Grant-in-Aid for Scientific Research (S)

Real Estate Markets, Financial Crisis, and Economic Growth

: An Integrated Economic Approach

Working Paper Series No.57

Determinants of Industrial Coagglomeration and Establishment-level Productivity

Daisuke Fujii
Kentaro Nakajima
and
Yukiko Umeno Saito

March, 2016

HIT-REFINED PROJECT
Institute of Economic Research, Hitotsubashi University
Naka 2-1, Kunitachi-city, Tokyo 186-8603, JAPAN
Tel: +81-42-580-9145
E-mail: hit-refined-sec@ier.hit-u.ac.jp
http://www.ier.hit-u.ac.jp/hit-refined/

Determinants of Industrial Coagglomeration and Establishment-level Productivity*

Daisuke Fujii
USC Dornsife INET
dfujii@usc.edu

Kentaro Nakajima
Tohoku University
nakajima.kentaro@gmail.com

Yukiko Umeno Saito
RIETI
saito-yukiko@rieti.go.jp

March 16, 2016

Abstract

This paper investigates the relationships between determinants of industrial coagglomeration and establishment-level productivity. For each pair of industries, we first construct degree of coagglomeration and indices for three factors of coagglomeration: inter-firm transactions, knowledge spillover, and labor market pooling. We then examine correlation between these three factors and degree of coagglomeration. Overall, inter-firm transactions and labor market pooling are positively correlated with the degree of coagglomeration whereas knowledge spillover has no significant relationship with coagglomeration. We also find that determinants of coagglomeration are quite different across industries. Further, we examine relationships between these factors and establishment-level productivity. In the results, we find that determinants of coagglomeration are not necessarily positively associated with productivity of establishments.

Keywords: coagglomeration, transaction costs, knowledge spillover, labor pooling

JEL classifications: R11

*This study is conducted as a part of the Project "Study on Corporate Finance and Firm Dynamics" undertaken at Research Institute of Economy, Trade and Industry (RIETI). Utilized data is establishment- and firm-level data pertaining to the Census of Manufactures (Kogyo Toukei Chosa) and the Basic Survey of Japanese Business Structure and Activities (Kigyo Katsudo Kihon Chosa) conducted by Ministry of Economy, Trade, and Industry. We thank Ryuichi Tamura and participants of the JEA at Kanagawa University, and Discussion Paper seminar at RIETI. We gratefully acknowledge the financial support from the Japan Society for the Promotion of Science (Nos. 25220502, 25380275, 25780181, 26245037, 26285051).

1 Introduction

The spatial distribution of economic activity is unevenly distributed. For instance, more than 20 percent of the Japanese population resides in Tokyo metropolitan area. The geographic concentration of economic activity is observed at an industry level as well including the famous examples of high-tech industries in Silicon Valley and auto industry in Detroit. In Japan, small and medium-size manufacturers agglomerate in Ota Ward of Tokyo and Higashi Osaka City in Osaka. Recent research has shown empirical evidence of industrial agglomeration. Duranton and Overman (2005, 2008) **??** find that over half of four-digit industries in UK agglomerate. Nakajima, Saito and Uesugi (2012)**?** also find similar results in Japan.

Marshall (1890)**?** pioneers the analysis of the causes of industrial agglomeration followed by many studies. He points out that positive externality caused by the concentration of firms is the main reason for agglomeration, and enumerates inter-firm transactions, knowledge spillover, technology transfer and labor market pooling as the examples of the externality which drives productivity gain for each establishment. Rosenthal and Strange (2001)**?** measure the effects of these factors on industrial agglomeration by regressing the degree of agglomeration on the indices of the three factors, and find all the factors significantly work as the determinants for agglomeration. Nakajima, Saito and Uesugi (2013)**?** also find the same results for Japan. Ellison, Glaeser and Kerr (2010)**?** investigate coagglomeration of pairwise industries by regressing a coagglomeration index on the factors of agglomeration for each industry pair.

This research examines the relationship between industry coagglomeration and its possible determinants listed above using firm-level data in Japan. We also examine industry differences in the determinants. Furthermore, we analyze relationships between establishment-level productivity and the possible determinants of coagglomeration. In previous literature, agglomeration has been pointed out to improve the productivity of establishments and workers in the location. This productivity improvement is confirmed by many empirical studies (e.g. Combes et al. 2012)**?**. However, few papers have examined which factors, i.e., possible determinants of agglomeration, actually improve the establishment-level productivity. To estimate this agglomeration effect on productivity, we construct indices of potential agglomeration externalities for each establishment and each possible determinant by assuming that an establishment receives externality from other establishments depending on industry relationships and distance. We assume that the externality from other establishments is decreasing in distance, and increasing in the industry pairwise index of the determinant in attention. We analyze the relationship between this externality index and establishments' productivity, and identify which potential agglomeration externality exhibits a positive correlation with establishment-level productivity.

First, on the determinants of coagglomeration, we found that inter-firm transactions and labor market pooling are significantly and positively correlated with the degree of coagglomeration as an overall tendency. We also found that the determinants of agglomeration are quite different among

industries, whereas previous literature only focuses on overall tendency. Next, regarding the agglomeration externality on productivity, we find that externality related to transactions shows a significant positive correlation with establishment-level productivity as an overall tendency. Again, differences among industries are found and determinants for each industry are not necessarily positively related to productivity.

This paper is organized as follows. Next section explains the four datasets we use in the current research: Census of Manufactures, Basic Survey of Japanese Business Structure and Activities, inter-firm transactions data by Tokyo Shoko Research and Japanese patent data. Section 3 details the methodology including the construction of our indices and regressions. Sections 4 reports the results, and Section 5 concludes.

2 Data

This paper uses establishment-level data from the Census of Manufactures and firm-level data from the Basic Survey of Japanese Business Structure and Activities, which are both provided by the Ministry of Economy, Trade and Industry (METI). We also use inter-firm transactions data from Tokyo Shoko Research, and Japanese patent data.

The Census of Manufactures (CM) provides data on manufacturing establishments. The CM collects data on all establishments in years ending with 0, 3, 5 and 8. For other years, it covers establishments with four or more employees. In this paper, we use the CM data in 2005. We transform the address information to latitude and longitudinal information using the geocoding system of the Center for Spatial Information Science at the University of Tokyo.

The Basic Survey of Japanese Business Structure and Activities (JBSA) was first conducted in 1992 to elucidate the business activities of Japanese firms, and has been conducted every year since 1995. Its coverage includes non-manufacturing firms with more than 50 employees and capital stock of over 30 million yen. It records the number of employees in each job category enabling us to capture the labor composition for each firm.

We use corporate information data from Tokyo Shoko Research (TSR) in 2005. This large-scale, comprehensive database covers 826,169 Japanese firms, which is more than half of the total number of firms in Japan. The dataset indexes firms' transaction partners by ID numbers, which gives a detailed network of firm transactions. We extract manufacturing firms, group them by JSIC 3-digit industry codes, and compute the number of inter-industry transactions for each industry pair.

The Japanese patent data from Japan Patent Office (JPO) between 1993 and 2010 are used. Because this dataset does not contain the information on industry classification, we merge the patent applications data with the firm data from TSR. If the name of the firm and address are identical, it is recorded as the same firm. We use the geocoding system to consistently match the addresses. We extract and group manufacturing firms according to JSIC 3-digit classifications, and compute the number of joint patent applications for each industry pair.

3 Methodology

3.1 Determinants of Coagglomeration

This paper examines three factors of agglomeration. This subsection describes their definitions and estimation strategies. As for the inter-firm transaction index, we use actual inter-firm transaction relationship information from TSR database. TSR database provides the information of firm-level transaction relationship, and we count the number of transaction relationships between industries. We normalize this number of transactions by dividing by numbers of firms in each industry, and call it inter-firm transaction index. For an industry pair i and j, the normalized number of firm transaction relationships is denoted by n_trans_{ij}. As the measure of knowledge spillovers, we use the information on joint application of patent between firms. JPO database provides the information on firm-level patent joint application, and we count number of joint applications between industries. We normalize this number of joint applications by dividing by numbers of firms in each industry, which is denoted by $n\_collabo_{ij}$ as a knowledge spillovers index. For the similarity of labor composition, we use the firm-level information on number of employees in each job category from JBSA. We aggregate it to industry-level and construct industry-level labor composition information. By calculating correlation coefficient on the composition of labor between industries, we obtain an index of similarity of labor composition denoted by $corr\_labor_{ij}$.

Then, we examine the relationship between the intensity of agglomeration and its factors. From the CM data, Ellison-Glaeser (EG) index of coagglomeration is computed for each industry pair. Using the locational data of establishments, we create 10 kilometer mesh. For each geographical mesh r, we compute how many establishments of industry i are located in the area, and the tendency for industry pairs i and j to coagglomerate (EG_{ij}). The EG index is defined as follows

$$EG_{ij} = \frac{\sum_{r=1}^{R} (s_{ri} - x_r)(s_{rj} - x_r)}{1 - \sum_{r=1}^{R} x_r^2}$$

where s_{ri} is the share of employment of industry i in region r, and x_r is the share of aggregate employment in region r. Table 1 lists the 10 most coagglomerated industry pairs according this this index.

Next, we analyze the relationship between the coagglomeration index EG_{ij} and the factors of agglomeration: inter-firm transactions (n_trans_{ij}), knowledge spillover ($n\_collabo_{ij}$), and labor market pooling ($corr\_labor_{ij}$). The estimation equation is the following.

$$EG_{ij} = \beta_0 + \beta_1 n\_trans_{ij} + \beta_2 n\_collabo_{ij} + \beta_3 corr\_labor_{ij} + \epsilon \tag{1}$$

Previous research (Ellison, Glaeser, and Kerr (2010) etc) runs above regression by pooling all industries. In addition to the pooled regression, we also estimate for each industry i to incorporate heterogeneous effects of agglomeration factors by industry.

Rank	JSIC	Industry	JSIC	Industry	EG
1	218	fur skins	219	miscellaneous leather products	0.095
2	202	rubber and plastic footwear and its findings	213	cut stock and findings for boots and shoes	0.074
3	202	rubber and plastic footwear and its findings	214	leather footwear	0.074
4	213	cut stock and findings for boots and shoes	218	fur skins	0.073
5	162	plate making for printing	169	service industries related to printing trade	0.070
6	163	bookbinding and printed matter	169	service industries related to printing trade	0.065
7	213	cut stock and findings for boots and shoes	214	leather footwear	0.056
8	213	cut stock and findings for boots and shoes	219	miscellaneous leather products	0.054
9	217	handbags and small leather cases	218	fur skins	0.052
10	217	handbags and small leather cases	219	miscellaneous leather products	0.048

Table 1: The most coagglomerated industry pairs

3.2 Potential Agglomeration Externalities on Productivity

To study the relationship between coagglomeration and establishment-level productivity, we construct an index of potential externality for each agglomeration factor by assuming that an establishment receives externality from other establishments which depends on bilateral distance and industry relationships. Precisely, the effects from other establishments decrease by distance in the order of -1, and increase by the industry pairwise index of the determinant in attention. We sum them up using the number of employees as weights. In what follows, x and y denote establishments, and i and j denote industries. Let I and J also denote the sets of establishments in those industries. Define the potential externality effect for each agglomeration factor as follows.

$$pot_x^t = \sum_j w_{ij}^t \sum_{y \in j} \frac{emp_y}{d_{xy}}, \text{ for } x \in j \text{ and } t \in \{trans, collabo, labor\}$$

The above index measures the potential externality for establishment x in industry i. The variables emp_y and d_{xy} are the number of employees of establishment y, and the distance between establishments x and y. The second sum implies that larger and closer establishments have more impact on x. The sum of the size-distance-weighted potential from establishments in industry j ($\sum_{y \in j} \frac{emp_y}{d_{xy}}$) is again weighted by the strength of relationships in terms of the focusing determinant t between industries i and j, w_{ij}^t. If industry j is well connected to i in terms of the factors (inter-firm transactions, knowledge spillover, and labor market pooling), establishments in the industry has a large influence on the potential externality of establishment x in industry i.

Let LP_x be the value added per worker of establishment x, our measure of establishment-level labor productivity.[1] Using the three potential agglomeration externalities constructed above, we consider the following regression specification

$$LP_x = \beta_0 + \beta_1 pot_x^{trans} + \beta_2 pot_x^{collabo} + \beta_3 pot_x^{labor} + \epsilon \quad (2)$$

[1]This simple measure of productivity guarantees the highest coverage of our dataset including very small establishments. Capital information is available only for the establishments that have over 30 employees.

Transaction	Collaboration	Labor similarity	Constant	Observations	R-squared
1.019***	0.324	0.00156***	-0.00118***	21,609	0.037
(0.276)	(0.246)	(0.000194)	(0.000143)		

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

Table 2: Baseline estimation on EG index and determinants of agglomeration

T-value	[-∞,-1.96)	[-1.96,-1.65)	[-1.65,0)	(0,1.65]	(1.65,1.96]	(1.96,∞]
Transaction	0.0%	0.0%	0.7%	21.8%	12.2%	65.3%
Collaboration	34.8%	7.6%	23.5%	22.7%	3.0%	8.3%
Labor similarity	4.8%	2.7%	23.8%	38.8%	11.6%	18.4%

Table 3: Distribution of t-values in regression 1

From this analysis, we aim to elucidate which coagglomeration factors are related to establishment-level productivity.

4 Regression Results

4.1 Result on the Determinants of Coagglomeration

The result of estimation equation 1 is shown in Table 2. The intensity of inter-firm transactions and the similarity of labor composition show positive and significant coefficients whereas the intensity of joint research is not significantly correlated with the coagglomeration index. This result suggests the importance of inter-firm transactions and labor market pooling as factors of coagglomeration. In contrast to Ellison et al. (2010) that find all the three determinants are positively significant, we cannot find any statistically significant effects on knowledge spillovers.

The determinants of coagglomeration may vary with industry. Next we estimate equation 1 by industry. Table 3 shows the distribution of the t-values. For inter-firm transactions, 78 % industries show t-values larger than 1.65 (10% significance) while 30.0 % show t-values over 1.65 for the similarity of labor composition. For knowledge spillover, only 11.3% have t-values larger than 1.65. This result also implies the importance of inter-firm transactions as a determinant of coagglomeration.

To examine the heterogeneous effects of the three determinants of agglomeration across industries, we aggregate the number of three-digit industries that exhibit positive and significant coefficients in each factor to two-digit industry levels. Table 4 summarizes the results. For example, the first row states that Food industry has nine three-digit industries. Out of the nine industries, nine, three and zero industries have positive coefficients for transaction, collaboration and labor similarity respectively. As we confirmed in Table 3, in the most of the industries, the coefficients for transactions are significantly positive. However, labor similarity is important in Iron and steel (JSIC 23) and Fabricated metal products (JSIC 25). Furthermore, in Iron and steel (JSIC 23),

2-digit industry		No. of 3-digit industries	Transaction		Collaboration		Labor similarity	
9	Food	9	9	(1.00)	3	(0.33)	0	(0.00)
10	Beverages, tobacco and feed	6	6	(1.00)	1	(0.17)	1	(0.17)
11	Textile mill products	9	6	(0.67)	0	(0.00)	1	(0.11)
12	Apparel and other finished products made from fabrics	6	6	(1.00)	0	(0.00)	1	(0.17)
13	Lumber and wood products	4	4	(1.00)	0	(0.00)	0	(0.00)
14	Furniture and fixtures	4	4	(1.00)	0	(0.00)	0	(0.00)
15	Pulp, paper and paper products	6	6	(1.00)	0	(0.00)	1	(0.17)
16	Printing and allied industries	4	2	(0.50)	0	(0.00)	2	(0.50)
17	Chemical and allied products	8	8	(1.00)	2	(0.25)	4	(0.50)
18	Petroleum and coal products	5	3	(0.60)	2	(0.40)	0	(0.00)
19	Plastic products, except otherwise classified	6	4	(0.67)	0	(0.00)	2	(0.33)
20	Rubber products	4	2	(0.50)	0	(0.00)	2	(0.50)
21	Leather tanning, leather products and fur skins	9	7	(0.78)	0	(0.00)	4	(0.44)
22	Ceramic, stone and clay products	9	7	(0.78)	1	(0.11)	2	(0.22)
23	Iron and steel	6	3	(0.50)	4	(0.67)	5	(0.83)
24	Non-ferrous metals and products	6	3	(0.50)	0	(0.00)	4	(0.67)
25	Fabricated metal products	9	2	(0.22)	1	(0.11)	4	(0.44)
26	General machinery	9	5	(0.56)	0	(0.00)	4	(0.44)
27	Electrical machinery, equipment and supplies	6	6	(1.00)	0	(0.00)	2	(0.33)
28	Information and communication electronics equipment	2	2	(1.00)	0	(0.00)	1	(0.50)
29	Electronic parts and devices	1	1	(1.00)	1	(1.00)	0	(0.00)
30	Transportation equipment	6	4	(0.67)	0	(0.00)	2	(0.33)
31	Precision instruments and machinery	7	7	(1.00)	0	(0.00)	0	(0.00)
32	Miscellaneous manufacturing industries	9	7	(0.78)	0	(0.00)	2	(0.22)

Table 4: Number of significantly positive industries in the coefficient for each determinants of agglomerations (shares in parenthesis)

collaboration also plays important role as an agglomeration force.

In sum, as the determinants of coagglomeration, in the pooled regression, we found that similarity of labor compositions and inter-firm transaction are positively significant. Further, from the industry-level analysis, we find that in the most of the industries, inter-firm transactions work as the determinant of coagglomeration.

4.2 Result on Potential Agglomeration Externalities on Productivity

Then, we move to the discussion on the role of determinants for agglomeration on establishment-level productivities. We present the results of regression 2, which estimates the effects of each potential externality on productivity. Table 5 shows the results by pooling all establishments. The coefficient of transaction potential externality is positive and significant. On the other hand, the coefficient of collaboration is not significant, furthermore, that of labor similarity is negatively significant. Collaboration and labor similarity do not improve establishments' productivities at least in the pooled regression. In the previous section, we find that transaction and labor similarity are important factors for coagglomeration. Regarding the externality on productivity, transaction has a positive effect, but labor similarity does not. This implies the gap between determinants of agglomeration and productivity externalities.

Transaction	Collaboration	Labor similarity	Constant	Observations	R-squared
138.4***	-42.94	-0.000691***	689.9***	276,502	0.017
(13.16)	(68.05)	(0.00024)	(6.418)		

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

Table 5: Baseline estimation on determinants of agglomeration and productivity

T-value	$[-\infty,-1.96)$	[-1.96,-1.65)	[-1.65,0)	(0,1.65]	(1.65,1.96]	$(1.96,\infty]$
Transaction	2.0%	0.7%	25.9%	44.9%	2.7%	23.8%
Collaboration	7.6%	3.8%	34.1%	44.7%	2.3%	7.6%
Labor similarity	17.0%	6.1%	40.1%	27.9%	1.4%	7.5%

Table 6: Distribution of t-values in regression 2

Above are the results for all industries pooled, yet the externalities may differ across industries. To address this issue, we also run regression 2 by industry. Table 6 summarizes the distributions of t-values for each coefficient by industry. From the table, we see that the coefficients for transactions are positively significant in many industries. In 26.5 % industries, the coefficients for transactions are positively significant at the 10% level. However, relative to the results in determinants for coagglomeration (Table 3), the share of industries that have significantly positive coefficient for transactions heavily declined. This implies that transaction as a determinant for coagglomeration does not necessarily improves establishments' productivities. On the other hand, the shares of industries that have significantly positive coefficients for collaborations and labor similarities are both around 9%. Industries that have positively significant coefficient for labor similarities are also declined relative to the results in determinants for coagglomeration.

Table 7 displays industries whose t-values are larger than 1.65 for each agglomeration factor. It is useful to find what industries show t-values larger than 1.65 (positive at 10% significance level) for each agglomeration factor. The top part of Table 7 lists industries whose transaction coefficient is positive at 10% significance level. There are many industries with high transport costs such as iron industries (JSIC 231) or cement and its products (JSIC 222) due to the weight of their products. The middle part of Table 7 shows industries which have a positive and significant coefficient of collaboration. There are industries in which knowledge spillovers strongly affect production activity such as motor vehicles, parts, and accessories (JSIC 301). The bottom part of Table 7 lists industries whose labor similarity coefficient is positive and significant. It contains industries in which artisan skills play an important role, implying there is a productivity externality through labor market pooling.

Table 8 lists two-digit industries along with the number of three-digit industries that show positive and significant coefficients for each externality factor like Table 4. For example, we see collaboration improves productivities in Textile mill products (JSIC11) .

Finally, to confirm gaps between factors that facilitates coagglomeration and that improves

JSIC	Industry	Transaction	t-value	Observations
102	alcoholic beverages	38,794	2.794	1,777
176	drugs and medicines	3,995	2.345	910
94	seasonings	3,972	1.83	1,747
328	manufacture of ordnance and accessories	3,735	2.131	37
103	tea and coffee	3,632	2.023	1,495
223	structural clay products, except those of pottery	2,767	4.319	451
222	cement and its products	2,355	3.055	5,949
99	miscellaneous foods and related products	2,214	5.386	12,145
121	textile outer garments and shirts	1,934	5.789	5,894
131	sawing, planning mills and wood products	1,684	3.47	5,277
173	industrial organic chemicals	1,486	4.401	689
125	other textile apparel and accessories	1,454	3.223	1,202
193	industrial plastic products	1,194	2.576	6,243
98	animal and vegetable oils and fats	1,117	1.861	202
97	bakery and confectionery products	945.2	2.258	6,715
124	Japanese style apparel and "tabi"-sock	931.7	2.792	495
133	wooden, bamboo and rattan containers	797.2	3.069	847
274	electronic equipment	594.3	1.843	1,097
194	foamed and reinforced plastic products	585.3	1.928	1,685
172	industrial inorganic chemicals	559.9	3.365	750
214	leather footwear	528.3	3.415	603
264	metal working machinery	409.2	8.335	7,956
304	aircraft and parts	396.8	2.582	258
169	service industries related to printing trade	345.1	2.091	107
242	secondary smelting and refining of non-ferrous metals	339	2.075	355
266	special industry machinery	332.9	2.845	4,915
256	metal coating, engraving and heat treating	313.6	6.331	6,333
258	bolts, nuts, rivets, machine screws and wood screws	310.5	3.05	1,933
253	heating apparatus and plumbing supplies	304.4	2.68	1,422
152	paper	284.6	2.333	472
191	plastic plates, bars and rods, pipes and tubes, pipe fittings and profile extrusions	244.1	2.213	1,215
161	printing	241.6	3.708	13,825
245	non-ferrous metal machine parts and tooling products	213.9	1.995	1,511
179	miscellaneous chemical and allied products	198.6	2.805	942
269	miscellaneous machinery and machine parts	192.6	6.64	10,132
209	miscellaneous rubber products	158.1	2.124	527
267	general industry machinery and equipment	111.9	3.198	6,883
162	plate making for printing	111.1	2.046	1,442
231	iron industries	86.78	2.512	30

JSIC	Industry	Collaboration	t-value	Observations
106	prepared animal foods and organic fertilizers	26,404	4.357	817
217	handbags and small leather cases	18,251	2.095	686
235	ferrous metal machine parts and tooling products	15,882	2.346	1,323
141	furniture	15,289	1.923	4,656
121	textile outer garments and shirts	13,018	2.862	5,894
263	machinery and equipment for construction and mining	11,541	2.068	1,232
116	dyed and finished textiles	6,059	4.461	1,912
254	fabricated constructional and architectural metal products	5,626	1.857	16,490
226	carbon and graphite products	5,211	2.15	166
224	pottery and related products	4,730	1.975	2,334
301	motor vehicles, parts and accessories	4,246	2.401	9,347
112	spinning mills	2,089	1.721	255
255	metal machine parts and tooling products	1,293	3.287	4,348

JSIC	Industry	Labor similarity	t-value	Observations
184	paving materials	0.0236	2.913	736
224	pottery and related products	0.0157	2.178	2,334
118	lace and other textile goods	0.0101	2.69	732
315	optical instruments and lenses	0.00779	2.794	967
326	lacquer ware	0.00676	1.725	536
124	Japanese style apparel and "tabi"-sock	0.00669	2.214	495
209	miscellaneous rubber products	0.00634	2.377	527
142	furniture for religious purposes	0.00619	2.943	432
212	mechanical leather products, except gloves and mittens	0.00432	1.933	55
122	knitted garments and shirts	0.00374	5.313	2,444
214	leather footwear	0.00316	2.768	603
161	printing	0.0029	2.883	13,825
252	tableware (occidental type), cutlery, hand tools and hardware	0.00231	2.33	2,592

Table 7: Industries whose coefficients are significant in regression 2

2-digit industry		No. of 3-digit industries	Transaction		Collaboration		Labor similarity	
9	Food	9	4	(0.44)	0	(0.00)	0	(0.00)
10	Beverages, tobacco and feed	6	2	(0.33)	1	(0.17)	0	(0.00)
11	Textile mill products	9	0	(0.00)	2	(0.22)	1	(0.11)
12	Apparel and other finished products made from fabrics	6	3	(0.50)	1	(0.17)	2	(0.33)
13	Lumber and wood products	4	2	(0.50)	0	(0.00)	0	(0.00)
14	Furniture and fixtures	4	0	(0.00)	1	(0.25)	1	(0.25)
15	Pulp, paper and paper products	6	1	(0.17)	0	(0.00)	0	(0.00)
16	Printing and allied industries	4	3	(0.75)	0	(0.00)	1	(0.25)
17	Chemical and allied products	8	4	(0.50)	0	(0.00)	0	(0.00)
18	Petroleum and coal products	5	0	(0.00)	0	(0.00)	1	(0.20)
19	Plastic products, except otherwise classified	6	3	(0.50)	0	(0.00)	0	(0.00)
20	Rubber products	4	1	(0.25)	0	(0.00)	1	(0.25)
21	Leather tanning, leather products and fur skins	9	1	(0.11)	1	(0.11)	2	(0.22)
22	Ceramic, stone and clay products	9	2	(0.22)	2	(0.22)	1	(0.11)
23	Iron and steel	6	1	(0.17)	1	(0.17)	0	(0.00)
24	Non-ferrous metals and products	6	2	(0.33)	0	(0.00)	0	(0.00)
25	Fabricated metal products	9	3	(0.33)	2	(0.22)	1	(0.11)
26	General machinery	9	4	(0.44)	1	(0.11)	0	(0.00)
27	Electrical machinery, equipment and supplies	6	1	(0.17)	0	(0.00)	0	(0.00)
28	Information and communication electronics equipment	2	0	(0.00)	0	(0.00)	0	(0.00)
29	Electronic parts and devices	1	0	(0.00)	0	(0.00)	0	(0.00)
30	Transportation equipment	6	1	(0.17)	1	(0.17)	0	(0.00)
31	Precision instruments and machinery	7	0	(0.00)	0	(0.00)	1	(0.14)
32	Miscellaneous manufacturing industries	9	1	(0.11)	0	(0.00)	1	(0.11)

Table 8: Number of significantly positive industries in the coefficient for each determinants of agglomerations on productivities (shares in parenthesis)

		Productivity estimation	
		Yes	No
Coagglomeration	Yes	25	89
estimation	No	14	22

(a) Transaction

		Productivity estimation	
		Yes	No
Coagglomeration	Yes	0	15
estimation	No	28	107

(b) Collaboration

		Productivity estimation	
		Yes	No
Coagglomeration	Yes	5	39
estimation	No	8	98

(c) Labor similarity

Table 9: Frequency table of industries that show significant coefficients

establishments' productivities, we summarize estimation results. Table 9 shows the results. Top panel shows the results on transaction. The first row shows the number of industries that have positively significant coefficient for transactions in the coagglomeration estimation. That is, we have 114 (25 + 89) industries that have positively significant coefficient for transactions in the coagglomeration estimation. Furthermore, only 25 of 114 industries also have positive coefficient for transactions in the productivity estimation. Similarly, middle and bottom panels show the results on collaboration and labor similarity, respectively. From this table, we can see the gap between the factors on coagglomeration and productivity improvement. Interestingly, collaboration works as a productivity improvement force only in the industries in which collaboration does not work as coagglomeration factors. That is, there is no industry that have positively significant coefficient for collaboration both coagglomeration and productivity estimations. More detailed table is shown in the Appendix.

To summarize, there is heterogeneity in the effect of agglomeration on productivity by industry. Furthermore, there is a gap between determinants for coagglomeration and productivity improvement factors.

5 Conclusion

This research examines the factors for coagglomeration, and investigates the externalities from these factors on establishments' productivities. By regressing the intensity of coagglomeration on its factors (pooling all industries), we find that inter-firm transactions and the similarity of labor composition are positively correlated with coagglomeration, but there is no significant relationship with the intensity of joint research. This implies the importance of inter-firm transactions and labor market pooling as the determinants of coagglomeration. From the regression results by industry, we confirm that the reduction of inter-firm transaction costs is an important factor for coagglomeration in many industries. On the other hand, on the estimation of productivity improvement effects, we find that only the coefficient of transactions is significant and positively related to establishment-level productivity in the pooled regression. We also find the large heterogeneity across industries in the estimation of productivity improvements. Furthermore, we find that determinants for coagglomeration are not necessarily associated with productivity of establishments.

Appendix

Table 10: Significant coefficients in the regressions 1 and 2 by industry

JSIC	Industry name	EG index			Productivity		
		Trans	Collabo	Labor	Trans	Collabo	Labor
91	livestock products	+	+				
92	seafood products	+		-			
93	canned and preserved fruit and vegetable products	+					
94	seasonings	+			+		
95	sugar processing	+	+				
96	flour and grain mill products	+		-			
97	bakery and confectionery products	+			+		
98	animal and vegetable oils and fats	+		-	+		
99	miscellaneous foods and related products	+	+		+	-	
101	soft drinks and carbonated water	+					
102	alcoholic beverages	+	+		+		-
103	tea and coffee	+	-		+		-
104	manufactured ice	+		+		+	
105	tobacco manufactures	+				+	
106	prepared animal foods and organic fertilizers	+				+	-
111	silk reeling plants					+	
112	spinning mills	+		+		+	
113	twisting and bulky yarns	+				+	
114	woven fabric mills						
115	knit fabrics mills	+					
116	dyed and finished textiles					+	-
117	rope and netting	+	-				
118	lace and other textile goods	+	-			-	+
119	miscellaneous textile mill products	+					
121	textile outer garments and shirts	+	-		+	+	-
122	knitted garments and shirts	+				+	+
123	underwear	+					
124	Japanese style apparel and "tabi"-sock	+	-	+	+	-	+
125	other textile apparel and accessories	+			+		
129	miscellaneous fabricated textile products	+					
131	sawing, planning mills and wood products	+			+		-
132	millwork, plywood and prefabricated structural wood	+					

133	wooden, bamboo and rattan containers	+			+	+	
139	miscellaneous manufacture of wood products	+					
141	furniture	+	-			+	
142	furniture for religious purposes	+				+	+
143	sliding doors and screens	+		-			
149	miscellaneous furniture and fixtures	+	-				
151	pulp	+		+		+	
152	paper	+			+		
153	coated and glazed paper	+					
154	paper products	+	-	-			
155	paper containers	+	-				
159	miscellaneous pulp, paper and paper worked products	+	-				
161	printing			+	+	-	+
162	plate making for printing	+			+		
163	bookbinding and printed matter	+	-				
169	service industries related to printing trade			+	+	+	
171	chemical fertilizers	+		-			-
172	industrial inorganic chemicals	+	+	+	+	-	
173	industrial organic chemicals	+	-	+	+		-
174	chemical fibers	+	-				
175	oil and fat products, soaps, synthetic detergents	+	-	+			-
176	drugs and medicines	+			+	-	-
177	cosmetics, toothpaste and toilet preparations	+	-				
179	miscellaneous chemical and allied products	+	+	+	+		-
181	petroleum refining	+	+				
182	lubricating oils and greases						
183	coke	+	+				
184	paving materials	+				+	+
189	miscellaneous petroleum and coal products				+		-
191	plastic plates, bars and rods, pipes and tubes,	+	-				
192	plastic films, sheets, floor coverings		-		+		-
193	industrial plastic products	+		+	+		-
194	foamed and reinforced plastic products	+					
195	compounding plastic materials		-	+			
199	miscellaneous plastic products	+	-				
201	tires and inner tubes	+	-	+			
202	rubber and plastic footwear and its findings	+	-	+			
203	rubber belts and hoses and mechanical rubber goods				+	-	+

209	miscellaneous rubber products		-	-		+	
211	leather tanning and finishing	+				-	+
212	mechanical leather products, except gloves and mittens	+	-				
213	cut stock and findings for boots and shoes	+		+	+	+	+
214	leather footwear	+		+		+	-
215	leather gloves and mittens	+		+			
216	baggage	+	-	-		+	
217	handbags and small leather cases	+		+			-
218	fur skins				+		
219	miscellaneous leather products				+	-	
221	glass and its products		-	-	-	+	+
222	cement and its products		+				-
223	structural clay products, except those of pottery	+	-		-	+	-
224	pottery and related products	+	-		-		
225	clay refractories	+					
226	carbon and graphite products	+	-	+			-
227	abrasive products	+	-		+		-
228	aggregate and stone products	+					
229	miscellaneous ceramic, stone and clay products	+		+			
231	iron industries	+	+	+			
232	steel, with rolling facilities	+		+		+	-
233	steel materials, except made by smelting furnaces		+	+			
234	coated steel		+				
235	ferrous metal machine parts and tooling products		+	+	+	-	
239	miscellaneous iron and steel	+		+			-
241	primary smelting and refining of non-ferrous metals	+		+			
242	secondary smelting and refining of non-ferrous metals		-		+		-
243	rolling of non-ferrous metals and alloys		-				
244	electric wire and cable	+	-	+			-
245	non-ferrous metal machine parts and tooling products	+		+			+
249	miscellaneous non-ferrous metal products			+	+		-
251	tin cans and other plated sheet products	+	-			+	
252	tableware (occidental type), cutlery, hand tools		-	+	-	+	-
253	heating apparatus and plumbing supplies		-		+	-	-
254	fabricated constructional and architectural metal	+	+	+			
255	metal machine parts and tooling products		-	+	+		-
256	metal coating, engraving and heat treating		-				
257	fabricated wire products		-	+			

258	bolts, nuts, rivets, machine screws and wood screws		-				
259	miscellaneous fabricated metal products		-			+	
261	boilers, engines and turbines	+			+	-	
262	agricultural machinery and equipment	+	-	-			-
263	machinery and equipment for construction and mining	+		+	+		-
264	metal working machinery				+		-
265	textile machinery	+					
266	special industry machinery				+	-	
267	general industry machinery and equipment			+			
268	office, service industry and household machines	+	-	+			
269	miscellaneous machinery and machine parts		-	+			
271	electrical generating, transmission, distribution	+			+	-	
272	household electric appliances	+	-	+			
273	electric bulbs and lighting fixtures	+	-				
274	electronic equipment	+	-	+			
275	electric measuring instruments	+	-				
279	miscellaneous electrical machinery equipment	+					
281	communication equipment and related products	+				+	-
282	electronic data processing machines	+		+			
291	electronic parts and devices	+	+				
301	motor vehicles, parts and accessories	+		+	+		-
302	railroad equipment and parts	+	-				
303	shipbuilding and repairing, and marine engines						
304	aircraft and parts	+					
305	industrial trucks and parts and accessories			+			
309	miscellaneous transportation equipment	+	-				
311	measuring instruments, analytical instruments	+	-				
312	surveying instruments	+	-			-	+
313	medical instruments and apparatus	+					
314	physical and chemical instruments	+	-				
315	optical instruments and lenses	+					
316	ophthalmic goods, including frames	+				+	
317	watches, clocks, clockwork-operated devices and parts	+					
321	precious metal products, including jewel			+			
322	musical instruments	+					
323	toys and sporting goods	+	-	+			+
324	pens, lead pencils, painting materials and stationery	+	-	-			
325	costume jewelry, costume accessories, buttons	+	-		+	+	-

326	lacquer ware	+	-
327	sundry goods of straw, "tatami" mats, and umbrellas	+	
328	manufacture of ordnance and accessories	+	
329	manufacturing industries, n.e.c.		