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The Geography of Trade and Agglomeration in Japan

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ABSTRACT

This paper examines the effect of imported intermediate inputs on local Japanese labor markets and the impact of an agglomeration economy on this trade exposure. An agglomeration economy might increase productivity, but the specific local labor market might be hard-hit when a large company withdraws from the market. This paper observes that rising inputs from abroad decrease the demand for employment of workers who have attained high and low levels of education and increase the demand for short-time workers. However, the agglomeration of manufacturing mitigates this trade exposure. This effect spills over to the non-manufacturing sector. Furthermore, this paper divides regions by R&D intensity. R&D eliminates the downward trend in the demand for less-educated workers in manufacturing in rural areas where manufacturing agglomerates. However, the results are not conclusive and are not the direct effect of R&D when imported intermediate inputs are on the rise because imported inputs highly correlate with the cross-term of imported inputs and R&D. Regarding wages, increasing imported intermediate inputs does not exhibit a clear effect on wages in manufacturing, although rising inputs from abroad decrease wages for short-time workers in all industries.

Keywords: Geography of trade, Agglomeration economy, Labor demand, Offshoring

JEL codes: J23, J24, J31

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1. Introduction

Many developed countries, including Japan, have experienced increasing overseas production or imported intermediate inputs and a collapse of domestic labor market over the past several decades. Many previous studies have analyzed the effect of increasing overseas productions on an entire country. These studies determined that the imports of intermediate goods from low-income countries affect the labor composition and shift labor requirements to highly skilled workers (Feenstra and Hanson, 1999; Ekholm and Hakkala, 2005; Ahn et al., 2008). Furthermore, offshoring increases the ratio of non-regular workers to whole-country workers (Machikita and Sato, 2011; Tomiura, Ito and Wakasugi, 2011), and middle-skill tasks are offshored to minimize the cost of the final goods/services using a task approach (Acemoglu and Autor, 2011; Autor, Levy Murnane, 2003; Black and Spitz-Oener, 2010).

However, little is known regarding the effect of trade on local labor markets. The labor market does not usually integrate into a whole in many countries, and the labor market is significantly segmented at the local level. In Japan, labor mobility is lower than the United States and approximately twice that of the European cross-region mobility within countries. Furthermore, the employment situation differs among local labor markets (Yugami, 2005; JILPT, 2007). Even the United States, labor mobility is not high as in a perfectly integrated labor market. Autor et al. (2013) conducted a rare study that reveals important differences in the exposure of local labor markets with respect to the impact of technology and trade by examining the geography effect of trade.

Moreover, the closure of a large company's factory often becomes a political issue for the local government. For instance, the local labor market in *Kameyama city* (Mie prefecture) was hard-hit by the closure of SHARP's factory[1]. *Totori city* (Totori prefecture) was significantly affected by the closure of a SANYO facility. Similar effects were observed in *Minokamo city* (Gifu prefecture) when SONY closed its facility. A closure of a factory decreases the labor demand for local employment, such as restaurants, shops and taxies in addition to reducing the employment of workers from this factory. Furthermore, if the supply chain agglomerates around the factory, its workers also lose their jobs. If the same type of manufacturing agglomerates in the specific region, the regional damage increases because agglomerated firms are under the same external competitive environment. However, an agglomeration economy also

[1] SHARP closed one of two factories and subsequently sold it to a Chinese manufacturer.

has advantages. Several studies argue that productivity rises in agglomeration economies (Ellison and Glaeser, 1999; Greenstone et al. 2010; Moretti, 2010; Kline and Moretti, 2012). Thus, the impact of trade in an agglomeration economy remains to be determined. Furthermore, differences among the local labor markets where manufacturing agglomerates require examination. Lastly, does R&D impact an agglomeration economy because a close relationship between a factory and laboratory confers an advantage on high value-added product over overseas productions? Japanese factories have shifted from acting as a mother factory to acting as a global factory that is managed at the same skill level[2].

Therefore, the objective of this paper was to explore the effect of imported intermediate inputs on local Japanese labor markets, the impact of an agglomeration economy on this trade exposure and the role of R&D on agglomeration economy. I analyzed these issue at the commuting zones (CZs) level by using the Basic Survey on Wage Structure and the Basic Survey of Japanese Business Structure and Activities, with information from 1997 to 2011. I simultaneously instrumented imported intermediate inputs by using changes in imported inputs of the entire country without a target CZ weighted by target CZ's composition of manufacturing industries.

Important previous studies on this subject have been presented in Autor et al. (2013) and Autor et al. (2012). Autor et al. (2013) found an absence of overlap in the geography of trade and technology shocks. The former is present where labor-intensive manufacturing spatially agglomerates, and the latter is present throughout the United States. Autor et al. (2013) measured technology change by specialization in routine tasks and compared the routine employment share by CZs and growth in import exposure per worker by CZs to illustrate the map of the United States. Specifically, Autor et al. (2012) analyzed the trade effect from China and argued that the share of manufacturing employees in the working age population of a CZ at the 75th percentile of import exposure declines by -0.65 percentage points more than in a CZ at the 25th percentile between 2000 and 2007 in the United States. These two papers indicate a strong geography trade effect via their main arguments.

Because dividing trade is affected by its path, Glendon and Vigdor (2003) examined three effects of the negative shock of export oriented firms: the direct effect of a specific firm's shock on suppliers of intermediate goods in the original county, the indirect effect of reduced employment in several neighboring counties caused by decreasing demand for a certain product because the counties may produce similar

[2] For example, the January 2013 issue of Business Labor Trend presented that a Japanese company named KYB plants this shift.

goods and the effect of labor shock on the endogenously determined local employment sector. Glendon and Vigdor (2003) demonstrated that the first effect is large in manufacturing, the second effect is large in agriculture and mining and the third effect is minimal for the given the impulse responses. The conceptual framework between this work and Glendon and Vigdor (2003) is similar.

The effects of geography trade presented in Glendon and Vigdor (2003) relate an agglomeration economy. Yilmazkuday (2011) calculated the portion of the specific good in a given region that is consumed as a final good within the home country using data from the United States. This study presented a negative correlation between this portion and industry-specific production (index of agglomeration) and showed that the agglomeration and specialization of industries play an important role in determining the patterns of trade.

Other previous studies also analyzed the geography of the trade effect using micro-data and analyzing the skill level (Celi and Maria Segnana, 2000; Hanson and Slaughter, 2002; Kandilov, 2009) or the FDI (Axarloglou and Pournarakis, 2007). They also examined the effect of trade liberalization on local markets (McLaren, 2010; Topalova, 2005; Topalova, 2010; Kovak, 2011).

First, this study found that rising inputs from abroad decrease the demand for employment and increase the demand for short-time workers, but the agglomeration of manufacturing mitigates this trade exposure. Increasing imported intermediate inputs also decreases the demand for employment in the non-manufacturing sector, but this demand increases in the agglomeration economy. Second, I attempted to determine differences among local labor markets where manufacturing agglomerates. R&D increases the demand for more highly educated workers in manufacturing and less educated workers in non-manufacturing. In rural and R&D intensive areas where manufacturing agglomerates, increasing imported inputs increases the demand for less educated workers in manufacturing, but this effect does not spill over to the non-manufacturing sector. However, these results are not the direct effect of R&D when imported intermediate products are on the rise. Furthermore, these results are not conclusive. Finally, rising inputs from abroad decrease wages for short-time workers in all industries, but these inputs do not clearly affect wages in the manufacturing sector.

The remainder of the paper is organized as follows. The next section describes the conceptual framework and empirical approach and explains the data set. Section 3 presents the empirical results, and Section 4 presents the conclusions and discussion.

2. Conceptual framework, empirical strategy and data

2.1 Conceptual framework

Assume that trade has a gravity structure following Autor et al. (2012), where one can map changes in trade quantities into labor outcome in applying the monopolistic competition model. I assumed that CZ *i* produces both manufacturing as tradable goods and other non-tradable goods and services, which could alternatively represent the consumption of leisure. The labor market outcomes of interest for CZ *i* are the change in employment in tradable manufacturing goods ($\ln L^m$), the change in employment in non-traded goods and services ($\ln L$) and the change in the wage ($\ln W_i$). Increasing the imported intermediate inputs affected CZ *i* by increasing the competition in the market in which CZ *i* produces the same manufacturing goods as the imported inputs and growing the activity of firms that use imported inputs. Increasing the capability of suppliers abroad affects the former. Increasing the demand of tradable manufacturing goods in world and domestic markets affects on the latter. Furthermore, the former decreases the number of workers for non-tradable goods and services. The latter increases the number of these workers.

The impacts of rising imported intermediate inputs on employment and wage in manufacturing are defined as follows:

$$\ln L_i^m = \rho_i \sum_s C_{is} \frac{L_{is}}{L_i^m}\left[\theta_{is}\ln EX_s - \frac{1}{\varphi_{is}}\ln A_s\right],$$

$$\ln W_i^m = \sum_s C_{is} \frac{L_{is}}{L_i^m}\left[\theta_{is}\ln EX_s - \frac{1}{\varphi_{is}}\ln A_s\right] \quad (1)$$

Employment and wage outcomes are the sum of the increase in demand for CZ *i*'s producers using intermediate domestic or foreign inputs given the change in expenditure in the world and domestic market ($\ln EX_s$) multiplied by the initial intensity of the R&D by CZ *i* (θ_{is}) and the decrease in demand for CZ *i*'s products that compete with production abroad. The latter is given by the growth in the capability of the foreign supplier ($\ln A_s$) multiplied by the inverse of the initial distance from the R&D center and intensity of the R&D center ($\frac{1}{\varphi_{is}}$). These shocks are added across sectors and weighted by the initial ratio of employment in industry *s* to the total employment in manufacturing and a general-equilibrium scaling factor ($C_{is}>0$). The employment equation is further scaled by ρ_i in a growing by agglomeration economy.

Increasing the capability of suppliers abroad decreases the employment and wages of workers who produce the intermediate inputs that compete with inputs produced abroad, but it increases the employment and wages of workers who sell goods abroad because the growth in the capability of suppliers abroad corresponds with the growth of expenditure abroad. The volume of R&D also positively affects the employment and wages of workers who sell goods abroad. Furthermore, the volume of R&D diminishes the competitive force of suppliers abroad, and the extent of this effect is larger when the R&D center is located in the given CZ *i* or near the CZs. These changes spill over to non-tradable sectors. Increasing the employment and wages of workers who sell goods abroad increases the employment and wages of workers in non-tradable sectors, and decreasing the employment and wages of workers who produce goods that compete with production abroad decreases the employment and wages of workers in non-tradable sectors.

The scaling factors C_{is} and ρ_i correspond to the intensity of the agglomeration economy in manufacturing for CZ *i* and differ among the CZs. I calculated the Gini index and the Gini index controlled establishment size (EG index) shown in detail in next section. To use (1) for the empirical analysis, I began by focusing on an increasing competition in the market in which CZ *i* produces the same manufacturing goods as imported inputs, thus ignoring the growth of expenditure abroad.

2.2 Empirical strategy

Two types of trade effects are estimated using following models:

$$\Delta L_{it}^{m} = \gamma_t + \beta_1 \Delta IPW_{it} + X_{it}'\beta_2 + \varepsilon_{it} \quad (2)$$

$$\Delta L_{it} = \gamma_t + \beta_1 \Delta IPW_{it} + X_{it}'\beta_2 + \varepsilon_{it} \quad (3)$$

where ΔL_{it}^{m} and ΔL_{it} are the decadal change in manufacturing employment and all industrial employment in CZ *i*, respectively. ΔIPW_{it} is the change in imported intermediate inputs by manufacturing firms per worker in a CZ, where imported inputs are apportioned to the CZ according to the location of the firm's establishments. The data of the imported intermediate inputs is collected by location headquarters. I then divided the volume of imported inputs by the number of establishments owned by each headquarter. I aggregated the volume of imported inputs per establishment by each CZ.

The vector X_{it} contains changes in the tangible fixed asset, volume of business and the start-of-period values of explanatory variables, such as the unemployment rate,

ratio of employment in manufacturing to whole employment, the ratio of college graduates to the population in the CZ, the ratio of female workers to the population in the CZ and the ratio of elderly people at least 65 years old to the population in the CZ. To this information, I added the specific industry manufacturing intensity, the Gini index[3] or EG index as calculated below, the ratio of R&D to the volume of business in manufacturing, the cross-terms of these variables and the change in the volume of imported intermediate inputs to a baseline analysis. All models are weighted by the start-of-period population in the CZ. The Gini index, which is equal to the manufacturing intensity C_{is} and ρ_i in the previous section, is calculated using the following equation:

$$G_i = \sum_s (S_{is} - S_s)^2 \tag{4}$$

where S_{is} is the employment share of industry s in manufacturing in CZ i in all manufacturing sectors of the CZ i, i.e. $S_{is} = E_{is} / TRE$, where E_{is} and TRE are the employment in industry s in manufacturing in CZ i and total employment in all manufacturing in CZ i ($\mathrm{TRE} = \sum_s E_{is}$), respectively. Ss is the employment share of industry s in manufacturing in aggregate employment in manufacturing, i.e. $Ss=NEs/TNE$, where NE_s and TNE are the employment in industry s throughout the country and total employment in all manufacturing throughout the country ($\mathrm{TNE} = \sum_s \sum_i E_{is}$), respectively. If G_i=1, the industrial composition in the given CZ is weighted in the specific industry in manufacturing.

The Gini index is not controlled the establishment size. Ellison and Glaeser (1997) proposed an index of industry concentration controlled industry plant size. Lu and Tao (2005) proposed measurement of regional specialization in terms of the Ellison and Glaeser (1997)'s index as follows:

$$EG_i \equiv \frac{G_i - (1 - \sum_{s=1}^{N} S_s^2) H_i^*}{(1 - \sum_{s=1}^{N} S_s^2)(1 - H_i^*)} \tag{5}$$

where $\mathrm{H_i^*} = \sum_{\mathrm{k=1}}^{\mathrm{K}} \left(\mathrm{E_{ik}} / \sum_{\mathrm{k=1}}^{\mathrm{K}} \mathrm{E_{ik}}\right)^2$ is Herfindahl index of CZ i, and E_{ik} is employment of

[3] This Gini index represents the intensity of the specific industry in manufacturing, not the intensity of manufacturing. The ratio of manufacturing employment represents intensity of manufacturing.

establishment *k* in CZ *i*, K is total number of establishments in CZ *i*. This paper call this index *EG index*.

This paper also examines the effect of trade on unemployment and wages of workers in manufacturing and all industries. I estimated models (2) and (3) but used the change in unemployment or wage instead of the change in employment as the explained variable.

The realized intermediate inputs from abroad may be correlated with industry labor demand shock, which constitutes a limitation to this estimation. To identify the casual effect of rising imported inputs on local labor markets, I employed an instrumental variable strategy. To identify the supply-driven component of intermediate inputs from abroad, such as the rising competitiveness of manufacturers abroad, lower wages or easy access to consumers' needs in abroad, I used an instrumental variable determined as follows:

$$\sum_s \omega_{si} IPW_s \tag{6}$$

where ω_{si} is the share of industry *s* in manufacturing in CZ *i* at the beginning of the estimation period; IPW_s is the nationwide imported inputs excluding the target CZ *i* in industry *s*. I used the industrial classification of the Basic Survey of Japanese Business Structure and Activities at the middle level to calculate the instrument.

2.3 Data

I used the Basic Survey on Wage Structure and the Basic Survey of Japanese Business Structure and Activities in 1997, 2006 and 2011[4]. I examined the decadal changes of two periods; the first period contained the change from 1997 to 2006, and the second period contained change from 2006 to 2011. To ensure that the two periods are comparable on a decadal scale, the difference in the second period was multiplied by a factor of 10/6. The Ministry of Health, Labor and Welfare conducts the Basic Survey on Wage Structure on establishments with 10 or more regular employees and private establishments with 5 to 9 regular employees. This survey also includes workers

[4] 1997 is the oldest data collected using the same definition with the latest data. Before 1997, the data on imported intermediated inputs included imported inputs of establishment abroad and offshore trading, but recent data exclude these volumes. 2011 is the latest data, and it reflects increases in Japanese trade after the financial shock of 2009.

selected by a uniform sampling method from among the establishments that were selected for the Basic Survey on Wage Structure to obtain a clear picture of the wage structure throughout Japan. The Basic Survey on Wage Structure provides rich information about workers, including their education level, age, gender and income. This paper estimates the above model by the worker's educational level, gender and employment status (short-time worker and unemployment).

The Minister of Economy, Trade and Industry conducts the Basic Survey of Japanese Business Structure and Activities. This survey covers enterprises with 50 or more employees that have excess capital or investment funds valued at over 30 million yen. The covered industries include the mining, manufacturing, wholesale and retail trade, as well as the food and drink industry. I added the information detailing where enterprises have their establishments to the Basic Survey of Japanese Business Structure and Activities using the Establishment and Enterprise Census. The Establishment and Enterprise Census is conducted on all establishments in Japan to compile a complete directory as the master sampling framework for various statistical surveys, including the Basic Survey on Wage Structure by the Statistics Bureau.[5]

I calculated the data both from a worker and enterprise point of view via CZs using the above two data sets. I then connected these data using CZ code[6]. This paper uses commuting zones proposed by the Center for Spatial Information Science[7]. The 2005 code outlines 251 commuting zones and 245 commuting zones for estimations. These commuting zones cover an area where population of the central city exceeds 10000, and approximately 90% of total employment [8] is concentrated at these commuting zones. Additionally, I used the population census to determine the unemployment ratio, college graduation rates and the population. The population census is conducted every five years, and I used the 1995, 2005 and 2010 data to generate the above dataset for 1997, 2006 and 2011. I also calculated the ratio of elderly people (>65 years old) from the data based on the records of the Basic Resident

[5]The author is grateful to the Ministry of Health, Labor and Welfare, the Minister of Economy, Trade and Industry, the Ministry of Internal Affairs and Communications Statistics Bureau for providing us with the Basic Survey on Wage Structure, the Basic Survey of Japanese Business Structure and Activities, the Establishment and Enterprise Census.

[6] The Basic Survey on Wage Structure and the Establishment and Enterprise Census contain information about an administrative area. I aggregated the administrative area into CZs. I responded to changes in the administrative area using information proposed by the Ministry of Internal Affairs and Communications Statistics Bureau.

[7] Kanamoto, a researcher at the Center for Spatial Information Science, proposed the data.

[8] Excluding agriculture, forestry, fisheries and public service.

Registration that the mayor of each municipality is responsible for preparing. I used the Basic Survey on Wage Structure and calculated the wage as follows because bonuses are part of the wage in Japan.

$$\text{Wage} = \text{monthly contractual cash earnings} + \text{bonus}/12 \quad [9] \tag{7}$$

Table 1 provides detailed descriptive statistics and shows that the correlation between the volume of imported intermediate inputs and the cross-term of R&D and imported inputs is large. Therefore, this paper avoids estimation using this cross-term.

3. Results

3.1 Indirect effects for manufacturing

Panel A in Table 2 shows the OLS estimation results for model (2). Table 2 indicates two estimations[10]: the models that include the Gini index and the cross-term equal to the Gini index multiples change in the imported inputs in column 1 and the model that includes ratio of R&D in manufacturing and the cross-term equal to the Gini index multiples ratio of R&D in manufacturing in column 2. Table 2 shows that the imported intermediate inputs decreases the demand for workers of both genders and all educational levels and increases the demand for short-time workers. The Gini index explains that an agglomeration economy does not increase the labor demand and decreases the labor demand in the several cases[11], but the cross-term shows that an increase in imported inputs increases the demand for highly and less educated workers and decreases the demand for short-time workers where manufacturing agglomerates. The ratio of R&D to the volume of business in manufacturing and its cross-term, which is equal to R&D multiples change in imported inputs, are insignificant in column 2, but the latter becomes significant in the estimation when excluding large cities, as explained below.

Panel B in Table 2 shows the instrumental variable estimation results for

[9] The Basic Survey on Wage Structure records total bonuses obtained in the previous year while recording contractual cash earnings in June in the survey year.
[10] Appendix 1 shows the other estimations at the baseline, plus the Gini index and plus the R&D ratio.
[11] The negative effect disappears in Panel B and Panel C in Table2.

model (2) when employing instrumental variables calculated using (6). Appendix 2 presents a first-stage result. The table presents only the target variables. The estimation results are the same as the results of OLS. A rise in the imported intermediate inputs decreases the demand for male and female highly and less educated workers and increases the demand for short-time workers, even if the instrumental variable estimations. An agglomeration economy eliminates this effect, as shown by the cross-term in column 1.

However, the volume of imported intermediate inputs in Tokyo, Osaka and Fukuoka is much larger than other cities. The third largest volume of imported inputs in Fukuoka is 2.7 times that of the fourth largest volume of imported inputs in Naha. I then estimated the model while excluding the data from Tokyo, Osaka and Fukuoka. Panel C in Table 2 shows these results of the OLS estimation because the instrumental variable of the first stage is insignificant. Remarkably, the ratio of R&D in manufacturing increases the demand for male and female less educated workers where manufacturing agglomerates. This result suggests that a close relationship between R&D and the production process protects the domestic labor market for less educated workers. The coefficients for more highly educated workers are insignificant because the estimation in Panel C of Table 2 excludes large urban cities. However, the result is not conclusive because this paper cannot examine the direct effect of R&D when imported intermediate inputs are rising due to strong correlations between imported inputs and the cross-term, which is imported inputs multiples R&D.

As for other explanation variables, increasing imported inputs decreases the demand for employment and increases the demand for short-time workers, even when excluding the three large cities. An agglomeration economy mitigates this effect in rural area as well as in the above estimations.

Table 3 shows the OLS estimation results for model (2) using EG index instead of Gini index. The agglomeration economy mitigates the negative effect of increasing imported inputs on the demand for workers, but it does not affect male and female less educated workers and male more highly educated workers when excluding large cities; Further, it affect negatively on female more highly educated workers[12]. Comparing the results in Table 2, scaling economy affects the local labor markets in terms of imported inputs.

Figure 1 is shaded to indicate its quartile rank within the distribution of CZs in the above results; it shows the decrease in less educated male workers to the increase

[12] These results does not change when excluded more cities in order of its imported inputs' volume.

in imported intermediate inputs[13]. Red colors correspond to the largest decrease in the worker quartile, followed by yellow, green and blue, which indicates the smallest decrease in the worker quartile. The red quartile includes large cities, such as Tokyo, Osaka, Fukuoka and Nagoya as well as cities that are located near the coast, which develop manufacturing and import many intermediate inputs. Additionally, the red quartile includes the CZs that are in the hinterland and use many imported inputs.

Figure 2 picks up red and yellow quartiles in Figure 1 and presents how agglomeration economy mitigates the decreases in less educated male workers to the increase in imported inputs. I calculated the volume of decreasing male less educated workers due to rising imported intermediate inputs and the volume of increasing the same workers due to agglomeration economy when imported inputs increases using the estimation results and aggregated the both volumes. Figure 2 is illustrated by red colors when agglomeration economy mitigates the most diminishing effect from trade, followed by orange, yellow and light green. Light green indicates when the agglomeration economy does not mitigate the diminishing of less educated male workers. Moreover, Figure 2 shows the average Gini index of two periods. The blue points represent the most agglomeration of the manufacturing quartile, and the purple points represent the second largest Gini index quartile. This paper finds that manufacturing agglomerates in many red, orange and yellow colors' CZs. In contrast, this paper rarely finds the case that agglomeration economy brings large decreasing of workers by increasing imported inputs; only two CZs indicate that manufacturing agglomerates but agglomeration economy does not much mitigates the diminishing of workers.

3.2 Indirect effects on all industries

Diminishing employment spills over into surrounding industries, such as restaurants, cleaning shops, daily shops and taxies. Panel A in Table 4 shows the OLS estimation results for model (3). The model includes the cross-term of the Gini index and change in imported intermediate inputs in column 1 and the cross term of R&D and Gini index in column 2. Notably, the ratio of R&D in manufacturing increases the demand for less educated male workers[14], but it does not strongly affect the demand for more highly educated workers. R&D in manufacturing affects the demand for highly

[13] I used the average of the change in imported intermediate inputs during two periods.
[14] Appendix 3 shows that the estimation that does not include the cross-term indicates that increasing R&D in manufacturing increases the demand for both male and female less educated workers.

educated workers in manufacturing[15], in contrast, it affects the demand for less educated workers in all industries. An analysis of the estimation results indicates that increasing the labor demand for highly educated workers in manufacturing by increasing R&D spills over into the demand for workers in restaurants, grocery shops, clothiers and other sectors due to highly educated workers who increase the demand for these shops.

Moreover, this result does not change in rural areas. Panel C in Table 4 shows the same results as Panel A, even if the estimation excludes the Tokyo, Osaka and Fukuoka data. This finding is consistent with the theoretical concept and evidence found in previous studies: increasing the labor demand in a specific sector spills over into other sectors (Moretti, 2010; Kazekami 2013) in urban and rural areas.

Second, the cross-term of R&D in the manufacturing and Gini index is insignificant in Table 4. Increasing R&D in the manufacturing sector protects the domestic labor market for less educated workers in rural areas, as shown in Table 2, but it does not spill over into the local service market. Previous studies (Moretti, 2010; Moretti and Thulin, 2013) argue that the demand for workers in other sectors, such as restaurants and shops, increases because highly educated workers' wages are higher, and they consequently bring more business to restaurants and shops.

As for the effect of an agglomeration economy on all industries in Table 4 is similar to that of manufacturing in Table 2. Increasing the imported inputs reduces the demand for workers in all industries and increases the demand for short-time workers, but it increases the demand where manufacturing agglomerates. These results does not change even when the estimation excludes the Tokyo, Osaka and Fukuoka data, as shown in Panel C of Table 4.

3.3 Effect for unemployment and wages

Imported intermediate inputs reduce the demand for workers and increase the demand for short-time workers shown above. However, imported inputs do not increase the number unemployed workers indicated in Panel A of Table 5. Column 3 and 4 in Panel A of Table 5 show that the agglomeration economy reduces the number of unemployed workers when the estimation excludes the Tokyo, Osaka and Fukuoka data.

Panels B and C in Table 5 show the trade effects on wages in manufacturing. Imported inputs increase the wage for less educated male workers in column 1 in Panel

[15] Shown in Appendix 3.

B in Table 5, but this effect is insignificant column 2. When I estimated the effect on contractual cash earnings without bonus, the estimation coefficient was insignificant when the model included the Gini index and the cross-term, which is the Gini index multiples imported inputs, but the coefficient was negative when the model included R&D. Furthermore, imported inputs decrease the wage in column 1 in Panel C of Table 5 when the estimation did not include the Tokyo, Osaka and Fukuoka data. Panels B and C in Table 5 also indicate that rising imported inputs decrease the wage for more highly educated male workers and short-time workers, but the results are not robust. Panels D and E in Table 5 present the trade effects on wages in all industries. Rising imported inputs decrease the wages for short-time workers, although increasing imported inputs does not clearly affect the wage for workers in manufacturing.

4. Conclusions and Discussions

This paper explores the effect of imported intermediate inputs on local Japanese labor markets and the impact of an agglomeration economy on this trade effect and the role of R&D in the agglomeration economy. Little is known about the effect of trade on local labor markets, although the labor market does not usually integrate into a whole in many countries, and the employment situation differs among local labor markets. Furthermore, increasing imported inputs sometimes results in closure of factories, which significantly affects the local labor market. The extent of agglomeration in the manufacturing sector directly correlates with the damage to the local labor market. However, an agglomeration economy presents advantages in productivity.

I analyzed these issues at the commuting zones (CZs) level using the Basic Survey on Wage Structure and the Basic Survey of Japanese Business Structure and Activities with information from 1997 to 2011. I utilized OLS and estimation using an instrumental variable. First, this paper find that rising inputs from abroad decrease the demand for more highly and less educated workers and increase the demand for short-time workers. However, the agglomeration of manufacturing mitigates this trade exposure. This effect spills over to the non-manufacturing sector.

Second, increasing the imported inputs increases the demand for less educated workers in manufacturing in rural and R&D-intensive areas where manufacturing agglomerates and does not increase the demand for workers in the non-manufacturing

sector while R&D itself increases the demand for more highly educated workers in manufacturing and less educated workers in the non-manufacturing sector. However, these results are not the direct effect of R&D, nor are they conclusive. Finally, a clear effect on wages in manufacturing was not observed, although rising inputs from abroad decrease wages for short-time workers in all industries.

This paper used mainly the Gini index to estimate the impact of an agglomeration economy on the trade effect. The Gini index indicates the intensity of specific manufacturing in the given CZs and does not represent the intensity of manufacturing. Therefore, the Gini index used in this study as a scaling factor, as explained in section 2, might explain the industrial style. JILPT (2007) argue that modular style industries, such as the personal computer and portable telephone industries, have a high ratio of part-time workers and are caught in a price war. In contrast, integral style industries, such as the automobile industry, have high ratio of permanent workers and promote production skills that involve affiliate companies. Therefore, integral style industries agglomerate, and the Gini index rises. Moreover, these industries provide an advantage over the competition with labor abroad. Furthermore, comparing the results using Gini index and EG index controlled establishment size, scaling economy affects the local labor markets in terms of imported inputs. In this paper, the intensity of manufacturing is represented by the ratio of employment in manufacturing to whole employment, but this ratio does not explain the effect well.

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Table 1 Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Δ Less educated male workers in manufacturing	490	−6559.57	8506.86	−25233.00	155.00
Δ Highly educated male workers in manufacturing	490	−4699.63	6439.63	−15779.00	152.00
Δ Less educated female workers in manufacturing	490	−2027.94	2442.47	−7054.00	59.00
Δ Highly educated female workers in manufacturing	490	−958.62	1294.52	−3481.00	31.00
Δ Short−time workers in manufacturing	490	14673.94	32163.56	−5090.00	93655.00
Δ Less educated male workers in all industries	490	−9568.04	13897.02	−42713.00	1033.33
Δ Highly educated male workers in all industries	490	−6222.48	10466.82	−30563.33	1403.33
Δ Less educated female workers in all industries	490	−3087.53	3905.74	−10176.00	773.33
Δ Highly educated female workers in all industries	490	−1031.10	4022.38	−10490.00	3653.00
Δ Short−time workers in all industries	490	7054.18	9983.82	−2575.00	28428.33
Δ Unemployment	490	2045.96	5358.84	−15740.84	15264.84
Δ Wages of less educated male workers in manufacturing	423	6062.47	8485.59	−12113.30	28585.24
Δ Wages of highly educated male workers in manufacturing	414	838.41	6461.29	−38205.30	33200.83
Δ Wages of less educated female workers in manufacturing	396	5995.93	7916.51	−10032.20	34924.06
Δ Wages of highly educated female workers in manufacturing	356	4180.18	5391.79	−13392.73	30066.67
Δ Wages of short−time workers in manufacturing	445	−1768.07	1328.79	−9563.54	4421.17
Δ Wages of less educated male workers in all industries	490	−496.37	295.96	−2142.01	3597.06
Δ Wages of highly educated male workers in all industries	490	−288.25	407.16	−3972.66	4154.10
Δ Wages of less educated female workers in all industries	490	−134.43	206.56	−1611.20	1642.21
Δ Wages of highly educated female workers in all industries	481	24.70	283.33	−4083.89	2749.58
Δ Wages of short−time workers in all industries	485	−113.08	141.99	−989.33	1191.20
Δ Imported intermediate inputs	490	786.82	2358.33	−1405.50	6322.70
Δ Tangible fixed asset	490	306.48	8111.76	−14404.87	16941.47
Δ Volume of business	490	1491.67	20722.21	−33079.71	44518.72
Unemployment ratio	490	5.34	1.52	1.84	13.99
Ratio of manufacturing employmen	490	27.39	12.61	0.00	79.86
Gini index	490	0.04	0.08	0.00	0.95
EG index	490	0.35	6.49	−76.19	45.12
Ratio of R&D in manufacturing	489	301.01	91.01	0.00	745.03
Ratio of college graduates	490	140.46	46.69	38.36	202.87
Ratio of female workers	490	331.81	139.97	40.50	1191.06
Ratio of elderly people at least 65 years old	490	175.46	40.71	86.64	356.09
Period	490	0.54	0.50	0.00	1.00

Table 1 Descriptive statistics (continued)

Correlation

	Δ Imported intermediate inputs	Δ Tangible fixed asset	Δ Volume of business	Unemployment ratio	Ratio of manufacturing employmen	Gini index	Ratio of R&D in manufacturing	Cross term of Gini index and R&D	Cross term of R&D and imported inputs	Cross term of Gini index and imported inputs	Ratio of college graduates	Ratio of female workers	Ratio of elderly people at least 65 years old	Period
Δ Imported intermediate inputs	1.00													
Δ Tangible fixed asset	0.88	1.00												
Δ Volume of business	0.92	0.99	1.00											
Unemployment ratio	−0.20	−0.20	−0.23	1.00										
Ratio of manufacturing employmen	0.35	0.46	0.48	−0.48	1.00									
Gini index	−0.14	−0.02	−0.04	−0.03	0.11	1.00								
Ratio of R&D in manufacturing	0.18	0.12	0.12	−0.05	−0.18	−0.31	1.00							
Cross term of Gini index and R&D	−0.15	−0.03	−0.04	−0.09	0.12	0.68	0.14	1.00						
Cross term of R&D and imported inputs	0.998	0.88	0.92	−0.21	0.34	−0.15	0.19	−0.15	1.00					
Cross term of Gini index and imported inputs	0.67	0.59	0.62	−0.20	0.34	−0.04	0.12	−0.04	0.65	1.00				
Ratio of college graduates	0.37	0.04	0.08	0.02	−0.34	−0.45	0.43	−0.37	0.39	0.12	1.00			
Ratio of female workers	−0.17	0.001	−0.02	−0.21	0.05	−0.08	0.09	−0.03	−0.17	−0.06	−0.31	1.00		
Ratio of elderly people at least 65 years old	−0.56	−0.40	−0.44	0.22	−0.17	0.33	−0.42	0.19	−0.56	−0.39	−0.61	0.11	1.00	
Period	−0.57	−0.59	−0.62	0.52	−0.63	0.08	−0.10	0.08	−0.56	−0.52	−0.04	−0.14	0.66	1.00

	Δ Imported intermediate inputs	Δ Tangible fixed asset	Δ Volume of business	Unemployment ratio	Ratio of manufacturing employmen	EG index	Ratio of R&D in manufacturing	Cross term of EG index and R&D	Cross term of R&D and imported inputs	Cross term of EGi index and imported inputs
EG index	−0.04	−0.005	−0.01	0.03	0.03	1.00				
Ratio of R&D in manufacturing	0.18	0.12	0.12	−0.05	−0.18	−0.15	1.00			
Cross term of EG index and R&D	−0.02	−0.002	−0.002	0.04	0.02	0.96	−0.10	1.00		
Cross term of R&D and imported inputs	0.998	0.88	0.92	−0.21	0.34	−0.04	0.19	−0.02	1.00	
Cross term of EG index and imported inputs	0.06	−0.01	−0.01	−0.09	0.14	−0.35	0.03	−0.30	0.04	1.00
Ratio of college graduates	0.37	0.04	0.08	0.02	−0.34	−0.02	0.43	0.02	0.39	−0.05
Ratio of female workers	−0.17	0.001	−0.02	−0.21	0.05	−0.09	0.09	−0.10	−0.17	−0.02
Ratio of elderly people at least 65 years old	−0.56	−0.40	−0.44	0.22	−0.17	0.08	−0.42	0.05	−0.56	0.06
Period	−0.57	−0.59	−0.62	0.52	−0.63	0.11	−0.10	0.11	−0.56	−0.06

Table 2 Change of manufacturing employment, imported inputs and agglomeration economy

	Depend variables: 10 x annual change in manufacturing employment																			
	Less educated male workers				Highly educated male workers				Less educated female workers				Highly educated female workers				Short-time workers			
	(1)		(2)		(1)		(2)		(1)		(2)		(1)		(2)		(1)		(2)	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Panel A. OLS estimates																				
Δ Imported intermediate inputs	−7.64 ***	0.21	−6.23 ***	0.24	−6.38 ***	0.21	−5.24 ***	0.22	−2.21 ***	0.07	−1.79 ***	0.08	−1.25 ***	0.04	−1.03 ***	0.04	19.58 ***	0.68	16.11 ***	0.70
Δ Tangible fixed asset	−1.74 ***	0.09	−1.51 ***	0.11	−1.36 ***	0.09	−1.19 ***	0.11	−0.51 ***	0.03	−0.45 ***	0.04	−0.33 ***	0.02	−0.30 ***	0.02	2.55 ***	0.30	2.01 ***	0.34
Δ Volume of business	1.27 ***	0.05	1.07 ***	0.06	1.13 ***	0.05	0.98 ***	0.06	0.38 ***	0.02	0.32 ***	0.02	0.24 ***	0.01	0.21 ***	0.01	−4.13 ***	0.17	−3.67 ***	0.19
Unemployment ratio	−3.79	68.09	7.47	85.72	151.88 **	67.83	156.59 *	80.17	−2.61	23.04	2.10	27.75	18.99	13.34	20.19	15.73	−175.59	221.04	−201.04	256.49
Ratio of manufacturing employmen	−33.36 ***	10.11	−41.60 ***	12.70	−24.36 **	10.07	−29.77 **	11.88	−10.16 ***	3.42	−12.74 ***	4.11	−4.83 **	1.98	−5.89 **	2.33	58.11 *	32.81	74.51 **	37.99
Gini index	−1989.04 *	1193.65	−2470.48	2125.98	−3481.67 ***	1189.23	−2802.91	1988.50	−398.76	403.89	−711.27	688.33	−649.06 ***	233.92	−536.97	390.10	9313.36 **	3875.21	7889.61	6361.61
Cross term of Gini index and imported inputs	250.02 ***	15.49			202.98 ***	15.43			73.83 ***	5.24			39.55 ***	3.04			−615.67 ***	50.30		
Cross term of Gini index and R&D			4.37	9.52			−3.00	8.91			2.38	3.08			−0.45	1.75			4.58	28.50
Ratio of R&D in manufacturing			1.70	1.59			2.30	1.49			0.43	0.51			0.45	0.29			−7.39	4.75
Ratio of college graduates	−51.61 ***	4.57	−71.66 ***	5.60	−43.97 ***	4.55	−61.13 ***	5.24	−16.88 ***	1.55	−22.68 ***	1.81	−9.32 ***	0.90	−12.65 ***	1.03	158.54 ***	14.84	210.33 ***	16.76
Ratio of female workers	1.52 **	0.68	1.68 *	0.86	0.97	0.67	0.99	0.81	0.38 *	0.23	0.44	0.28	0.18	0.13	0.18	0.16	−3.84 *	2.20	−3.84	2.58
Ratio of elderly people at least 65 years old	−13.08 ***	4.38	−15.37 ***	5.67	−15.43 ***	4.36	−17.32 ***	5.30	−4.54 ***	1.48	−5.11 ***	1.84	−3.23 ***	0.86	−3.56 ***	1.04	51.43 ***	14.21	55.88 ***	16.96
Period	1128.99 ***	366.22	147.23	464.37	1020.55 ***	364.86	259.59	434.34	338.63 ***	123.92	37.51	150.35	209.68 ***	71.77	59.12	85.21	−4331.44 ***	1188.95	−1935.02	1389.54
Constant	7185.80 ***	1423.70	9971.30 ***	1848.75	6757.77 ***	1418.43	8895.63 ***	1729.20	2360.70 ***	481.73	3165.07 ***	598.57	1471.60 ***	279.00	1879.34 ***	339.23	−23158.09 ***	4622.07	−29241.95 ***	5532.05
Adj R-squared	0.96		0.94		0.93		0.90		0.94		0.92		0.93		0.91		0.97		0.96	
Panel B. 2SLS estimates																				
Δ Imported intermediate inputs	−10.45 ***	2.16	−11.72 ***	3.73	−7.72 ***	1.91	−8.86 ***	2.99	−3.26 ***	0.75	−3.63 ***	1.23	−1.53 ***	0.38	−1.75 ***	0.59	26.12 ***	6.54	29.86 ***	10.25
Gini index	−1243.38	1498.40	398.44	3634.07	−3127.40 **	1324.64	−910.68	2908.11	−120.44	521.92	249.60	1198.38	−574.99 **	261.89	−158.11	574.78	7573.73 *	4529.27	696.46	9973.42
Cross term of Gini index and imported inputs	336.69 ***	68.90			244.16 ***	60.91			106.18 ***	24.00			48.16 ***	12.04			−817.87 ***	208.26		
Cross term of Gini index and R&D			−2.96	14.62			−7.84	11.70			−0.08	4.82			−1.41	2.31			22.97	40.13
Ratio of R&D in manufacturing			1.47	2.30			2.15	1.84			0.35	0.76			0.42	0.36			−6.81	6.31
Uncentered R2	0.9652		0.917		0.9506		0.9035		0.9516		0.8966		0.9527		0.9076		0.9706		0.9422	
Panel C. OLS estimates excluding the large cities(Tokyo, Osaka and Fukuoka)																				
Δ Imported intermediate inputs	−10.80 ***	0.42	−6.25 ***	0.42	−5.13 ***	0.21	−2.91 ***	0.21	−3.36 ***	0.14	−1.98 ***	0.14	−0.94 ***	0.05	−0.56 ***	0.05	17.87 ***	1.09	10.76 ***	0.94
Gini index	81.78	306.94	256.67	544.51	−293.29 *	154.62	10.28	270.65	243.89 **	104.73	160.61	177.03	−35.19	37.59	0.95	59.59	−259.03	805.17	−1045.42	1235.62
Cross term of Gini index and imported inputs	210.28 ***	12.28			101.82 ***	6.18			63.48 ***	4.19			17.70 ***	1.50			−322.29 ***	32.20		
Cross term of Gini index and R&D			5.25 **	2.44			1.24	1.21			2.44 ***	0.79			0.33	0.27			−5.43	5.54
Ratio of R&D in manufacturing			−0.14	0.41			0.19	0.21			−0.14	0.13			0.04	0.05			−1.07	0.94
Adj R-squared	0.77		0.64		0.75		0.61		0.77		0.66		0.70		0.61		0.82		0.79	

Notes: N=490 for (1) and 489 for (2) in Panel A and Panel B, 484 for (1) and 483 for (2) in Panel C.
***, ** and * denote 1%, 5% and 10% significance levels, respectively.

Table 3 Change of manufacturing employment, imported inputs and agglomeration economy using EG index

	Depend variables: 10 x annual change in manufacturing employment																			
	Less educated male workers				Highly educated male workers				Less educated female workers				Highly educated female workers				Short-time workers			
	(1)		(2)		(1)		(2)		(1)		(2)		(1)		(2)		(1)		(2)	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Panel A. OLS estimates																				
ΔImported intermediate inputs	−6.76 ***	0.25	−6.32 ***	0.24	−5.74 ***	0.24	−5.34 ***	0.23	−1.95 ***	0.08	−1.82 ***	0.08	−1.13 ***	0.05	−1.05 ***	0.04	17.74 ***	0.76	16.45 ***	0.72
EG index	4.70	16.11	−78.26	58.60	1.18	15.17	−79.66	55.01	0.80	5.24	−23.87	18.97	−0.43	2.97	−17.23	10.78	6.79	48.37	251.73	175.59
Cross term of EG index and imported inputs	0.14 ***	0.03			0.13 ***	0.03			0.04 ***	0.01			0.03 ***	0.01			−0.42 ***	0.09		
Cross term of EG index and R&D			0.209	0.187			0.21	0.176			0.063	0.0606			0.0445	0.0344			−0.625	0.561
Ratio of R&D in manufacturing			1.80	1.34			1.82	1.26			0.55	0.43			0.36	0.25			−6.07	4.01
Adj R-squared	0.94		0.94		0.91		0.90		0.92		0.92		0.91		0.91		0.96		0.96	
Panel B. OLS estimates excluding the large cities(Tokyo, Osaka and Fukuoka)																				
ΔImported intermediate inputs	−6.39 ***	0.42	−6.35 ***	0.42	−2.99 ***	0.21	−2.93 ***	0.21	−2.04 ***	0.14	−2.03 ***	0.14	−0.58 ***	0.05	−0.56 ***	0.05	11.07 ***	0.94	10.91 ***	0.95
EG index	7.44	6.04	16.74	15.62	4.97 *	2.98	7.46	7.68	1.91	2.00	4.19	5.17	1.16 *	0.66	−0.21	1.70	0.34	13.69	−28.45	35.33
Cross term of EG index and imported inputs	0.05	0.13			−0.02	0.06			0.01	0.04			−0.03 **	0.01			−0.23	0.28		
Cross term of EG index and R&D			−0.02	0.05			−0.01	0.02			−0.01	0.02			0.00	0.01			0.06	0.11
Ratio of R&D in manufacturing			0.38	0.35			0.35 *	0.17			0.08	0.12			0.07 *	0.04			−1.59 **	0.79
Adj R-squared	0.63		0.63		0.61		0.61		0.64		0.64		0.61		0.61		0.79		0.79	

Notes: N=490 for (1) and 489 for (2) in Panel A and 484 for (1) and 483 for (2) in Panel B.
***, ** and * denote 1%, 5% and 10% significance levels, respectively.

Table 4 Change of employment in all industries, imported inputs and agglomeration economy

	Depend variables: 10 x annual change in employment in all industries																			
	Less educated male workers				Highly educated male workers				Less educated female workers				Highly educated female workers				Short-time workers			
	(1)		(2)		(1)		(2)		(1)		(2)		(1)		(2)		(1)		(2)	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Panel A. OLS estimates																				
ΔImported intermediate inputs	−11.57 ***	0.27	−9.40 ***	0.33	−9.75 ***	0.31	−8.14 ***	0.32	−3.80 ***	0.12	−3.11 ***	0.13	−1.79 ***	0.07	−1.53 ***	0.07	8.18 ***	0.39	6.68 ***	0.39
Gini index	−2560.99 *	1549.33	−2467.04	2938.85	−4994.97 ***	1759.40	−3686.18	2903.69	−1237.28 *	668.41	−1276.57	1139.02	−948.52 **	427.41	−860.03	655.65	5647.13 **	2243.79	4968.90	3494.17
Cross term of Gini index and imported inputs	384.71 ***	20.11			286.12 ***	22.83			122.42 ***	8.68			45.58 ***	5.55			−267.64 ***	29.12		
Cross term of Gini index and R&D			2.37	13.16			−6.20	13.01			1.09	5.10			−0.35	2.94			2.95	15.65
Ratio of R&D in manufacturing			4.39 **	2.20			3.81 *	2.17			1.23	0.85			0.39	0.49			−2.42	2.61
Adj	0.97		0.95		0.94		0.92		0.94		0.91		0.98		0.97		0.89		0.88	
Panel B. 2SLS estimates																				
ΔImported intermediate inputs	−15.73 ***	2.92	−17.96 ***	5.53	−12.44 ***	2.93	−14.26 ***	4.62	−5.31 ***	1.20	−6.01 ***	1.99	−2.75 ***	0.77	−3.07 ***	1.10	10.80 ***	3.62	12.32 **	5.05
Gini index	−1455.83	2024.58	2010.34	5378.69	−4279.49 **	2025.89	−486.60	4501.02	−837.73	829.27	238.74	1932.36	−693.04	530.26	−58.50	1065.83	4949.78 **	2508.06	2016.59	4910.38
Cross term of Gini index and imported inputs	513.17 ***	93.09			369.28 ***	93.15			168.86 ***	38.13			75.28 ***	24.38			−348.69 ***	115.32		
Cross term of Gini index and R&D			−9.08	21.64			−14.38	18.11			−2.79	7.78			−2.40	4.29			10.50	19.76
Ratio of R&D in manufacturing			4.03	3.40			3.55	2.85			1.10	1.22			0.32	0.67			−2.18	3.11
Uncentered	0.97		0.93		0.95		0.90		0.95		0.89		0.97		0.95		0.92		0.88	
Panel C. OLS estimates excluding the large cities(Tokyo, Osaka and Fukuoka)																				
ΔImported intermediate inputs	−19.95 ***	0.79	−11.37 ***	0.78	−8.29 ***	0.45	−5.03 ***	0.40	−4.93 ***	0.25	−3.02 ***	0.22	−1.02 ***	0.17	−0.79 ***	0.13	1.22 **	0.52	0.37	0.41
Gini index	−863.12	585.51	650.28	1026.55	−592.38 *	333.99	294.53	523.32	25.52	184.87	192.82	292.70	−42.37	124.18	80.12	174.66	−576.69	382.45	−401.96	538.86
Cross term of Gini index and imported inputs	391.25 ***	23.42			148.87 ***	13.36			86.97 ***	7.39			10.38 **	4.97			−38.31 **	15.30		
Cross term of Gini index and R&D			2.92	4.60			−0.83	2.35			1.72	1.31			−0.42	0.78			−2.33	2.42
Ratio of R&D in manufacturing			1.49 *	0.78			0.80 **	0.40			0.23	0.22			0.13	0.13			0.09	0.41
Adj	0.74		0.59		0.69		0.62		0.66		0.57		0.42		0.41		0.74		0.74	

Notes: N=490 for (1) and 489 for (2) in Panel A and Panel B, 484 for (1) and 483 for (2) in Panel C.
***, ** and * denote 1%, 5% and 10% significance levels, respectively.

Table 5 Change of unemployment, wages, imported inputs and agglomeration economy

	Depend variables: 10 x annual change in unemployment							
	(1)		(2)		(3)		(4)	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Panel A. 2SLS estimates (column 1&2) and OLS estimates excluding large cities(Tokyo, Osaka and Fukuoka; column 3&4)								
ΔImported intermediate inputs	−2.89	3.39	−2.97	3.84	−2.06	2.62	−1.21	2.06
Gini index	−3073.80	2345.93	−2759.68	3741.32	−5771.08 ***	1930.36	−4950.55 *	2699.89
Cross term of Gini index and imported inputs	96.98	107.87			60.43	77.20		
Cross term of Gini index and R&D			−2.34	15.05			−5.10	12.10
Ratio of R&D in manufacturing			−2.30	2.37			−2.01	2.05
Uncentered R2/Adj R-squared	0.70		0.69		0.21		0.21	
Number of observations	490		489		484		483	

	Depend variables: 10 x annual change in wages of manufacturing workers(Panel B and C)/ wages of workers in all industries(Panel D and E)											
	Less educated male workers				Highly educated male workers				Less educated female workers			
	(1)		(2)		(1)		(2)		(1)		(2)	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Panel B. 2SLS estimates for column 1 and OLS estimates for column 2												
d_wage1M	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
ΔImported intermediate inputs	12.64 *	7.48	−0.66	0.42	−0.39	6.17	−2.68 ***	0.64	6.31	5.23	−0.47	0.39
Gini index	−9597.05	5853.66	1799.73	5018.32	−3834.42	5632.94	9508.59	8192.68	−3652.15	4385.44	591.61	5077.21
Cross term of Gini index and imported inputs	−442.16 *	240.86			−65.90	200.07			−181.72	167.34		
Cross term of Gini index and R&D			−42.66 **	20.29			−78.71 **	35.98			−13.96	19.59
Ratio of R&D in manufacturing			6.05 **	2.97			0.75	4.60			4.65 *	2.79
Uncentered R2/Adj R-squared	0.66		0.82		0.32		0.31		0.83		0.83	
Number of observations	423		423		414		414		396		396	
Panel C. OLS estimates excluding the large cities(Tokyo, Osaka and Fukuoka)												
ΔImported intermediate inputs	−6.85 *	3.71	−1.24	2.89	−3.94	5.55	−3.81	4.26	−2.36	3.49	1.99	2.72
Gini index	−9025.87 ***	3383.83	1025.12	4972.69	−3442.70	5592.35	12061.50	7965.82	−2487.09	3494.19	1113.42	5088.11
Cross term of Gini index and imported inputs	258.65 **	112.42			69.23	169.12			185.49 *	105.23		
Cross term of Gini index and R&D			−43.53 **	20.12			−90.70 ***	35.13			−10.10	19.70
Ratio of R&D in manufacturing			7.10 **	2.99			4.16	4.56			4.15	2.85
Adj R-squared	0.74		0.74		0.28		0.29		0.75		0.75	
Number of observations	417		417		408		408		390		390	
Panel D. 2SLS estimates												
ΔImported intermediate inputs	−0.04	0.29	−0.03	0.33	−0.49	0.44	−0.44	0.49	−0.15	0.21	−0.11	0.23
Gini index	252.91	202.74	45.80	317.19	−38.78	304.50	−605.25	477.83	80.92	143.74	−133.59	221.37
Cross term of Gini index and imported inputs	−0.94	9.32			16.89	14.00			2.97	6.61		
Cross term of Gini index and R&D			1.45	1.28			3.74 *	1.92			1.26	0.89
Ratio of R&D in manufacturing			0.12	0.20			−0.15	0.30			−0.22	0.14
Uncentered	0.78		0.78		0.33		0.33		0.39		0.41	
Number of observations	490		489		490		489		490		489	
Panel E. OLS estimates excluding the large cities(Tokyo, Osaka and Fukuoka)												
ΔImported intermediate inputs	−0.21	0.26	−0.30	0.21	−0.01	0.36	−0.10	0.29	0.08	0.18	−0.15	0.14
Gini index	247.62	193.79	56.40	270.56	−110.19	268.55	−809.45 **	373.14	95.71	132.05	−183.34	185.07
Cross term of Gini index and imported inputs	−6.84	7.75			−7.27	10.74			−10.72 *	5.28		
Cross term of Gini index and R&D			1.21	1.21			4.29 **	1.67			1.41 *	0.83
Ratio of R&D in manufacturing			0.17	0.21			−0.19	0.28			−0.24 *	0.14
Adj	0.03		0.04		0.08		0.09		0.10		0.10	
Number of observations	484		483		484		483		484		483	

Notes: ***, ** and * denote 1%, 5% and 10% significance levels, respectively. # denotes 10.9% significance level.

Table 5 Change of unemployment, wages, imported inputs and agglomeration economy (continued)

	Depend variables: 10 x annual change in wages of manufacturing workers(Panel B and C)/ wages of workers in all industries(Panel D and E)							
	Highly educated female workers				Short-time workers			
	(1)		(2)		(1)		(2)	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Panel B. 2SLS estimates for column 1 and OLS estimates for column 2								
d_wage1M	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Δ Imported intermediate inputs	−4.66	4.73	−0.43	0.43	0.13	0.81	−0.20 **	0.08
Gini index	1139.70	5451.65	2981.68	8083.71	711.59	668.80	1052.12	1010.57
Cross term of Gini index and imported inputs	155.24	152.21			−17.64	26.05		
Cross term of Gini index and R&D			−12.44	30.45			−1.47	4.13
Ratio of R&D in manufacturing			1.02	3.32			−0.17	0.57
Uncentered R2/Adj R-squared	0.71		0.60		0.90		0.72	
Number of observations	356		356		445		445	
Panel C. OLS estimates excluding the large cities(Tokyo, Osaka and Fukuoka)								
Δ Imported intermediate inputs	−3.60	3.88	0.55	2.99	−0.69	0.71	−0.82	0.55
Gini index	−1215.11	5229.35	4311.75	8114.91	679.65	641.02	1105.09	1005.37
Cross term of Gini index and imported inputs	191.96	117.63			−4.09	21.18		
Cross term of Gini index and R&D			−15.84	30.62			−2.41	4.11
Ratio of R&D in manufacturing			2.06	3.39			0.06	0.58
Adj R-squared	0.53		0.53		0.63		0.63	
Number of observations	350		350		439		439	
Panel D. 2SLS estimates								
Δ Imported intermediate inputs	−0.45	0.34	−0.49	0.40	−0.26 *	0.15	−0.31 #	0.19
Gini index	365.06	246.67	215.14	418.36	65.83	104.42	264.61	191.36
Cross term of Gini index and imported inputs	13.50	10.83			7.35	4.79		
Cross term of Gini index and R&D			1.33	1.78			−1.19	0.82
Ratio of R&D in manufacturing			−0.06	0.25			−0.05	0.12
Uncentered	−0.22		−0.36		0.42		0.26	
Number of observations	481		480		485		484	
Panel E. OLS estimates excluding the large cities(Tokyo, Osaka and Fukuoka)								
Δ Imported intermediate inputs	−0.27	0.27	−0.25	0.21	−0.17 *	0.10	−0.25 ***	0.08
Gini index	241.18	208.82	−50.32	296.87	7.36	75.79	119.34	106.04
Cross term of Gini index and imported inputs	−0.84	8.05			−2.57	3.00		
Cross term of Gini index and R&D			2.05	1.39			−0.89 *	0.50
Ratio of R&D in manufacturing			−0.08	0.21			−0.06	0.08
Adj	0.03		0.03		0.34		0.35	
Number of observations	475		474		479		478	

Notes: ***, ** and * denote 1%, 5% and 10% significance levels, respectively. # denotes 10.9% significance level.

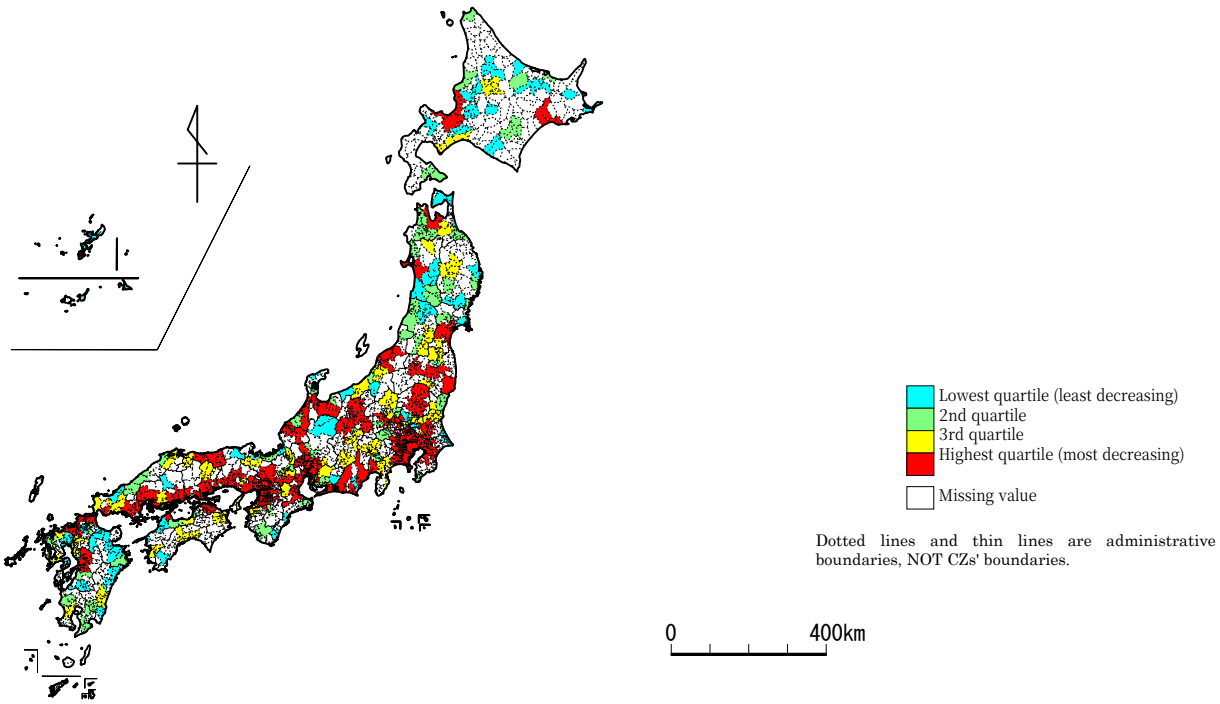

Figure 1-the decrease in less educated male workers to the increase in imported inputs

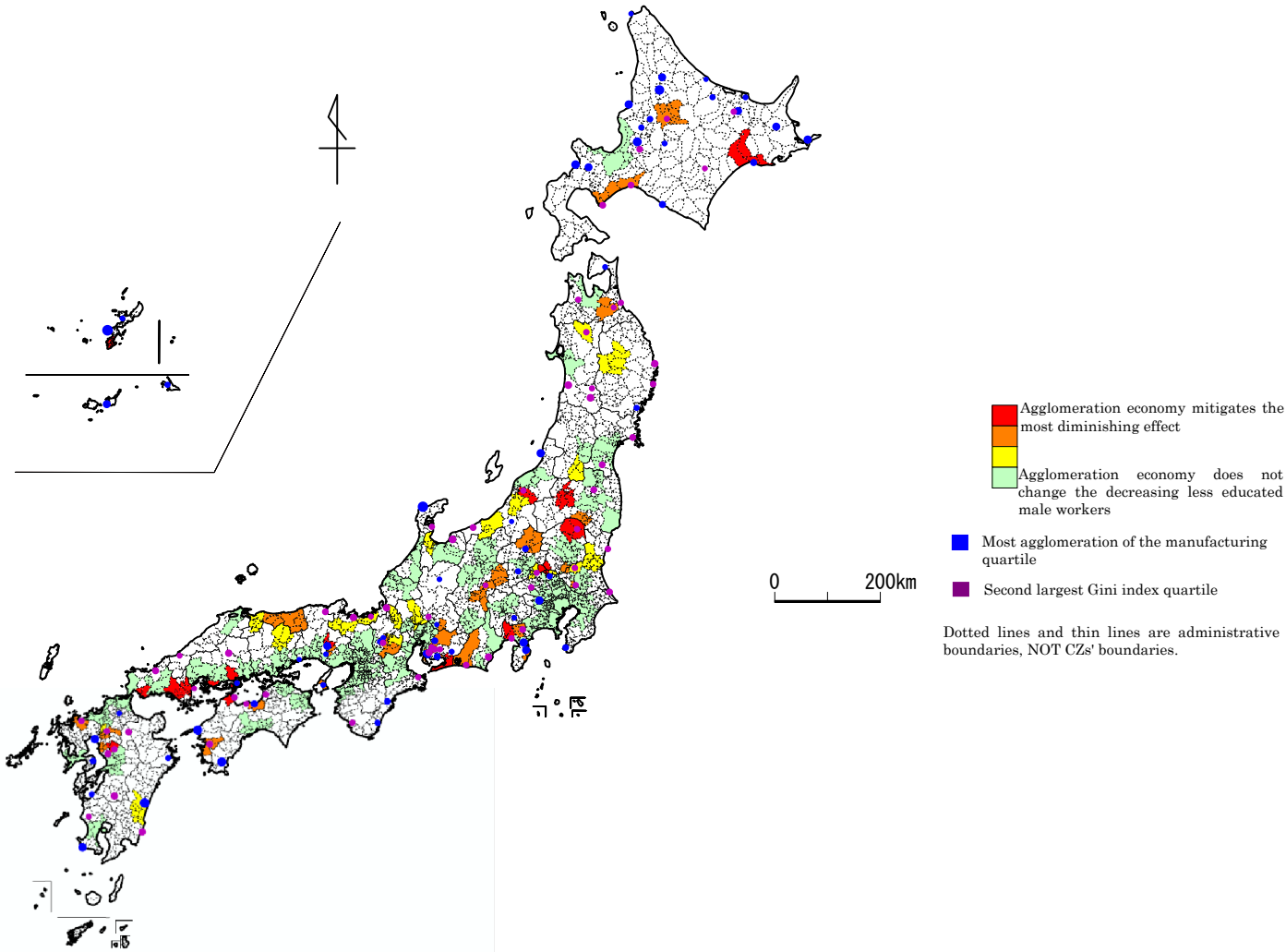

Figure 2-impact of agglomeration economy on the decreases in less educated male workers

Appendix 1 Change of manufacturing employment and imported inputs: alternative OLS estimates

Depend variables: 10 x annual change in manufacturing *less educated male workers*

	(1)		(2)		(3)		(4)		(5)	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Δ Imported intermediate inputs	−6.27 ***	0.23	−6.25 ***	0.23	−7.64 ***	0.21	−6.24 ***	0.23	−6.23 ***	0.24
Δ Tangible fixed asset	−1.50 ***	0.11	−1.49 ***	0.11	−1.74 ***	0.09	−1.51 ***	0.11	−1.51 ***	0.11
Δ Volume of business	1.07 ***	0.06	1.07 ***	0.06	1.27 ***	0.05	1.08 ***	0.06	1.07 ***	0.06
Unemployment ratio	3.28	83.72	−12.84	84.53	−3.79	68.09	3.00	85.09	7.47	85.72
Ratio of manufacturing employmen	−40.35 ***	12.44	−42.46 ***	12.53	−33.36 ***	10.11	−40.88 ***	12.59	−41.60 ***	12.70
Gini index			−1964.99	1482.07	−1989.04 *	1193.65	−1773.69	1487.27	−2470.48	2125.98
Cross term of Gini index and imported inputs					250.02 ***	15.49				
Cross term of Gini index and R&D									4.37	9.52
Ratio of R&D in manufacturing							2.11	1.31	1.70	1.59
Ratio of college graduates	−69.26 ***	5.23	−71.40 ***	5.47	−51.61 ***	4.57	−72.17 ***	5.49	−71.66 ***	5.60
Ratio of female workers	2.19 ***	0.81	1.90 **	0.84	1.52 **	0.68	1.63 *	0.85	1.68 *	0.86
Ratio of elderly people at least 65 years old	−18.18 ***	5.42	−18.14 ***	5.42	−13.08 ***	4.38	−15.63 ***	5.63	−15.37 ***	5.67
Period	304.27	450.66	313.51	450.36	1128.99 ***	366.22	184.12	456.98	147.23	464.37
Constant	10347.85 ***	1688.06	10935.59 ***	1744.01	7185.80 ***	1423.70	9980.34 ***	1847.12	9971.30 ***	1848.75
Adj R-squared	0.94		0.94		0.96		0.94		0.94	

Notes: N=490 for (1), (2) and (3) and 489 for (4) and (5).

***, ** and * denote 1%, 5% and 10% significance levels, respectively.

Appendix 2 First stage estimates of Panel B in Table 2

	(1)		(2)	
	Coef.	Std. Err.	Coef.	Std. Err.
Δ Tangible fixed asset	−0.28 ***	0.02	−0.30 ***	0.02
Δ Volume of business	0.21 ***	0.01	0.22 ***	0.01
Unemployment ratio	48.02 ***	15.21	51.48 ***	17.03
Ratio of manufacturing employmen	3.57	2.23	3.24	2.50
Gini index	235.78	260.80	426.21	414.65
Cross term of Gini index and imported inputs	31.08 ***	3.08		
Cross term of Gini index and R&D			−0.92	1.86
Ratio of R&D in manufacturing			−0.11	0.31
Ratio of college graduates	15.79 ***	0.70	16.03 ***	0.81
Ratio of female workers	−0.66 ***	0.15	−0.75 ***	0.17
Ratio of elderly people at least 65 years old	5.46 ***	0.92	5.60 ***	1.07
Period	−102.68	80.21	−221.23 **	90.05
instrumental variable	0.00 **	0.00	0.00 **	0.00
Constant	−2652.55 ***	286.91	−2571.55 ***	340.04
Uncentered R2	0.98		0.97	

Notes: N=490 for (1) and 489 for (2).

***, ** and * denote 1%, 5% and 10% significance levels, respectively.

Appendix 3 Change of employment, imported inputs and agglomeration economy: estimates of model excluding the cross-term

	Depend variables: 10 x annual change in manufacturing employment									
	Less educated male workers		Highly educated male workers		Less educated female workers		Highly educated female workers		Short-time workers	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
ΔImported intermediate inputs	−6.24 ***	0.23	−5.24 ***	0.22	−1.79 ***	0.08	−1.03 ***	0.04	16.11 ***	0.70
Gini index	−1773.69	1487.27	−3280.71 **	1390.96	−331.68	481.73	−608.07 **	272.86	8619.06 *	4449.53
Ratio of R&D in manufacturing	2.11	1.31	2.02 *	1.22	0.66	0.42	0.41 *	0.24	−6.96 *	3.92
Adj R-squared	0.94		0.90							
	Depend variables: 10 x annual change in employment in all industries									
ΔImported intermediate inputs	−9.40 ***	0.32	−8.14 ***	0.32	−3.11 ***	0.13	−1.53 ***	0.07	6.67 ***	0.39
Gini index	−2089.27	2055.55	−4674.55 **	2031.37	−1103.13	796.69	−915.21 **	458.58	5439.80 **	2443.97
Ratio of R&D in manufacturing	4.61 **	1.81	3.23 *	1.79	1.33 *	0.70	0.35	0.40	−2.14	2.15
Adj R-squared	0.95		0.92		0.91		0.97		0.88	

Notes: N=489

***, ** and * denote 1%, 5% and 10% significance levels, respectively.