sectors or 2) manufacturing sectors in this paper. This paper explains the specialized sectors in detail in section 3. If the core sector increases the productivity of local service sectors, this paper briefly examines the mechanism behind why the core sectors improve the productivity of service sectors. Previous papers have argued for several mechanisms such as Darwinian selection and efficiency increases within plants or firms (Syverson, 2011). Clarifying the positive effect of core sectors on local service sectors will give policy makers some suggestions on whether economic policy for individual industry is enough or if economic policy based on local industrial structure is needed. Although the demand of local markets is an important issue for the productivity of local service sectors, earlier papers emphasized the supply side, and few papers have studied this issue. Furthermore, the few previous papers used the population density or degree of industrial agglomeration to analyze this issue.

In the next section, this paper summarizes the previous literature. In section 3, this paper explains the empirical approach and data. In section 4, this paper summarizes the Japanese local economy, including regional differences in productivity

in service sectors, regional industrial structure and distribution of population. This paper shows the estimation results in section 5 and investigates the mechanism of increasing productivity in service sectors in section 6. Finally, this paper discusses and concludes this study in section 7.

2. Previous literature

Moretti (2010) and Kazekami (forthcoming) find that an increase in employment in the manufacturing and innovation sectors increases the employment in the service sectors. The demand for service sectors increases because of the increase in the wages and employment in the manufacturing and innovation sectors. A large demand size of the service sectors may induce heightened competition and improving productivity in the service sectors. This paper questions whether the productivity in the service sectors increases or not based on the volume of large core sectors.

Syverson (2011) summarizes the factors that can influence the productivity level and growth in producers' operating environments. First is the competition. One mechanism is Darwinian selection. Competition moves market share towards more efficient producers, shrinking relatively high cost firms/plants, sometimes forcing their exit, and opening up room for more efficient producers. The second mechanism is that the efficiency increases within plants or firms. Heightened competition can induce firms to take costly productivity-raising actions that they may otherwise not.

Syverson (2004) investigates the connection between competition and productivity in a case study of the ready-mixed concrete industry. He finds that the productivity distribution of ready-mixed plants is truncated from below as density rises. Markets with denser construction activity have higher lower-bound productivity levels, higher average productivity, and less productivity dispersion. In another study, Foster, Haltiwanger, and Krizan (2006) find that aggregate productivity growth in the U.S. retail sector is almost exclusively through the exit of less efficient single-store firms and by their replacement with more efficient national chain store affiliates.

This paper emphasizes the demand size in local markets because large demand size generally induces high competition. In Syverson (2004), he evaluates the competition by demand density (demand per unit area). Syverson (2004, 2011) places importance on the demand-side, while most previous research emphasizes the supply-side of service sectors. Furthermore, Vives (2008) reconciles theory with the

available empirical results and shows that the increasing the market size increases cost reduction expenditure per firm, but the number of firms may increase or diminish. He argues that increasing the market size may increase the number of free-entry firms and it increases less than proportionately. Owing to reduction in margins, direct effects prevail and the free-entry number of firms decreases with market size.

Regarding competition, Nishimura, Nakajima and Kiyota (2005) examine whether Darwinian selection worked for Japanese manufacturing firms during the banking crisis period of 1996-1997. They find that Darwinian selection malfunctions in severe recessions. This paper investigates which mechanisms of competition (Darwinian selection or improving the productivity within the plans) work in a later section. This paper finds that the number of firms is the most stagnant in the highest quartile of the change in the service sectors. The efficiency increases within plants may work.

Syverson (2011) proposes other factors that can influence productivity level in producers' operating environment. The second factor is productivity spillover. Thick-input-market effect and knowledge transfer increases productivity. Moretti (2004) empirically demonstrates this factor. The third is deregulation or proper regulation. Deregulation mitigates the incentive that reduces productivity. Syverson (2011) introduces several papers that demonstrate this third factor in the sugar market and in the power plant market, as well as environmental regulations that affect the manufacturing plants' productivity levels. The fourth is flexibility of the input market. It is easier for consumers to shift their purchases from one product to another.

The other factors that improve productivity in the service sectors are also observed in the previous literature. Brezis and Krugman (1997) focus on the industry structure at the beginning and learning by doing. Lucas (1988), Rauch (1991) and Moretti (2004) argue the externality effect of human resources. Moretti (2004) estimates plant-level production functions using a unique firm-worker matched data set. He demonstrates that the documented spillovers between two industries that are located in the same city and are economically close are larger than the spillovers between two industries that are located in the same city and are economically distant. Morikawa (2014) also notes that the scale economy, high operating rate and rational production plan due to large demand are factors that can improve the productivity level in addition to the above factors.

This paper emphasizes the volume of core sectors, in other words, specialized sectors and manufacturing sectors that affect the productivity of service sectors. Therefore, regarding the previous studies concerning manufacturing sectors, Hall

(1992) argues that regions with large manufacturing sectors do not accept new industries because of sunk costs. Brezis and Krugman (1997) also argue that the regions with success in manufacturing do not accept new industries and that employment growth is large in the regions where employment of new industries is concentrated. Simon (2004) finds that the manufacturing employment share negatively correlates with rising, skill-intensive employment growth and positively correlates with rising, unskilled-intensive and declining-industry sectors. Simon (2004) interprets the positive coefficient as mirroring the cities with large manufacturing employment shares that may have served as a source of labor to unskilled-intensive firms in rising industries. However, the positive effects of manufacturing share at the industrial level are fragile and Simon (2004) does not have an opinion about the relationship between productivity and employment growth or saving employment.

This paper has a geography point of view because the volume of core sectors that affect the productivity in the local service sectors is different between cities. Therefore, regarding the factor that determines the geographical difference of productivity, Combes, Duranton and Gobillon (2008) argue that the workers are selected by cities. Glaeser and Mare (2001) and Gould (2007) say that the metropolitan areas increase the quality of employment. Combes, Duranton and Gobillon (2008) estimate the geographical difference of productivity using French data of individuals and demonstrate that the skill of employment most affects productivity and the effect of non-human resources is small.

Regarding the literature related to Japan, only a few researchers have studied productivity in the service sectors because of poor data (Morikawa, 2014; Ito and Lechevalier, 2009; Dekle, 2002). Tabuchi (1986) and Nakamura (1985) analyze the agglomeration of manufacturing but do not analyze its externality effect on service sectors. Dekle (2002) estimates Japanese macro data and finds that the agglomeration economy increases the productivity in the financial, service, retail and wholesale sectors, but does not affect productivity in the manufacturing sectors.

Morikawa (2014) is one of the rare studies that analyzes productivity in the service sectors. He finds that a doubled population density increases productivity in the service sectors by 7-15%. However, he uses a survey of selected service industries and picks up the specific industries, i.e., cinemas, golf courses, tennis clubs, fitness centers, bowling alleys, golf driving ranges, cultural centers, matrimonial agencies and wedding ceremony hall brokers, and aesthetic salon services. Population density is related the demand size, and if core sectors increase the service sectors such as in this paper's framework, the population density may increase. Therefore, this paper also considers

the population density; this paper estimates the effect of population density on the productivity of service sectors using the data of this paper and analyzes the relationships between volume of core sectors and population density.

Moreover, population density is associated with the agglomeration economy that this paper already indicated as one factor. In fact, Morikawa (2014) introduces several papers that find a positive impact of population density on the productivity in the manufacturing sectors. However, this paper also emphasizes the industrial structure a bit more. This paper wonders whether the population density has a positive impact on productivity in the service sectors even if that population density is composed of an aging population. Furthermore, some cities have only declining industries and project a dropping future population density; a major source of employment is in care welfare centers in some cities and care welfare centers are a non-tradable sector. This paper questions whether a level of population density has the same impact on the productivity in the service sectors in those cities.

3. Empirical approach and data

First, this paper estimates the TFP in the service sectors. To estimates the TFP, this paper estimates the production function using following Levinsohn and Petrin's (2003) model.

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \omega_{it} + e_{it} \quad (1)$$

y_{it} is the log of output (sales) in firm i in year t, l_{it} is the log of number of labors in firm i in year t, k_{it} is the log of capital in firm i in year t, m_{it} is intermediate inputs in firm i in year t and ω_{it} is unobservable productivity shock. All firms are non-tradable service sectors, e.g., wholesale, retail trade and entertainment, but do not include the information and communication industry and the electricity, gas, heat supply and water industries. Intermediate input's demand function is given as

$$m_{it} = m_t(\omega_{it}, k_{it})$$

and it must be monotonic in ω_{it} for all k_{it} to qualify as a valid proxy. This paper estimates this function by a two-step estimation. From this production function, this paper calculates the TFP in firm i in year t, TFP_{it}. Then, this paper calculates the average TFP in city j and average TFP during five or six years in city j.

$$TFP_{jp} = \frac{\sum_{t}^{t+4\ or\ 5} average\ TFP_{jt}}{5\ or\ 6\ years} \quad (2)$$

p is the estimation period, i.e., from 2000 to 2005, 2005 to 2010 and 2010 to 2014.

Second, this paper analyzes the effect of core sectors in each city, i.e., specialized sectors or manufacturing sectors on TFP or on the employment using the following model.

$$TFP_{jp} = \gamma_0 + \gamma_1 \ln CV_{jp-1} + \gamma_2 d \ln CV_{jp} + \gamma_3 \ln SV_{jp-1} + \gamma_4 Over65_{jp} + \gamma_5 d_p + \varepsilon_{jp}$$

or

$$\ln empl_{jp} = \gamma_0 + \gamma_1 \ln CV_{jp-1} + \gamma_2 d \ln CV_{jp} + \gamma_3 \ln SV_{jp-1} + \gamma_4 Over65_{jp} + \gamma_5 d_p + \varepsilon_{jp} \quad (3)$$

$\ln CV_{jp-1}$ is the log of total added value in city j in the core sectors (specialized sectors or manufacturing sectors) and it is the average of the previous estimation period p, i.e., from 1995 to 2000, 2000 to 2005 and 2005 to 2010. The value of $d \ln CV_{jp}$ is the change in the log of average total added value in the core sectors from the previous period in city j, whereas $\ln SV_{jp-1}$ is the log of total added value in the service sectors in city j and it is the average of the previous period. $Over65_{jp}$ is the ratio of the elderly population in city j in the first year of the estimation period. $\ln empl_{jp}$ is the log of employment in the service sectors in city j and it is the average of the period p. d_p is the time dummy variable. This paper examines equation (3) as 1) the main estimation, and also estimates 2) the estimation using the commuting zone j instead of city j, 3) the estimation for urban cities and for rural cities, comparing the effect of core sectors in rural and urban cities, 4) the estimation using TFP, which is calculated using the number of sales as an output instead of monetary volume, and 5) the estimation using the population density in city j instead of the log of the average total added value in the core sectors. This paper uses fixed effect model. Additionally, this paper estimates the production function using equation (1) by industry and using the Olley and Pakes model, analyzes the effect of added value in the core sectors, and shows the results in the Appendix1.

It may be possible that the city level is too narrow and the neighboring cities share the same economic zone. Therefore, this paper analyzes at the commuting zone level instead of the city level. To examine whether the conceptual framework in this paper, where the core sectors increase the demand for service sectors and increasing the demand in service sectors induces an improvement in productivity and employment in the service sectors, is applicable even in rural small cities, this paper divides the sample into rural and urban cities.

Furthermore, Syverson (2011) discusses the estimation methods of productivity. He argues that not accounting for the within-industry price difference causes high productivity businesses to not be particularly technologically efficient if prices reflect in part idiosyncratic demand shifts. Therefore, this paper estimates the numerical productivity in the newspaper, photo printing, and bowling sectors because only these sectors had price data available[2]. In addition, some sectors produce several goods, e.g., eating and drinking places sectors sell pizza, Japanese noodles, and other foods. The prices of those goods are different. This paper would like to divide the amount of added value by the price. Hence, this paper needs to study the sectors that produce only one good. Because previous papers considered the effect of population density to capture the demand size or level of competition in the service sectors, this paper conducts analysis using population density too.

To determine the specialized sectors, this paper uses the specialized index in each city published by the Ministry of Internal Affairs and Communications. This specialized index means that employment is concentrated in this sector more than in other cities and this sector may trade goods with other cities. The specialized index, ρ_{sj}, is calculated using the following equation.

$$\rho_{sj} = \frac{x_{sj} / \sum_{s=1}^{m} x_{sj}}{\sum_{j=1}^{n} x_{sj} / \sum_{s=1}^{m} \sum_{j=1}^{n} x_{sj}} \times \kappa_s \quad (4)$$

where x_{sj} is the employment in sector s (s=1,2,….m) in city j (j=1,2,….n). κ_s is the self-sufficient rate in sector s. The core sector is the sector whose specialized index is greater than one. If labor productivity in the sector s is equal between cities, if a sector has more than one on the specialized index, this means that this sector trades surplus with other cities. Sector with more than one on the specialized index are, for example, agriculture, forestry, mining, information services, and manufacturing. Of course, it is different between cities. Some manufacturing sectors are not core sectors for some cities. Some service sectors, such as retail sales of drinking and eating and hotels also could be the core sectors in some cities. This paper does not exclude some service sectors with more than one on the specialized index because these sectors have large demand at the local level. I would like to use the specialized index calculated in the same economic zones in future study. (When this paper considers the analysis at the commuting zone level, this paper accounts for the specialized sectors if at least one city in the commuting zone has more than one specialized index.)

[2] Data of price by city is only available in the selected cities.

To calculate the numerical productivity, this paper estimates the numerical volume of output in the newspaper, photo printing, and bowling sectors in the following equation.

$$Numberical\ voluem\ of\ output_{sj} = \overline{Total\ added\ value_{sij} \Big/ price_{sj}} \tag{5}$$

where $Total\ added\ value_{sij}$ is currency added value in firm i in sector s in city j, $price_{sj}$ is price of sector s in city j and $Numberical\ voluem\ of\ output_{sj}$ is an average numerical volume of output by city j. Using this numerical volume of output, this paper estimates the numerical productivity using equations (1) and (2). Therefore, this paper estimates the effect of core sectors on numerical productivity using the average numerical productivity 1) of the newspaper, photo printing and bowling sectors and 2) of the newspaper and photo printing sectors. This is because the price data from bowling[3] is not available in cities with populations of less than 50,000.

As for data, this paper obtains data on sales, added value, tangible fixed assets, intermediate inputs (cost plus sales and general administration cost minus payroll, depreciation, welfare, rent and tax) and employment from the Basic Survey of Japanese Business Structure and Activities from 1995 to 2014 conducted by the Minister of Economy, Trade and Industry. The survey is administered to enterprises with 50 or more employees that have excess capital or investment funds valued at over 30 million yen. This survey collects data by each firm. Therefore, this paper uses the Establishment and Enterprise Census to incorporate the information detailing the locations of the enterprise establishments into the Basic Survey of Japanese Business Structure and Activities.

The Establishment and Enterprise Census is conducted for all establishments in Japan by the Ministry of Internal Affairs and Communications. This paper divides the data in the Basic Survey of Japanese Business Structure and Activities by the number of establishments and aggregates the data by city. The cities sometimes merge during the estimation periods. This paper adjusts for those cases. When this paper uses the commuting zones, this paper refers to the commuting zone codes in 2010 as proposed by the Center for Spatial Information Science[4]. A commuting zone is the zone in which the residents share the same economic and social area and in which more than

[3] The price data of the bowling sector in 2010 are not available in the published data.
[4] Kanamoto, a researcher at the Center for Spatial Information Science, proposed the data.

10% of the residents commute to the same central cities. This paper aggregates the data collected at the city level and simply calculates the average number[5] by commuting zone.

This paper also obtains the ratio of the elderly population (more than 65 years old) and the population from the Basic Resident Registration. This paper divides the cities into urban and rural using the median of population in 2000; cities with more than the median of population are classified as urban cities and those under the median of population are classified as rural cities. This paper obtains the population density from the population census. Table 1 shows detailed descriptive statistics.

4. Regional difference in productivity and industrial structure in Japan

Before the estimation, this paper shows the Japanese local economy in the service sectors. Figure 1 indicates the Japanese map color-coded by the quartile of total factor productivity (TFP) of service sectors, the quartile of population density, the quartile of added value in the manufacturing sectors and the quartile of added value in the specialized sectors. The TFP of service sectors[6] differs between cities. ("City" means municipality in this paper, in other words, it includes rural areas.) This difference is significant as much as the regional differences of TFP are in the manufacturing sectors. Figure 2 indicates the histogram of TFP in service sectors in each city (red line) and TFP in manufacturing sectors in each city (blue line). The standard deviation of TFP in manufacturing sectors, 0.68, is a little bit bigger than in service sectors, 0.51, but the standard deviation of TFP in the service sectors is not small. The map of population density in Figure 1 indicates that most people live in several large cities, especially in three large economic cities (Tokyo, Osaka and Nagoya). The regional difference in TFP is very similar to the difference of added value in the manufacturing or the specialized sectors rather than the map of population density. Of course, the population density and the activity of core sectors are related. This paper estimates this relationship in section 5.

[5] This paper does not use the population weight in this version.
[6] This paper explains the estimation method of TFP in the next section.

5. Estimation Results

Main results

Table 2 indicates the effect of regional specialized sectors on the TFP of the local service sectors using the equation (3). Columns (3) to (5) show that the 1% higher level of added value in the specialized sectors in the previous estimation period increases the productivity, TFP, in the local service sectors by approximately 4-5 %, if the change in the added value in the specialized sectors is the same volume during the estimation period. The 1% increase of the change in the added value in the specialized sectors during the estimation period increases the TFP in the service sectors by approximately 4 %. The level of added value in the service sectors in the previous period also increases the TFP in the service sectors.

Table 3 indicates the effect of manufacturing sectors on the TFP in the local service sectors. The level of added value in the manufacturing sectors in the previous period increases the TFP in the local service sectors by 2.5 %, as indicated in columns (1) and (5). Although the results are not shown in Table 3, the effect of the level of added value in the manufacturing sectors in the previous period on the TFP does not change if this paper includes only the ratio of elderly population, the added value of service sectors in the previous sectors and both variables without the change of the added value in the manufacturing sectors. It also does not change if this paper includes the change of added value in the manufacturing sectors and the added value in the service sectors in the previous period[7]. The change in the added value in the manufacturing sectors decreases the TFP in the service sectors, but this negative effect is insignificant if the level of added value in the manufacturing in the previous period is controlled.

The results in Table 2 and Table 3 clarify that the volume of core sectors in a local economy increases the productivity in the local service sectors. Even if this paper calculated the productivity using alternative method, i.e. the estimation by industry and the estimation using Olley and Pakes model, the volume of core sectors in a local economy increases the productivity in the local service sectors as shown in Appendix 1 table. The magnitudes of effect are almost similar to the main results. One exception is that the magnitude of effect from the volume of specialized sectors on TFP estimated by each industry is little bit larger than that of main results or that of Olley and Pakes model. The increasing of productivity in the service sector might increase employment in the service sectors. Tables 4 and 5 show the effect of core sectors on employment in the local service sectors.

[7] These results are available upon request.

Table 4 indicates that the higher added value in the specialized sectors increases employment in the local service sectors. This means that one hundred thousand dollars of added value in the specialized sectors increase the employment in the local service sectors by 45 employees when this paper uses the average added value in the specialized sectors and the average level of employment in the service sectors. The change in the added value of the specialized sectors also increases the employment in the service sectors. Table 5 implies the increase in the change in the added value in the manufacturing sectors decreases employment in the service sectors, however, the change in the added value in manufacturing decreases during the estimation period. This may indicate that the industrial structure changed.

Estimation by commuting zones

It may be possible that the city level is too narrow and the neighboring cities share the same economic zone. Therefore, this paper does analysis at the commuting zone level instead of the city level. However, the main results do not change. Table 6 indicates that the volume of specialized sectors in the previous period increases the productivity in the service sectors as well as the change in the added value of specialized sectors. The level of added value of manufacturing sectors in the previous period positively affects the productivity level in the service sectors when the ratio of elderly population and the level of added value in the service sectors at the previous period are controlled, but the change in the added value of manufacturing is not included. As for the level of employment in the service sectors shown in Table 7, the level in the previous period and the change in the added value of specialized sectors increase the level of employment as well in Table 4. The added value of manufacturing sectors in the previous period also increases employment without its change, regardless of whether this paper controls for the elderly population rate and the added value in the service sectors in the previous period[8].

Therefore, even if this paper uses the vaster economic zone rather than the city level, the core sectors, especially their volume in the previous period, increases the productivity and the employment of the local service sectors.

[8] The result without the elderly population rate and the added value in the service sectors in the previous period is available upon request.

Comparing the effect between urban and rural cities

This paper examines whether the core sectors determine the demand size of local service sectors and if increasing demand improves productivity even in the small cities. Table 8 indicates that the specialized sectors affect the productivity of service sectors even in the rural small cities. Moreover, the magnitude of added value in the specialized sectors in the previous period of rural cities is larger than those of urban cities. The population of rural cities is under the median and that of urban cities is over the median. The level of added value in the manufacturing sectors in the previous period has a positive effect on the productivity in the service sectors when estimated without its change. The magnitude of urban cities is larger than that of rural cities. The reason might be some urban cities have large manufacturing firms. As for rural cities, the change in added value of the manufacturing sectors in rural cities decreases the employment in service sectors as shown in Table 9. During the estimation period, the added value of manufacturing sectors is almost negative in many rural cities. Therefore, the decrease in the manufacturing sectors increases the number of local service sectors in rural cities. The diminishing of manufacturing sectors may indicate the industrial structure change in rural cities. This impact is bigger in rural cities than in urban cities.

Estimation using the numerical productivity

Table 10 indicates the result using the numerical productivity of service sectors instead of currency productivity because currency productivity includes increases in price. Columns (1) and (3) show that the level of added value of specialized sectors in the previous period and the change in the added value of specialized sectors increase the numerical productivity when this paper estimates for the newspaper, photo printing, and bowling sectors; and in newspaper and photo printing service sectors. However, this paper does not confirm the positive effect of the level of added value in the manufacturing sectors in the previous period when this paper uses numerical productivity. Additionally, this paper analyzes the effect of the core sectors on employment using the same sample cities. Columns (5) through (8) indicate that the level of added value in the specialized sectors in the previous period, the change in the added value in the specialized sectors and the level of added value in the manufacturing sectors in the previous period increase employment.

Effect of population density

Few studies have examined the effect of demand size on productivity in the service sectors and those studies consider the population density. Therefore, this paper estimates the effect of population density on the productivity of the service sector and the number of employment. Table 11 indicates that the 1% crowded population density in the previous period increases the productivity in the local service sectors by 1.2%. Table 2 already indicates that an increase of three hundred million dollars of added value in the specialized sectors increases the productivity in the local service sectors by 4-5%. In contrast, Table 11 shows that the increase of 11.5 people per square kilometer in the previous period increases the productivity in the local service sectors by 1.2%, and an increase of 46 people per square kilometer increases the productivity in the local service sectors by 4.8%. Which is harder: three hundred million dollars of added value or 46 people per square kilometer? Additionally, there might be a relationship between improving the productivity in the service sectors and the increase in the local population density. This paper discusses this issue later.

Remarkably, the population density in the *previous* period has a negative impact on the employment in the service sectors; however, the population density in the *same* period has a positive impact on employment in the service sectors. The population density in the previous period does not increase employment directly. A previous paper that finds a positive impact of population density on productivity (Morikawa, 2014) uses the population density in 2005 and the data for estimation of productivity from 2002-2005. Positive correlation between population density and the productivity of service sectors is consistent with the theory of this paper that the expanding of core sectors increases the demand size of service sectors via the higher wages of core sectors and increases of their employment, which then increases their productivity. Increasing the employment of core sectors increases the population density. However, in this case, the population density does not directly increase the productivity of service sectors. As for employment, the results of this paper indicate that the improving the productivity in the service sectors results in the increase in employment and therefore increases in the population density.

Table 12 indicates that the added value of specialized sectors in the previous period increases the current population density and the change in the population density. Moreover, the added value of specialized sectors in the previous period does not positively correlate with population density in the previous period. Additionally, this paper compares the magnitude of coefficients between the volume of core sectors and the population density. Table 4 already indicates that one hundred thousand

dollars of added value in the specialized sectors increase the employment by 45 employees. In contrast, Table 11 shows that an increase in 45 people per square kilometers at the same time as the estimation period of employment created 45 jobs.

6. Investigation of the mechanisms

In this section, this paper roughly investigates the mechanisms of improving the productivity in the service sectors in the cities with large core sectors. Figure 3 indicates the histogram of productivity in the service sectors in 2010. The red line shows the histogram of cities that have larger specialized sectors than the mean. The blue line shows the histogram of cities that have smaller specialized sectors than the mean. The few cities with low productivity in the service sectors in the cities with larger specialized sectors are shown by a red line. This means that the firms with lower productivity in the service sectors are kicked out of the market. The firms with higher productivity in the service sectors are selected in the cities with larger specialized sectors. The average of productivity in the cities with the large specialized sectors is higher than that of the cities with small specialized sectors. Moreover, the dispersion of productivity is less in the cities with large specialized sectors. Figure 4 indicates the histogram of productivity in the service sectors in 2010, dividing the cities by the mean of added value of manufacturing. As well as the specialized sectors, there are a few firms with lower productivity in the service sectors in the cities with larger manufacturing sectors.

Next, this paper investigates which mechanism of improving the productivity works, Darwinian selection or the efficiency increases within plants or firms. First, this paper compares the number of firms in the service sectors in each city by quartile of productivity in the service sectors. Figure 5 indicates that the fourth quartile (highest productivity-group) has the largest number of firms in the service sectors. The competition between the firms might be intense because of the number of firms. Second, this paper compares the change in the number of firms in the service sectors in each city by the quartile of the *change in the productivity* in the service sectors. Figure 6 indicates that the cities with the highest change in the productivity in the service sectors, the cities in the fourth quartile, are most stagnant. The cities in the first and second quartiles increase the number of firms in the service sectors much more in 2005 and 2007 but also lost the largest number of firms in 2008 and 2011. Therefore, it might be possible that the efficiency increases in the exciting firms or plants results in the

lower productivity firms in the cities with large core sectors being truncated, as shown in Figures 3 and 4.

7. Conclusion

This paper examines whether the productivity and employment in the local service sectors are higher in cities with larger core sectors (the specialized sectors or manufacturing sectors). The competitions of service sectors are high if the demand size of service sectors are large. The demand size of service sectors are decided by the size of the local economy and the size of the local economy is determined by the core sectors. The core sectors are mostly tradable sectors and their demand size is not determined by the local market size because their goods or services can be sold outside the local areas.

As a result, a 1% higher level of added value in the specialized sectors in the previous estimation period, a 1% increase in the change in the added value in the specialized sectors and a 1% higher level of added value in the manufacturing sectors in the previous estimation period increase the productivity in the local service sectors by approximately 4~5 %, 4% and 2.5%, respectively. Furthermore, the increase of one hundred thousand dollars of added value in the specialized sectors increases the employment by 45 employees in the local service sectors. These results are confirmed even if this paper divides the region using the commuting zone instead of city.

The specialized sector affects the productivity of service sectors even in the rural small cities. Moreover, the magnitude of the effect from the added value in the specialized sectors in the previous period of rural cities is larger than those of urban cities. In contrast, the magnitude of the effect of the manufacturing sector in the urban cities is larger than in the rural cities. The reason might be some urban cities have large manufacturing firms. The diminishing of manufacturing sectors has a positive impact on the employment in the service sectors in rural cities. It seems like the appearance of the industrial structure changes. This impact is larger in rural cities rather than in urban cities.

This paper also analyzes the above estimation using the numerical productivity in the newspaper, photo printing and bowling sectors instead of currency productivity because currency productivity includes the increase in price. This paper confirms that the positive effect of the specialized sectors on the productivity and employment in the service sectors. To compare with the few previous studies that consider the effect of

demand size on the productivity in the service sectors, this paper uses the population density as well as the previous studies. An increase of 46 people per square kilometer in the previous period increases the productivity in the local service sectors by 4.8% while three hundred million dollars of added value in the specialized sectors increases the productivity in the local service sectors by almost the same amount. High population density means the large demand size of service sectors. Therefore, the results of previous studies are consistent with this paper. However, this paper finds that the population density in the previous period does not increase the employment in the service sectors but the current population density does. Therefore, the core sectors increase the demand size of service sectors and the productivity of service sectors, and then result in an increase in employment and population density. In fact, the results of regression of the added value of specialized sectors in the previous period on the current population density and the change in the population density indicate the positive coefficients.

The volume of core sectors in the local economy increases the demand in the local service sectors; it may increase the competition, and it increases the productivity of exciting firms in the local service sectors or it selects higher-productivity firms. The increase in the service sector might increase the employment in the service sectors. To investigate the mechanisms, this paper observes the number of firms in the service sectors in each city by quartile of productivity in the service sectors and the change in the number of firms in each city by quartile of the change in the productivity in the service sectors. The cities with higher productivity have a large number of firms, but it seems that the entry and exit occurs less in the cities with the higher change in the productivity of the service sectors.

One of the limitations of this research is that this study does not calculate the specialized index of each commuting zone for the estimation using the commuting zone. This paper uses the specialized index calculated by each city that is published by Ministry of Internal Affairs and Communications. This paper accounts for the specialized sectors if at least one city in the commuting zone has more than one specialized index. However, the specialized index in some cities indicates that, for example, retail sale of drinking and eating sector is more than one. This may be due to residents in neighboring cities coming to the shops in the central city. The commuting zone includes the central city and the neighboring city. Therefore, the specialized index of retail sale of drinking and eating sector in this commuting zone may be less than one, and the retail sales of drinking and eating sector is not the specialized sector for this commuting zone. If this paper can obtain the data of self-sufficient data for a calculation

of the specialized index, this paper would like to calculate the specialized index by commuting zone and analyze the evidence using the commuting zone in future research.

As for expanding studies, the more detailed investigation of mechanisms behind why large core sectors and large demand size of service sectors improve the productivity is needed even if large core sectors do increase the productivity of service sectors. Furthermore, for future research, this paper would like to analyze whether the cities shrunk the core sectors by offshoring decrease the demand of local service sectors and those cities decrease the productivity of the service sectors.

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Table1 descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
TFP in the service sectors	4765	5.569	0.416	3.066	8.621
the log of employment in the service sectors	4765	6.847	1.775	1.803	11.573
ln CV_1(specialized sectors)	4765	8.997	1.759	1.918	14.173
ln CV_1 (manufacturing sectors)	4765	8.754	1.920	1.342	13.904
d ln CV (specialized sectors)	4765	0.067	0.438	-3.494	5.111
d ln CV (manufacturing sectors)	4765	-0.058	0.366	-2.784	3.263
ln SV_1	4765	8.271	1.901	-1.290	13.398
over65	4765	25.617	6.234	9.032	54.290
dummy1	4765	0.336	0.472	0.000	1.000
dummy2	4765	0.332	0.471	0.000	1.000
log of current population density	4764	5.430	1.785	0.742	10.016
log of population density in the previous period	4765	5.464	1.753	1.394	9.900
change in the log of population density	4764	-0.034	2.630	-8.246	8.269

ln CV_1: log of total added value in the core sectors (specialized sectors or manufacturing sectors) of previous period

d ln CV : the change in the log of average total added value in the core sectors from the previous period

ln SV_1: the log of total added value in the service sectors of the previous period

Over65: the ratio of the elderly population in the first year of the estimation period

Dummy1: dummy for the second period

Dummy2: dummy for the third period

Table2 the main estimation results of TFP using the specialized sectors

	(1)	(2)	(3)	(4)	(5)
VARIABLES	TFP in the service sectors				
ln CV_1(specialized sectors)	0.00806		0.0514***	0.0519***	0.0421***
	(0.00718)		(0.0144)	(0.0144)	(0.0138)
d ln CV (specialized sectors)		0.00463	0.0427***	0.0426***	0.0410***
		(0.00613)	(0.0123)	(0.0123)	(0.0118)
ln SV_1					0.151***
					(0.00928)
over65				0.00257	0.00365*
				(0.00206)	(0.00198)
dummy1	0.108***	0.110***	0.104***	0.0969***	0.0764***
	(0.00546)	(0.00536)	(0.00562)	(0.00775)	(0.00755)
dummy2	0.0906***	0.0937***	0.0885***	0.0756***	0.0265**
	(0.00569)	(0.00554)	(0.00571)	(0.0118)	(0.0117)
Constant	5.430***	5.501***	5.040***	4.976***	3.809***
	(0.0638)	(0.00390)	(0.129)	(0.139)	(0.151)
Observations	4,765	4,765	4,765	4,765	4,765
Number of x1	1,631	1,631	1,631	1,631	1,631
Adjusted R-squared	-0.318	-0.318	-0.313	-0.313	-0.211
city FE	Yes	Yes	Yes	Yes	Yes
year FE	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

ln CV_1: log of total added value in the core sectors (specialized sectors or manufacturing sectors) of previous period

d ln CV : the change in the log of average total added value in the core sectors from the previous period

ln SV_1: the log of total added value in the service sectors of the previous period

Over65: the ratio of the elderly population in the first year of the estimation period

Dummy1: dummy for the second period

Dummy2: dummy for the third period

Table3 the main estimation results of TFP using the manufacturing sectors

	(1)	(2)	(3)	(4)	(5)
VARIABLES	TFP in the service sectors				
ln CV_1 (manufacturing sectors)	0.0255***		0.0119	0.0120	0.0249**
	(0.00973)		(0.0128)	(0.0128)	(0.0123)
d ln CV (manufacturing sectors)		-0.0228***	-0.0166	-0.0169*	-0.00988
		(0.00776)	(0.0102)	(0.0103)	(0.00984)
ln SV_1					0.153***
					(0.00927)
over65				0.00266	0.00391**
				(0.00205)	(0.00197)
dummy1	0.113***	0.115***	0.115***	0.109***	0.0864***
	(0.00554)	(0.00565)	(0.00566)	(0.00769)	(0.00750)
dummy2	0.0941***	0.0934***	0.0939***	0.0807***	0.0287**
	(0.00541)	(0.00538)	(0.00541)	(0.0115)	(0.0115)
Constant	5.276***	5.498***	5.394***	5.331***	3.950***
	(0.0859)	(0.00396)	(0.112)	(0.122)	(0.144)
Observations	4,765	4,765	4,765	4,765	4,765
Number of x1	1,631	1,631	1,631	1,631	1,631
Adjusted R-squared	-0.315	-0.315	-0.315	-0.314	-0.210
city FE	Yes	Yes	Yes	Yes	Yes
year FE	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

ln CV_1: log of total added value in the core sectors (specialized sectors or manufacturing sectors) of previous period

d ln CV : the change in the log of average total added value in the core sectors from the previous period

ln SV_1: the log of total added value in the service sectors of the previous period

Over65: the ratio of the elderly population in the first year of the estimation period

Dummy1: dummy for the second period

Dummy2: dummy for the third period

Table4 the main estimation results of employment using the specialized sectors

	(1)	(2)	(3)	(4)	(5)
VARIABLES	the log of employment in the service sectors				
ln CV_1(specialized sectors)	0.0436***		0.231***	0.231***	0.220***
	(0.00908)		(0.0178)	(0.0178)	(0.0173)
d ln CV (specialized sectors)		0.0136*	0.184***	0.184***	0.183***
		(0.00778)	(0.0152)	(0.0152)	(0.0147)
ln SV_1					0.168***
					(0.0116)
over65				-0.00102	0.000181
				(0.00255)	(0.00247)
dummy1	0.246***	0.253***	0.225***	0.228***	0.205***
	(0.00690)	(0.00679)	(0.00696)	(0.00960)	(0.00942)
dummy2	0.305***	0.319***	0.295***	0.301***	0.246***
	(0.00719)	(0.00702)	(0.00707)	(0.0146)	(0.0146)
Constant	6.271***	6.655***	4.584***	4.610***	3.310***
	(0.0806)	(0.00495)	(0.160)	(0.172)	(0.189)
Observations	4,765	4,765	4,765	4,765	4,765
Number of x1	1,631	1,631	1,631	1,631	1,631
Adjusted R-squared	0.145	0.139	0.183	0.182	0.234
city FE	Yes	Yes	Yes	Yes	Yes
year FE	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

ln CV_1: log of total added value in the core sectors (specialized sectors or manufacturing sectors) of previous period

d ln CV : the change in the log of average total added value in the core sectors from the previous period

ln SV_1: the log of total added value in the service sectors of the previous period

Over65: the ratio of the elderly population in the first year of the estimation period

Dummy1: dummy for the second period

Dummy2: dummy for the third period

Table5 the main estimation results of employment using the manufacturing sectors

	(1)	(2)	(3)	(4)	(5)
VARIABLES	the log of employment in the service sectors				
ln CV_1 (manufacturing sectors)	0.0299**		-0.00821	-0.00827	0.00634
	(0.0123)		(0.0163)	(0.0163)	(0.0158)
d ln CV (manufacturing sectors)		-0.0423***	-0.0466***	-0.0465***	-0.0385***
		(0.00983)	(0.0130)	(0.0130)	(0.0126)
ln SV_1					0.173***
					(0.0118)
over65				-0.00129	0.000125
				(0.00260)	(0.00252)
dummy1	0.257***	0.263***	0.262***	0.266***	0.241***
	(0.00703)	(0.00716)	(0.00717)	(0.00975)	(0.00959)
dummy2	0.318***	0.317***	0.317***	0.323***	0.264***
	(0.00686)	(0.00682)	(0.00685)	(0.0146)	(0.0147)
Constant	6.393***	6.651***	6.723***	6.753***	5.186***
	(0.109)	(0.00502)	(0.142)	(0.155)	(0.184)
Observations	4,765	4,765	4,765	4,765	4,765
Number of x1	1,631	1,631	1,631	1,631	1,631
Adjusted R-squared	0.140	0.143	0.143	0.143	0.197
city FE	Yes	Yes	Yes	Yes	Yes
year FE	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

ln CV_1: log of total added value in the core sectors (specialized sectors or manufacturing sectors) of previous period

d ln CV : the change in the log of average total added value in the core sectors from the previous period

ln SV_1: the log of total added value in the service sectors of the previous period

Over65: the ratio of the elderly population in the first year of the estimation period

Dummy1: dummy for the second period

Dummy2: dummy for the third period

Table6 the estimation results of TFP by commuting zones

	(1)	(2)	(3)	(4)	(5)
VARIABLES	TFP in the service sectors				
ln CV_1(specialized sectors)	0.0600***	0.0421**			
	(0.0201)	(0.0194)			
d ln CV (specialized sectors)	0.0646***	0.0528***			
	(0.0176)	(0.0169)			
over65		0.00229		0.00269	0.00270
		(0.00217)		(0.00217)	(0.00217)
ln SV_1		0.162***		0.165***	0.165***
		(0.0128)		(0.0128)	(0.0128)
dummy1	0.104***	0.0802***	0.114***	0.0863***	0.0881***
	(0.00806)	(0.00972)	(0.00818)	(0.00960)	(0.00975)
dummy2	0.0991***	0.0412***	0.101***	0.0386***	0.0383***
	(0.00818)	(0.0137)	(0.00778)	(0.0135)	(0.0135)
ln CV_1 (manufacturing sectors)			0.0134	0.0284**	0.0171
			(0.0175)	(0.0130)	(0.0168)
d ln CV (manufacturing sectors)			-0.0105		-0.0149
			(0.0146)		(0.0140)
Constant	4.980***	3.786***	5.398***	3.888***	3.981***
	(0.179)	(0.202)	(0.151)	(0.167)	(0.188)
Observations	2,897	2,897	2,897	2,897	2,897
Number of x1	997	997	997	997	997
Adjusted R-squared	-0.341	-0.238	-0.349	-0.242	-0.242
city FE	Yes	Yes	Yes	Yes	Yes
year FE	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

ln CV_1: log of total added value in the core sectors (specialized sectors or manufacturing sectors) of previous period
d ln CV : the change in the log of average total added value in the core sectors from the previous period
ln SV_1: the log of total added value in the service sectors of the previous period
Over65: the ratio of the elderly population in the first year of the estimation period
Dummy1: dummy for the second period
Dummy2: dummy for the third period

Table7 the estimation results of employment by commuting zones

VARIABLES	(1)	(2)	(3)	(4)	(5)
	the log of employment in the service sectors				
ln CV_1(specialized sectors)	0.219***	0.202***			
	(0.0226)	(0.0220)			
d ln CV (specialized sectors)	0.177***	0.165***			
	(0.0198)	(0.0192)			
over65		0.000599		0.000800	0.000813
		(0.00246)		(0.00251)	(0.00251)
ln SV_1		0.161***		0.172***	0.172***
		(0.0146)		(0.0149)	(0.0149)
dummy1	0.223***	0.203***	0.255***	0.230***	0.233***
	(0.00907)	(0.0110)	(0.00940)	(0.0111)	(0.0113)
dummy2	0.290***	0.241***	0.309***	0.254***	0.253***
	(0.00920)	(0.0156)	(0.00894)	(0.0156)	(0.0156)
ln CV_1 (manufacturing sectors)			0.00892	0.0334**	0.0125
			(0.0201)	(0.0151)	(0.0194)
d ln CV (manufacturing sectors)			-0.0231		-0.0277*
			(0.0167)		(0.0162)
Constant	4.547***	3.406***	6.416***	4.816***	4.989***
	(0.201)	(0.229)	(0.173)	(0.193)	(0.218)
Observations	2,897	2,897	2,897	2,897	2,897
Number of x1	997	997	997	997	997
Adjusted R-squared	0.151	0.201	0.110	0.168	0.169
city FE	Yes	Yes	Yes	Yes	Yes
year FE	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

ln CV_1: log of total added value in the core sectors (specialized sectors or manufacturing sectors) of
d ln CV : the change in the log of average total added value in the core sectors from the previous period
ln SV_1: the log of total added value in the service sectors of the previous period
Over65: the ratio of the elderly population in the first year of the estimation period
Dummy1: dummy for the second period
Dummy2: dummy for the third period

Table8 estimation results to compare between urban and rural cities

	Urban cities				Rural cities			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	TFP in the service sectors							
ln CV_1(specialized sectors)	0.0479***	0.0315**			0.0501**	0.0440**		
	(0.0152)	(0.0151)			(0.0208)	(0.0201)		
d ln CV (specialized sectors)	0.0476***	0.0458***			0.0472***	0.0444***		
	(0.0125)	(0.0123)			(0.0178)	(0.0172)		
over65		0.00578***	0.00623***	0.00634***		0.00541	0.00570	0.00570
		(0.00143)	(0.00142)	(0.00142)		(0.00360)	(0.00361)	(0.00361)
ln SV_1		0.104***	0.103***	0.101***		0.140***	0.141***	0.141***
		(0.0130)	(0.0126)	(0.0126)		(0.0132)	(0.0132)	(0.0132)
dummy1	0.0899***	0.0650***	0.0725***	0.0757***	0.115***	0.0815***	0.0897***	0.0895***
	(0.00399)	(0.00582)	(0.00572)	(0.00586)	(0.0101)	(0.0129)	(0.0128)	(0.0129)
dummy2	0.0547***	0.00108	0.000236	0.000163	0.126***	0.0519***	0.0533***	0.0534***
	(0.00411)	(0.00940)	(0.00921)	(0.00920)	(0.0103)	(0.0198)	(0.0195)	(0.0195)
ln CV_1 (manufacturing sectors)			0.0317***	0.00886			0.0269*	0.0292
			(0.00878)	(0.0126)			(0.0142)	(0.0183)
d ln CV (manufacturing sectors)				-0.0276**				0.00283
				(0.0110)				(0.0141)
Constant	5.065***	4.135***	4.135***	4.376***	5.059***	4.006***	4.132***	4.114***
	(0.152)	(0.183)	(0.158)	(0.185)	(0.165)	(0.204)	(0.176)	(0.197)
Observations	2,407	2,407	2,407	2,407	2,329	2,329	2,329	2,329
Number of x1	808	808	808	808	817	817	817	817
Adjusted R-squared	-0.050	-0.003	-0.004	-0.001	-0.343	-0.250	-0.252	-0.252
city FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

ln CV_1: log of total added value in the core sectors (specialized sectors or manufacturing sectors) of previous period

d ln CV : the change in the log of average total added value in the core sectors from the previous period

ln SV_1: the log of total added value in the service sectors of the previous period

Over65: the ratio of the elderly population in the first year of the estimation period

Dummy1: dummy for the second period

Dummy2: dummy for the third period

Table9 estimation results of employment to compare between urban and rural cities

	Urban cities				Rural cities			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	the log of employment in the service sectors							
ln CV_1(specialized sectors)	0.183***	0.134***			0.239***	0.232***		
	(0.0221)	(0.0213)			(0.0260)	(0.0251)		
d ln CV (specialized sectors)	0.130***	0.129***			0.200***	0.196***		
	(0.0183)	(0.0174)			(0.0223)	(0.0215)		
over65		-0.00307	-0.00285	-0.00281		0.00561	0.00604	0.00605
		(0.00202)	(0.00204)	(0.00204)		(0.00451)	(0.00464)	(0.00463)
ln SV_1		0.238***	0.245***	0.244***		0.171***	0.176***	0.175***
		(0.0184)	(0.0181)	(0.0182)		(0.0166)	(0.0170)	(0.0170)
dummy1	0.220***	0.210***	0.226***	0.227***	0.236***	0.197***	0.232***	0.235***
	(0.00581)	(0.00824)	(0.00823)	(0.00844)	(0.0127)	(0.0162)	(0.0164)	(0.0165)
dummy2	0.304***	0.271***	0.278***	0.278***	0.296***	0.210***	0.227***	0.226***
	(0.00599)	(0.0133)	(0.0132)	(0.0133)	(0.0129)	(0.0247)	(0.0251)	(0.0251)
ln CV_1 (manufacturing sectors)			0.0195	0.0117			0.0426**	0.0131
			(0.0126)	(0.0182)			(0.0182)	(0.0235)
d ln CV (manufacturing sectors)				-0.00945				-0.0359**
				(0.0159)				(0.0181)
Constant	6.026***	4.337***	5.422***	5.504***	3.555***	2.295***	3.758***	3.987***
	(0.222)	(0.259)	(0.228)	(0.267)	(0.206)	(0.256)	(0.226)	(0.253)
Observations	2,407	2,407	2,407	2,407	2,329	2,329	2,329	2,329
Number of x1	808	808	808	808	817	817	817	817
Adjusted R-squared	0.566	0.608	0.596	0.595	0.018	0.083	0.032	0.034
city FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

ln CV_1: log of total added value in the core sectors (specialized sectors or manufacturing sectors) of previous period

d ln CV : the change in the log of average total added value in the core sectors from the previous period

ln SV_1: the log of total added value in the service sectors of the previous period

Over65: the ratio of the elderly population in the first year of the estimation period

Dummy1: dummy for the second period

Dummy2: dummy for the third period

Table10 estimation results using the numerical productivity

	newspaper, photo printing, and bowling		newspaper and photo printing		newspaper, photo printing, and bowling		newspaper and photo printing	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	TFP in the service sectors				the log of employment in the service sectors			
ln CV_1(specialized sectors)	1.594***		1.724***		0.212***		0.211***	
	(0.563)		(0.562)		(0.0469)		(0.0478)	
d ln CV (specialized sectors)	1.609***		1.639***		0.154***		0.156***	
	(0.465)		(0.465)		(0.0388)		(0.0396)	
over65	-0.0263	-0.0102	-0.0372	-0.0215	0.000181	0.000801	0.00109	0.00193
	(0.0405)	(0.0408)	(0.0411)	(0.0414)	(0.00338)	(0.00341)	(0.00350)	(0.00353)
ln SV_1	-0.580	-0.420	-0.441	-0.189	0.203***	0.269***	0.206***	0.269***
	(0.447)	(0.406)	(0.447)	(0.407)	(0.0373)	(0.0339)	(0.0380)	(0.0347)
dummy1	0.364**	0.500***	0.396**	0.554***	0.181***	0.208***	0.179***	0.205***
	(0.156)	(0.167)	(0.156)	(0.166)	(0.0130)	(0.0134)	(0.0133)	(0.0136)
dummy2	1.494***	1.456***	1.699***	1.677***	0.257***	0.267***	0.256***	0.265***
	(0.242)	(0.244)	(0.241)	(0.244)	(0.0201)	(0.0204)	(0.0205)	(0.0208)
ln CV_1 (manufacturing sectors)		0.0657		0.132		0.0527**		0.0519**
		(0.426)		(0.429)		(0.0245)		(0.0251)
d ln CV (manufacturing sectors)		-0.0386		-0.0384				
		(0.421)		(0.431)				
Constant	-0.363	14.21**	-2.581	11.76*	4.275***	5.310***	4.248***	5.296***
	(6.331)	(6.387)	(6.333)	(6.409)	(0.528)	(0.465)	(0.539)	(0.477)
Observations	746	746	720	720	746	746	720	720
Number of x1	281	281	273	273	281	281	273	273
Adjusted R-squared	-0.160	-0.191	-0.051	-0.080	0.650	0.639	0.648	0.637
city FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

ln CV_1: log of total added value in the core sectors (specialized sectors or manufacturing sectors) of previous period

d ln CV : the change in the log of average total added value in the core sectors from the previous period

ln SV_1: the log of total added value in the service sectors of the previous period

Over65: the ratio of the elderly population in the first year of the estimation period

Dummy1: dummy for the second period

Dummy2: dummy for the third period

Table11 the estimation results of the effect from population density

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	TFP in the service sectors			the log of employment in the service sectors			the log of employment in the service sectors		
ln_dpop_1	0.0134***	0.0117***	0.0120***	-0.00765***	-0.0106***	-0.00924***			
	(0.00171)	(0.00167)	(0.00166)	(0.00219)	(0.00214)	(0.00209)			
ln_dpop							0.00721***	0.00787***	0.00729***
							(0.00213)	(0.00207)	(0.00202)
ln CV_1(specialized sectors)			0.0463***			0.216***			0.216***
			(0.0137)			(0.0172)			(0.0172)
d ln CV (specialized sectors)			0.0457***			0.179***			0.182***
			(0.0117)			(0.0147)			(0.0147)
over65		0.00536***	0.00537***		-0.00177	-0.00114		0.000377	0.000706
		(0.00197)	(0.00197)		(0.00254)	(0.00248)		(0.00253)	(0.00247)
ln SV_1		0.146***	0.146***		0.178***	0.172***		0.174***	0.170***
		(0.00923)	(0.00923)		(0.0119)	(0.0116)		(0.0118)	(0.0116)
dummy1	0.110***	0.0777***	0.0725***	0.252***	0.235***	0.208***	0.265***	0.243***	0.216***
	(0.00530)	(0.00730)	(0.00750)	(0.00678)	(0.00937)	(0.00942)	(0.00768)	(0.00984)	(0.00990)
dummy2	0.116***	0.0422***	0.0406***	0.302***	0.252***	0.235***	0.316***	0.261***	0.244***
	(0.00612)	(0.0116)	(0.0118)	(0.00782)	(0.0149)	(0.0148)	(0.00682)	(0.0147)	(0.0146)
Constant	5.420***	4.119***	3.702***	6.703***	5.318***	3.392***	6.614***	5.186***	3.273***
	(0.0110)	(0.0895)	(0.151)	(0.0141)	(0.115)	(0.189)	(0.0137)	(0.116)	(0.189)
Observations	4,765	4,765	4,765	4,765	4,765	4,765	4,764	4,764	4,764
Number of x1	1,631	1,631	1,631	1,631	1,631	1,631	1,631	1,631	1,631
Adjusted R-squared	-0.293	-0.196	-0.191	0.142	0.199	0.238	0.141	0.196	0.237
city FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

ln_dpop_1: log of population density in the previous period

ln_dpop : log of current population density

ln CV_1: log of total added value in the core sectors (specialized sectors or manufacturing sectors) of previous period

d ln CV : the change in the log of average total added value in the core sectors from the previous period

ln SV_1: the log of total added value in the service sectors of the previous period

Over65: the ratio of the elderly population in the first year of the estimation period

Dummy1: dummy for the second period

Dummy2: dummy for the third period

Table12 the effects of the added value of core sectors on the population density

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	log of current population density		change in the log of population density		log of population density in the previous period	
ln CV_1(specialized sectors)	0.383**		0.734***		-0.351**	
	(0.152)		(0.264)		(0.147)	
d ln CV (specialized sectors)	-0.0393		0.356		-0.395***	
	(0.130)		(0.225)		(0.126)	
over65	-0.0777***	-0.0854***	0.0652*	0.0588	-0.143***	-0.144***
	(0.0217)	(0.0218)	(0.0377)	(0.0377)	(0.0210)	(0.0211)
ln SV_1	-0.177*	-0.136	-0.628***	-0.582***	0.450***	0.446***
	(0.102)	(0.102)	(0.177)	(0.177)	(0.0989)	(0.0989)
dummy1	-1.537***	-1.477***	-1.861***	-1.766***	0.324***	0.289***
	(0.0830)	(0.0829)	(0.144)	(0.143)	(0.0804)	(0.0801)
dummy2	0.280**	0.410***	1.451***	1.586***	-1.171***	-1.176***
	(0.129)	(0.127)	(0.224)	(0.220)	(0.125)	(0.123)
ln CV_1 (manufacturing sectors)		0.00899		0.137		-0.128
		(0.136)		(0.236)		(0.132)
d ln CV (manufacturing sectors)		0.0574		0.133		-0.0755
		(0.109)		(0.188)		(0.105)
Constant	5.868***	9.028***	-2.994	2.151	8.864***	6.877***
	(1.664)	(1.595)	(2.888)	(2.759)	(1.612)	(1.540)
Observations	4,764	4,764	4,764	4,764	4,765	4,765
Number of x1	1,631	1,631	1,631	1,631	1,631	1,631
Adjusted R-squared	-0.094	-0.104	-0.097	-0.101	-0.047	-0.051
city FE	Yes	Yes	Yes	Yes	Yes	Yes
year FE	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

ln CV_1: log of total added value in the core sectors (specialized sectors or manufacturing sectors) of previous period

d ln CV : the change in the log of average total added value in the core sectors from the previous period

ln SV_1: the log of total added value in the service sectors of the previous period

Over65: the ratio of the elderly population in the first year of the estimation period

Dummy1: dummy for the second period

Dummy2: dummy for the third period

Appendix1 TFP is calculated by alternative estimations

TFP is calculated	by industry		by Olley and Pakes model	
	(1)	(2)	(3)	(4)
VARIABLES	TFP in the service sectors			
ln CV_1(specialized sectors)	0.0707***		0.0419***	
	(0.0178)		(0.0134)	
d ln CV (specialized sectors)	0.0464***		0.0429***	
	(0.0152)		(0.0114)	
ln CV_1 (manufacturing sectors)		0.0298*		0.0243**
		(0.0160)		(0.0120)
d ln CV (manufacturing sectors)		-0.00527		-0.00456
		(0.0127)		(0.00953)
ln SV_1	0.0893***	0.0936***	0.140***	0.141***
	(0.0123)	(0.0123)	(0.00922)	(0.00921)
over65	0.00325	0.00314	0.00433**	0.00459**
	(0.00254)	(0.00254)	(0.00191)	(0.00190)
dummy1	0.109***	0.123***	0.147***	0.156***
	(0.00969)	(0.00967)	(0.00728)	(0.00725)
dummy2	0.0401***	0.0496***	0.0803***	0.0819***
	(0.0151)	(0.0148)	(0.0113)	(0.0111)
Constant	4.019***	4.357***	3.718***	3.864***
	(0.196)	(0.188)	(0.147)	(0.141)
Observations	4,730	4,730	4,736	4,736
Number of x1	1,622	1,622	1,625	1,625
Adjusted R-squared	-0.305	-0.309	0.022	0.021
city FE	Yes	Yes	Yes	Yes
year FE	Yes	Yes	Yes	Yes

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

ln CV_1: log of total added value in the core sectors (specialized sectors or manufacturing sectors) of previous period

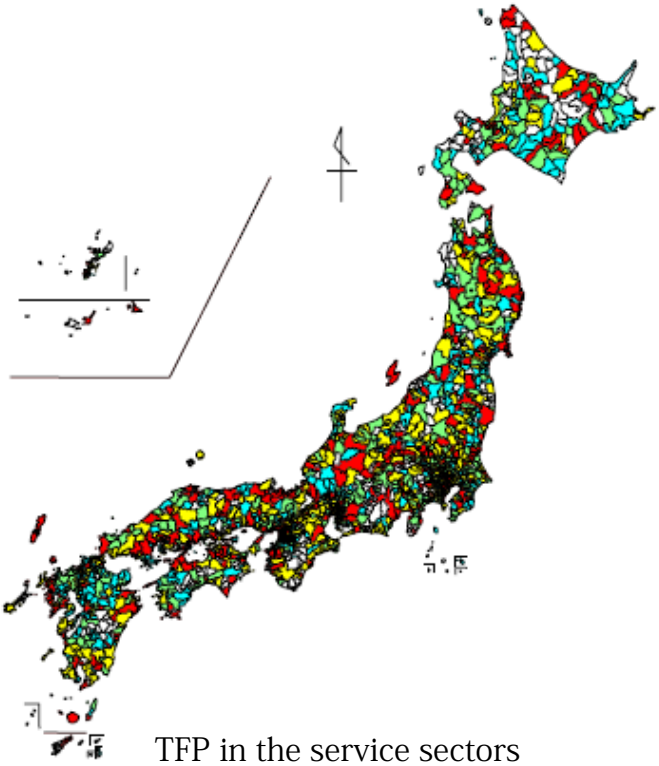
d ln CV : the change in the log of average total added value in the core sectors from the previous period

ln SV_1: the log of total added value in the service sectors of the previous period

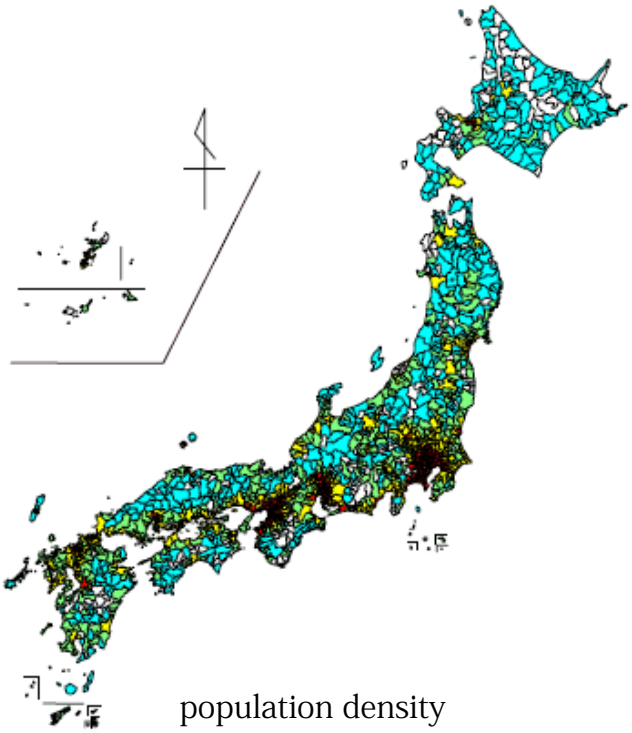
Over65: the ratio of the elderly population in the first year of the estimation period

Dummy1: dummy for the second period

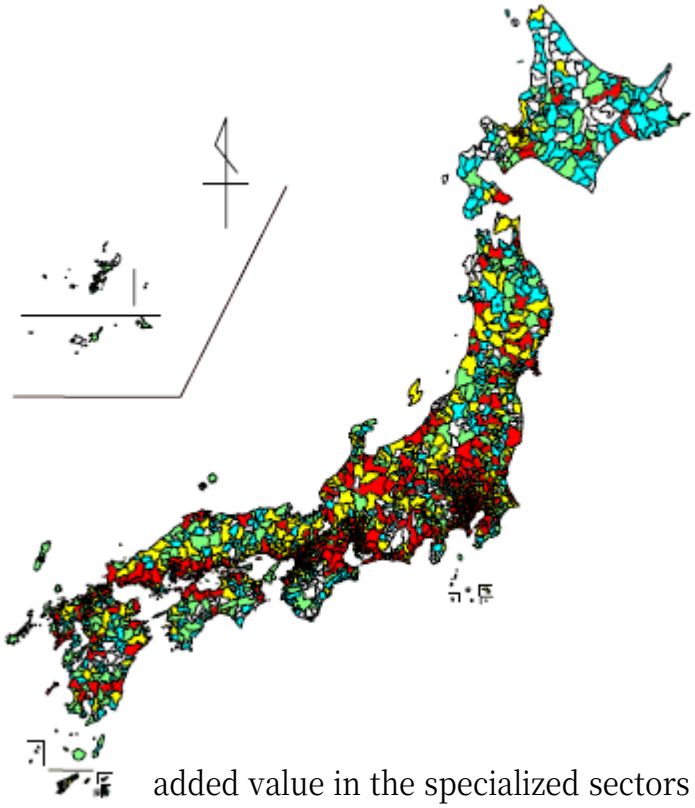
Dummy2: dummy for the third period



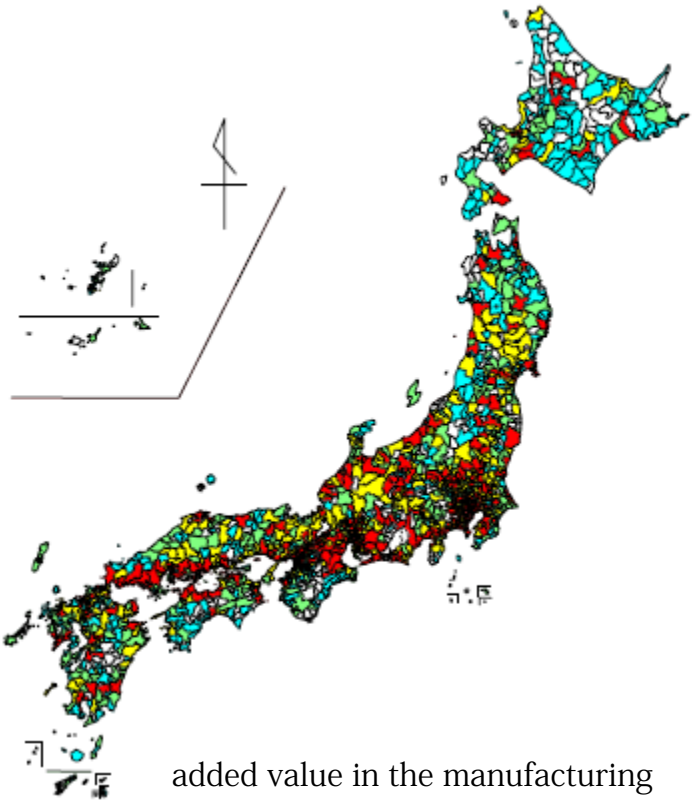
TFP in the service sectors



population density



added value in the specialized sectors



added value in the manufacturing sectors

Figure 1 Regional difference of productivity and industrial structure

4th quartile
3rd quartile
2nd quartile
1st quartile
missing value

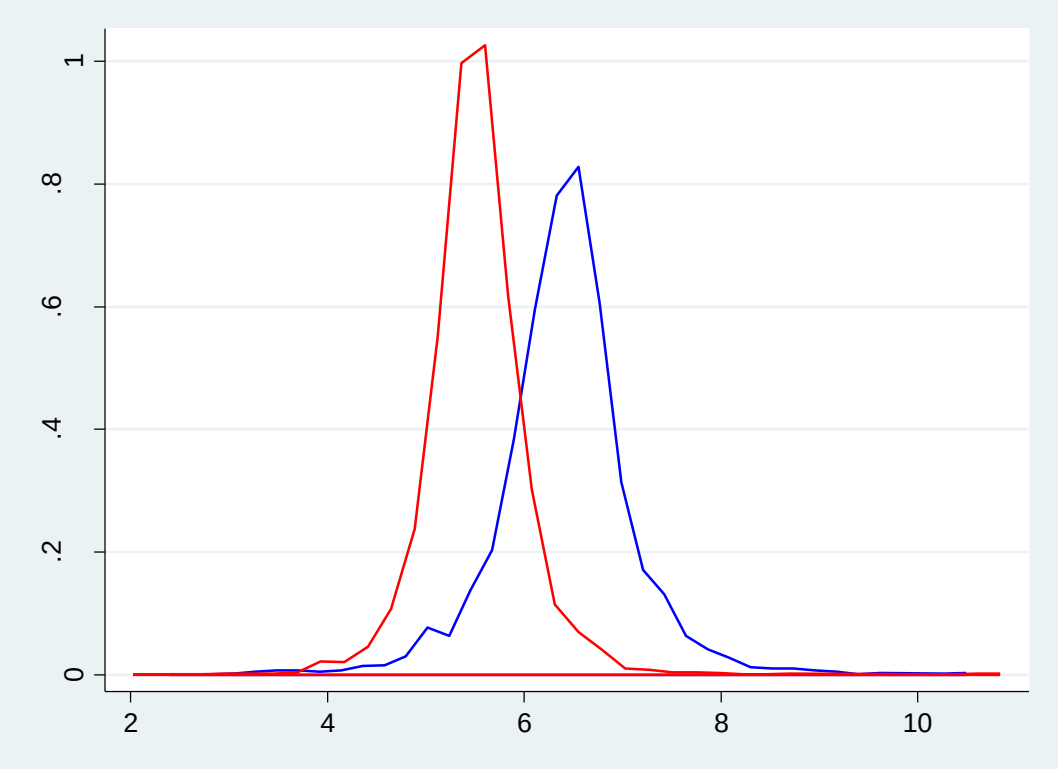


Figure2 the histogram of TFP in service sectors (red) and in manufacturing (blue) in each cities

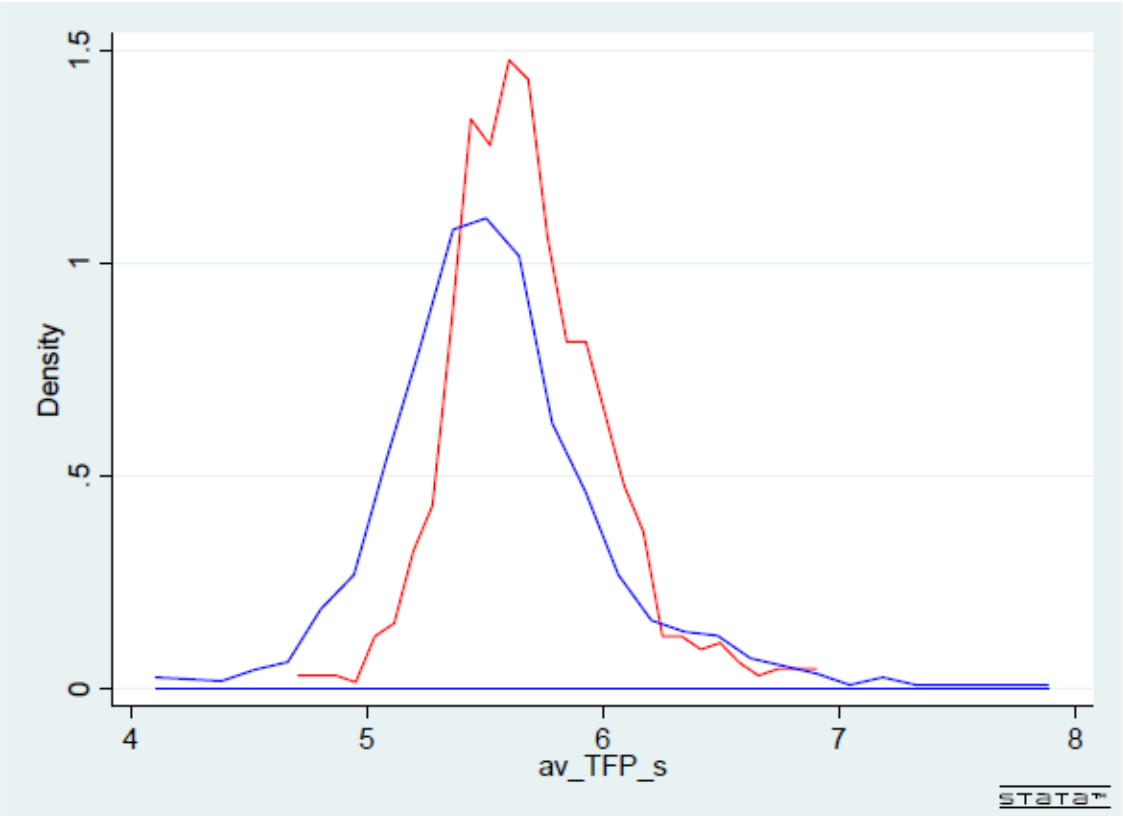


Figure3 the histogram of TFP in the service sectors: cities with larger specialized sectors than the mean (red) and cities with smaller specialized sectors than the mean (blue)

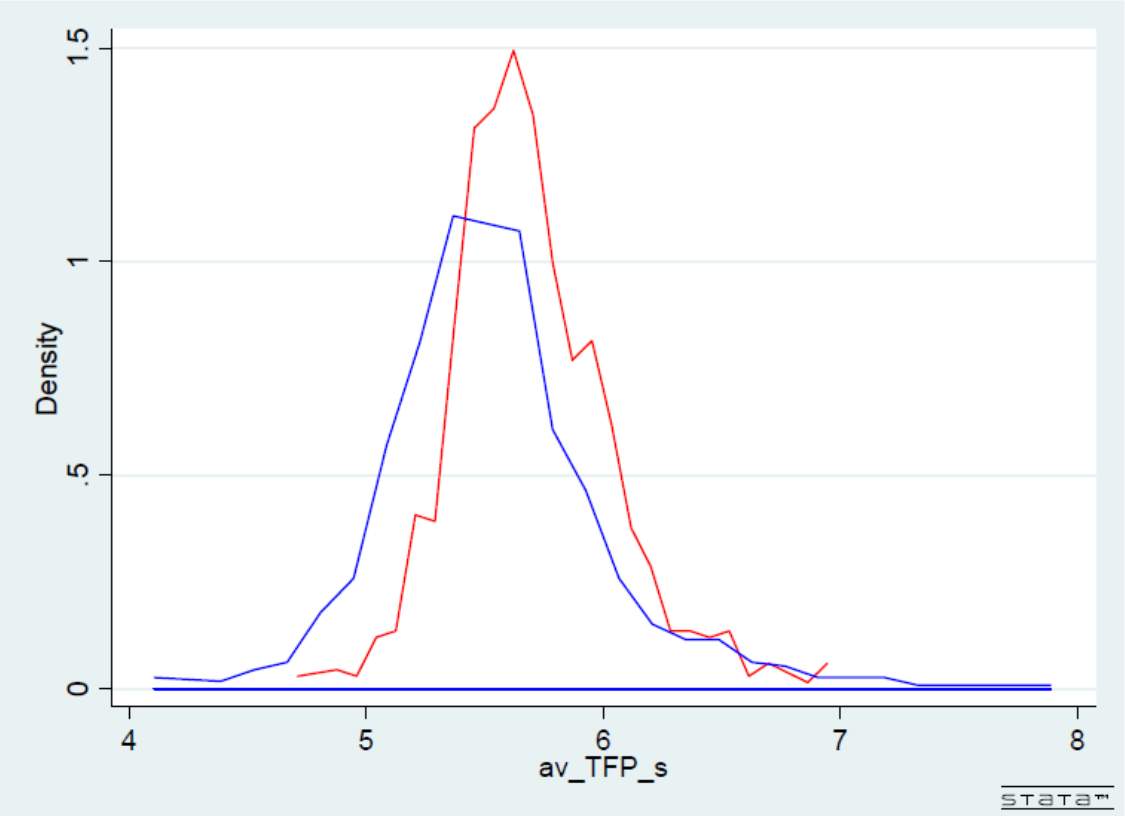


Figure 4 the histogram of TFP in the service sectors: cities with larger manufacturing sectors than the mean (red) and cities with smaller manufacturing sectors than the mean (blue)

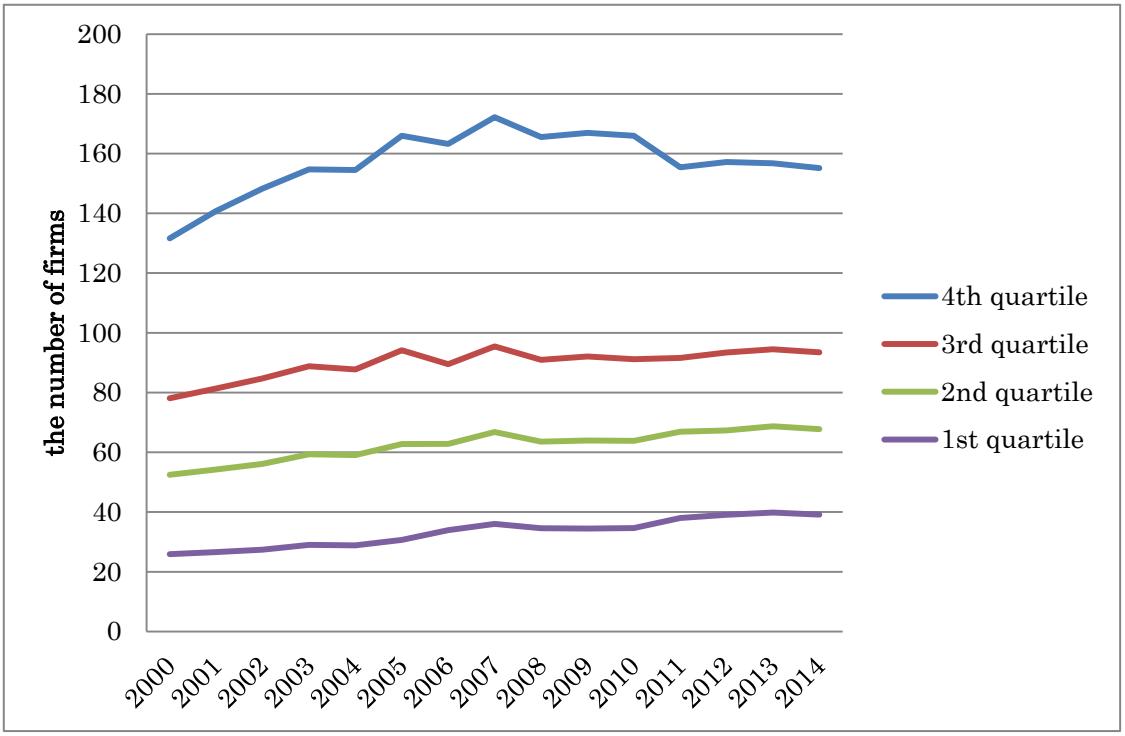


Figure 5 the number of firms in the service sectors by the quartile

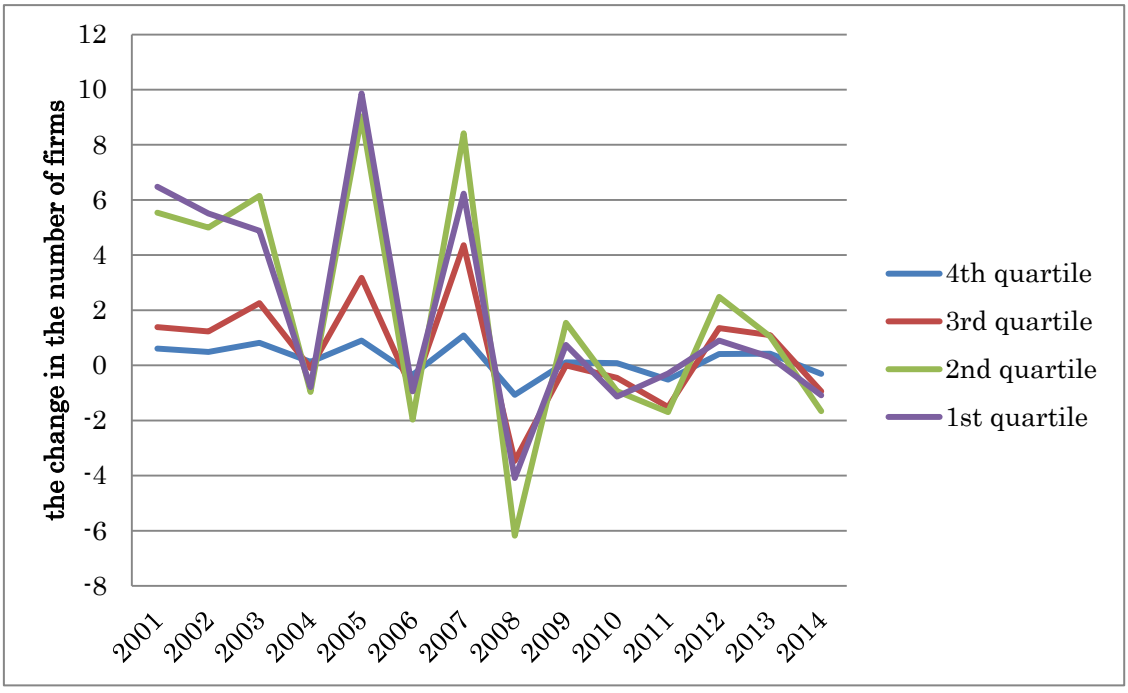


Figure 6 the change in the number of firms in the service sectors by the quartile