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## The Localization of Interfirm Transaction Relationships

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# The Localization of Interfirm Transaction Relationships\*

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## Abstract

Using a unique dataset of more than 140,000 manufacturing firms in Japan containing information on their suppliers and customers, this paper looks at the physical distances between transaction partners to examine the localization of transaction relationships. We find the following. First, based on a counterfactual that controls for the location of firms and their potential partners, transaction relationships in about 90-95% of the 150 three-digit manufacturing industries can be labelled as localized at distances of 40km or less. This indicates that physical distance is a key factor in firms' choice of transaction partners. Second, based on a counterfactual that controls for the average distance of transaction relationships in the manufacturing sector as a whole, we find that in about 40% of industries transaction relationships are localized at short distances of up to 40km. Third, the extent of industrial localization and the extent of the localization of transaction relationships are positively correlated. However, there are a number of exceptions and we provide potential explanations for these.

*Keywords:* Interfirm transactions; agglomeration; transaction distance

*JEL classification:* R11

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# 1 Introduction

Industrial activities are localized in certain areas. The agglomerations of automobile assemblers and suppliers in places such as Toyota City in Japan and Detroit in the US are the famous examples of industrial localization. Duranton and Overman (2005) and Nakajima, Saito, and Uesugi (2010a) show that about half of all the manufacturing industries tend to localize in the UK and in Japan, respectively. As presented in a comprehensive survey on micro-foundations of agglomeration by Duranton and Puga (2004), inter-firm transactions are one of the most important sources for industrial localization. Several of the previous studies have used industry-level data and provided empirical evidence for the relevance of such transactions. Rosenthal and Strange (2001) employ input-output tables in the US and present that stronger transaction relationships within a certain industry facilitate localization in the particular industry. Ellison, Glaeser, and Kerr (2010) use the same input-output tables in order to examine how co-agglomerations between two industries are related to the extent of inter-industry transaction relationships. Sizable amount of transactions between industries, which we are able to know by input-output tables, may well motivate firms in these industries to reduce their transaction costs and to locate closely from each other.

However, one of the major misgivings of these previous studies is the evidence that firms actually reduce their transaction costs by locating in clusters. Most direct evidence should be that firms choose their transaction partners that locate closely from them, but the previous studies have failed to provide such evidence mainly due to lack of data. Further, the use of aggregated data on inter (intra) industry transactions amount may mask the true causality between transaction relationships and industry agglomeration. It is possible that the number of transaction relationships between (within) industries (extensive margin) has greater influence on industry agglomeration than the amount of transactions within these relationships (intensive margin). However, the data from input-output tables contain no information on extensive margins of these transaction relationships and thus unable to examine which one of extensive and intensive margins are of greater importance in determining industry agglomeration.

Using a unique dataset of 142,282 manufacturing firms with the information on their suppliers and customers of all industries in Japan, we provide a comprehensive examination of physical distances of inter-firm transaction relationships for the first time in the literature and discuss how they are localized. Figure 1 illustrates how inter-firm transaction relationships are formed

in Japan. On the one hand, we find that transaction partners are closely located with each other. The mean and quartile-point distances between manufacturing firms and their trading counterparts are 153.3 kilometers (mean), 8 kilometers (25-percentile), 39 kilometers (median), and 246 kilometers (75-percentile), respectively. On the other hand, there appears to be conspicuous heterogeneity in these distances across industries in the manufacturing sector. The figure shows that the means and quartile-point distances for all the 150 three-digit manufacturing industries wildly differ from each other.

Figure 1

In order to test localization regarding transaction relationships, we need to employ appropriate measures that have desirable properties, the properties equivalent to the ones for measuring localization of firms' locations (e.g. pp. 256-259 in Combes, Mayer, and Thisse, 2008). In this paper, we introduce statistical measures that satisfy such properties and examine localization of transaction relationships by applying Duranton and Overman's (2005) pairwise distance approach used for detecting geographical localization of firms. In the method of DO, they first draw a distribution of bilateral distances of firms in an industry. Second, they compare the distribution with a counterfactual that firms randomly choose their locations from all the sites in the whole manufacturing industries. In this way, the method tests the statistical significance of the departure from randomness.

Instead of bilateral distances between all the possible pairs of firms in an industry, we calculate bilateral distances between firms that have transaction relationships and draw their distributions. Further, in order to examine localization of transaction relationships in two different ways, we employ two types of counterfactuals and compare them with the distributions of transaction relationship distances: a counterfactual that focuses on potential transaction relationships conditional on the locations of firms (location-based counterfactual) and a counterfactual that solely focuses on actual transaction relationships (relationship-based counterfactual).

More specifically, the location-based counterfactual uses the location information of firms in an industry and that of all the firms which potentially transact with these firms. A distribution of distances between firms and their potential partners, which is defined for each industry, represents the tendency for potential transaction relationships to localize. Using the counterfactual, we investigate the relevance of geographical proximity in determining transaction relationships for each industry. If distance matters, firms in the industry tend to choose

relationships with proximate partners from the pool of potential transaction relationships. In contrast, the relationship-based counterfactual closely follows the spirit of DO and represents the overall tendency for transaction relationships to localize in the entire manufacturing industry. Using the counterfactual, we measure the extent of departure from the overall tendency of transaction relationships to agglomerate.

Our major findings include the following. First, close to 95% of about 150 three-digit manufacturing industries have their transaction relationships localized at the distances of 40 kilometers or less relative to the location-based counterfactual, indicating that physical distance is a very important factor for a firm to choose its transaction partners for most industries. It should also be noted that the comparison with the location-based counterfactual makes most of the manufacturing industries being localized in their transaction relationships and that the use of such counterfactual is not appropriate to detect heterogeneity in the extent of localization across industries. Second, about one-third of the three-digit manufacturing industries have their transaction relationships localized at the distances of 40 kilometers or less relative to the relationship-based counterfactual. Transaction relationships of firms in these industries are more concentrated at short distances than those of firms in the entire manufacturing industry. Third, the extent of industrial localization and that of localization of transaction relationships using the relationship-based counterfactual are positively correlated. However, localized industries are not necessarily the industries with proximate inter-firm transaction relationships and vice versa. Some of the industries we identified as agglomerated have their distributions of transaction relationship distances skewed toward the right relative to the industry average, while some other industries whose transaction relationships are localized at short scales show no significant tendency to agglomerate.

The remainder of the paper is organized as follows. Sections 2 and 3 describe our firm-level dataset and empirical approach, respectively. Section 4 provides the empirical results. And Section 5 concludes.

## 2 Data

The dataset we use is compiled by a major credit research firm, Tokyo Shoko Research Incorporated (TSR). The dataset includes 826,169 large and small corporations in Japan and consists of two subsets: a dataset on firms' characteristics and a dataset on interfirm relationships. Nec-

essary information for the dataset is collected by field researchers of TSR, who not only utilize public sources such as financial statements, corporate registrations, and public relations documents, but also implement face-to-face interviews with firms, their customers and suppliers, and banks which extend loans to them.

The sub-dataset on firm characteristics includes information on a firm’s name, address, industry classification code,<sup>1</sup> products, year of establishment, number of employees, sales, business profit, and credit score. The other sub-dataset on interfirm relationships includes information on the names of suppliers and customers of a firm.<sup>2</sup> There exists an upper limit of 24 with regard to the number of counterparts each firm can report as its customers or suppliers. The total number of interfirm relationships is approximately four million.

There are several unique features of this dataset. First, it covers about half of the total of 1.52 million corporations<sup>3</sup> in Japan. Since each of these roughly 830,000 firms reports the names of its customers and suppliers, this dataset makes it possible to describe actual interfirm relationships in all industries in Japan more comprehensively than with any other dataset before. Note, however, that not all transaction relationships are covered in the dataset because of the upper limit on the number of transaction counterparts each firm can report.

Second, by combining the two sub-datasets on firm characteristics and interfirm relationships, we have information on the characteristics of the customers and suppliers of each firm. Furthermore, the dataset includes information on firms’ location, which enables us to calculate the distance between two firms engaged in a transaction relationship. In order to identify the geographical location of each firm, we geocode firms’ address data using the CSV Address Matching Service provided by the Center for Spatial Information Science, University of Tokyo.<sup>4</sup>

To examine the localization of transaction relationships, we follow previous studies on industrial localization and concentrate on the manufacturing sector only, which reduces the number of firms in our dataset to 142,282. While the sample is limited to manufacturing firms and the number of observations is 142,282 throughout the paper, the transaction partners of these manufacturing firms do not necessarily all fall into the manufacturing sector. In fact, many belong to other industries such as wholesale and services. Therefore, we employ data on the transac-

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<sup>1</sup>Industry classifications follow the Japanese Standard Industry Classification (JSIC).

<sup>2</sup>The dataset also has information on the names of major shareholders of a firm. However, we focus on the transaction relationships in this paper and do not use the information on shareholders.

<sup>3</sup>Statistics Bureau, 2004 Establishment and Enterprise Census of Japan.

<sup>4</sup><http://newspat.csis.u-tokyo.ac.jp/geocode>

tion relationships between firms in the manufacturing sector and their transaction counterparts, which may well be firms in non-manufacturing industries.

### 3 Empirical Approach

This section provides an overview of our empirical approach, which closely follows Duranton and Overman’s (2005) point-distance method. However, while they measure the industrial localization of manufacturing firms, we measure the localization of their transaction relationships. Our Kernel-density approach á la Duranton and Overman (2005) consists of three steps. First, we calculate the pairwise distances between a firm in a particular industry and its transaction partners. These transaction partners can be either manufacturing or non-manufacturing firms. We then estimate a kernel density function of the distance distribution. Second, in order to implement statistical tests, we construct two types of counterfactuals. The first counterfactual uses the location information of firms and their potential partners and calculates the distances between them. The counterfactual randomly chooses from the pool of such potential transaction relationships. As previous studies (e.g., (Duranton and Overman, 2005; Nakajima, Saito, and Uesugi, 2010a)) have shown, the geographical distribution of firms or establishments itself is localized. Thus, by using this location-based counterfactual, we control for the fact that there is a tendency for firms to agglomerate. The second counterfactual we employ randomly chooses from the pool of actual transactions between firms and their transaction partners. In other words, we use the overall tendency of transaction relationships to be localized as a benchmark. Third, based on these two counterfactual distance distributions, we construct two confidence interval bands and test whether the transaction relationships in an industry can be considered to be localized.

#### 3.1 Kernel Densities

We begin by estimating the density distribution of pairwise distances between transaction partners. Let  $S^A$  be the set of firms in industry  $A$ , and  $n_A$  be the number of elements, which in our case is the number of firms in the industry. The set of transaction partners of firm  $i$  in industry  $A$  is denoted by  $S_i$ , and the number of these partners is denoted by  $n_i$ . It is worth noting that firms in set  $S_i$  can fall into either the manufacturing or the non-manufacturing sector. The great circle distance between firm  $i$  and its transaction partner  $j$  is denoted by  $d_{ij}$ .

We then estimate the kernel-smoothed densities ( $K$ -densities) of the pairwise distances between transaction partners. The estimator of the  $K$ -density at distance  $d$  is

$$\hat{K}_A(d) = \frac{1}{h \sum_{i \in S^A} n_i} \sum_{i \in S^A} \sum_{k \in S_i} f\left(\frac{d - d_{ik}}{h}\right), \quad (1)$$

where  $h$  is the bandwidth and  $f$  is the kernel function. Following Silverman (1986), we use a Gaussian kernel with optimal bandwidth.

## 3.2 Counterfactuals

In this subsection, we construct the counterfactuals used to test the localization of transaction relationships. As mentioned, we employ two types of counterfactuals: a location-based counterfactual and a relationship-based counterfactual.

### 3.2.1 Location-based Counterfactual

We start with what we call the location-based counterfactual. To do so, we consider the location of each firm in industry  $A$ , define potential transaction partners for it, and then calculate the distances between each firm and its potential transaction partners. In this way, we control for the tendency of firms and their potential transaction partners to geographically localize. If all firms and their potential partners are located close to each other, the counterfactual distribution of relationship distances is skewed toward the short end of distances. Thus, the test of localization using the location-based counterfactual focuses on the departure from the randomness in which firms in industry  $A$  choose from the pool of potential transaction partners. This test is useful in examining the importance of physical distances in determining transaction relationships for each industry after controlling for the geographical localization of firms in the industry.

More detailed explanations about the procedure are in order. A firm in industry  $A$  transacts not only with firms in its own industry but also in other industries. For each firm, we choose its potential transaction partners from the pool of firms of the industry that the actual partners belong to. If firm  $i$  in industry  $A$  has an actual transaction relationship with a firm in industry  $B$ , the firm's potential transaction partner is randomly chosen from the pool of firms in industry  $B$ . For each of the  $n_i$  transaction partners for firm  $i$ , we randomly choose a potential partner. We then calculate the  $n(i)$  relationship distances between the firm and its potential transaction



partners. We calculate such distances for every firm  $i \in S^A$  and estimate a counterfactual  $K$ -density. Then we repeat the above procedure 1,000 times and construct confidence intervals.

### 3.2.2 Relationship-based Counterfactual

Next, let us describe the relationship-based counterfactual, which solely focuses on transaction relationships but not on firms' location. The counterfactual is similar to the one considered by Duranton and Overman (2005) in that it considers the tendency of manufacturing industry as a whole to localize. This counterfactual therefore can be used to examine the departure from the tendency in manufacturing industry as a whole for transaction relationships to be localized, which is useful for detecting inter-industry heterogeneity in the localization of transaction relationships.

We start the construction of the counterfactual by pooling all the transaction relationships of all manufacturing firms. We then randomly choose  $n_i$  transaction relationships for firm  $i$  from the pool of these actual transaction relationships. In other words, the counterfactual is based on the assumption that firms in a particular industry, say industry  $A$ , choose their transaction relationships subject to the average tendency of transaction patterns of the manufacturing sector as a whole. Picking up such potential transaction relationships for every firm  $i \in S^A$ , we can estimate the counterfactual  $K$ -density in industry  $A$ . We repeat the above procedure 1,000 times in order to have 1,000 counterfactual  $K$ -densities, which are used for constructing confidence intervals.

## 3.3 The Localization of Transaction Relationships

To statistically test the localization of transaction relationships, we construct two-sided confidence intervals containing 95% of the randomly drawn  $K$ -densities. Following Duranton and Overman (2005), we employ local and global confidence bands. Local confidence bands are obtained by selecting the 5th and 95th percentiles of the simulated 1,000 counterfactual  $K$ -densities at each distance  $d$ , which are labeled as the upper confidence band  $\overline{K}_A(d)$  and the lower confidence band  $\underline{K}_A(d)$ . The interval between  $\overline{K}_A(d)$  and  $\underline{K}_A(d)$  is the 95% local confidence interval band of industry  $A$  at distance  $d$ .

Since these local confidence bands only provide statements at each distance  $d$ , we calculate global confidence bands, which we use to measure the deviation of  $K$ -densities from the

counterfactuals over the entire range of distances, which in our case is 0 to 180 km.<sup>5</sup> The global confidence bands are defined so that 95% of the 1,000 randomly drawn  $K$ -densities lie above the lower band and another 95% of the randomly drawn  $K$ -densities lie below the upper band. Hence, we obtain the upper global confidence band  $\overline{\overline{K}}_A(d)$  and the lower global confidence band  $\underline{\underline{K}}_A(d)$  of industry  $A$ . If  $\hat{K}_A(d) > \overline{\overline{K}}_A(d)$  for at least one  $d \in [0, 180]$ , we can say with 95% confidence that transactions in industry  $A$  are globally localized. On the other hand, if  $\hat{K}_A(d) < \underline{\underline{K}}_A(d)$  for at least one  $d \in [0, 180]$ , and industry  $A$  is not defined as localized, transaction relations in industry  $A$  can be considered to be globally dispersed.

In addition to examining whether a specific industry is localized or dispersed, we also measure the extent of localization or dispersion for each industry at each distance. Specifically, and again following Duranton and Overman (2005), we define the following index of transaction relationship localization at each distance  $d$ :

$$\Gamma_A(d) \equiv \max\left(\hat{K}_A(d) - \overline{\overline{K}}_A(d), 0\right), \quad (2)$$

In addition, we define the following index of transaction relationship dispersion for each industry at each distance:

$$\Psi_A(d) \equiv \begin{cases} \max\left(\underline{\underline{K}}_A(d) - \hat{K}_A(d), 0\right) & \text{if } \sum_{d=0}^{d=180} \Gamma_A(d) = 0 \\ 0 & \text{otherwise.} \end{cases} \quad (3)$$

We further define the indices of the extent of transaction relationship localization and dispersion for each industry by  $\Gamma_A$  and  $\Psi_A$ , respectively. We do this by summing up  $\Gamma_A(d)$  and  $\Psi_A(d)$  for all values of  $d$ .

## 4 Results

### 4.1 Summary Statistics

Let us start our examination by looking at summary statistics for the transaction relationships of the 142,282 firms in our dataset. For the manufacturing sector as a whole, the median relationship distance is 39km, while the mean distance is much larger at 153.3km. This is

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<sup>5</sup>We follow Duranton and Overman (2005) in setting the upper bound of 180km.

consistent with the shape of the distribution of transaction relationship distances, which is shown in Figure 2. The distribution is skewed toward the shortest end of the scale, but there are also a small but non-negligible number of observations at the longer end.

Figure 2

As seen in Figure 1, there appears to be considerable inter-industry heterogeneity in terms of the distances of actual transaction relationships. Let us therefore have a closer look at the ten three-digit manufacturing industries with the smallest median transaction relationship distances (1) and the largest ones (2). Doing so indicates that the majority of (three-digit) industries in the two tables hail from a small number of broader (two-digit) industries.”] Specifically, four of the industries with the shortest median transaction distances fall under the heading of printing businesses (JSIC16) and a further two under leather processing industries (JSIC21). On the other hand, of the industries with the largest median transaction distances, seven belong to the textile and apparel industries (JSIC11 and 12).

Tables 1 and 2

Next, while Figure 1 showed actual transaction distances, Figure 3 shows potential transaction distances. For the manufacturing sector as a whole, the median relationship distance is 460 km and the mean is 543.5 km, both of which are much larger than the actual distances. Another difference from the actual relationship distances is the smaller gap between the mean and the median, indicating that the distribution of potential relationship distances is less skewed to the left than that of actual relationship distances.

Figure 3

## 4.2 Localization of Transaction Relationships Relative to Location-based Counterfactual

This and the next subsection present our empirical results based on the approach introduced in Section 3. We estimate the  $K$ -density distribution of interfirm transaction relationship distances for each industry and compare it with the two counterfactuals. Here, we start examining localization using the location-based counterfactual. [We construct the confidence bands from 1,000 counterfactual  $K$ -density distributions of interfirm transaction relationship distances drawn from

the pool of transaction relationships after controlling for the location of firms and their potential transaction partners. We do this exercise for each of the 150 three-digit manufacturing industries. For illustration, we present two figures showing the results for Ophthalmic Goods including Frames (JSIC316; Figure 4(a)) and Leather Footwear (JSIC214; Figure 4(b)).

The solid lines in these figures represent  $K$ -densities. Moreover, the bold dashed lines are the global confidence bands, while the thin dashed lines are the local confidence bands. The figures show that the  $K$ -densities are overwhelmingly concentrated at the short end of distances in both industries.

Figures 4(a) and 4(b)

Further, we examine the number of manufacturing industries that can be classified either as localized or as dispersed in terms of interfirm transaction relationship distances relative to the location-based counterfactual.”?] Figures 5(a) and 5(b) respectively depict the share of localized and dispersed industries in terms of their transaction relationships. For short distances in the range of 0–40km, Figure 5(a) shows that transaction relationships of 90–95% of all manufacturing industries are localized. More specifically, most industries can be considered as localized in terms of their transaction relationships at relatively small scales, but the number of industries whose transaction relationships are localized falls rapidly at medium scales (70km). In contrast, Figure 5(b) shows that transaction relationships are dispersed only in a small number of industries at the smallest scales, while the number gradually increases at medium and large scales. The number of industries whose transaction relationships are dispersed within a range of 0–100km remains largely the same.

Figures 5(a) and 5(b)

### 4.3 Localization of Transaction Relationships Relative to Relationship-based Counterfactual

Next, we consider the localization of transaction relationships relative to the relationship-based counterfactual. We construct the confidence bands from 1,000 counterfactual  $K$ -density distributions of interfirm transaction relationship distances drawn from the pool of transaction relationships for the manufacturing industry as a whole.

We use the same two industries for illustrative purpose as in the preceding subsection, Ophthalmic Goods including Frames (JSIC316) and Leather Footwear (JSIC214). Figures 6(a) and (b) show the  $K$ -densities for the two industries, which are the same as in Figures 4(a) and (b), but the local and the global confidence bands are replaced with those generated by the location-specific counterfactual.

Figure 6(a) for the Ophthalmic Goods industry provides an example of interfirm transaction relationships being localized at the short end of distances. For every distance within the range of 0–50km, the  $K$ -density is above the upper global confidence band. Thus, the interfirm transaction relationships in this industry can be considered as localized in the range between 0–50km. On the other hand, Figure 6(b) for the Leather Footwear industry provides an example of transaction relationships being dispersed. For every distance within the range of 16–180km, the  $K$ -density is below the lower global confidence band and never above the upper global confidence band. Thus, interfirm transaction relationships in this industry are dispersed within the range.

Figures 6(a) and 6(b)

Next, we examine the share of manufacturing industries whose interfirm transaction relationships can be considered either as localized or as dispersed. Figures 7(a) and 7(b) respectively depict the number of localized and dispersed industries in terms of their transaction relationships. Figure 7(a) shows that for short distances in the range of 0–40km, [the transaction relationships of almost 40% of all manufacturing industries are localized. The share of industries whose transaction relationships can be considered as localized falls rapidly for medium distances (40–60km), but gradually increases for long distances (60–180km). On the other hand, Figure 7(b) shows that transaction relationships are dispersed in less than 20% of all manufacturing industries for the shortest distances, but the share gradually increases for medium distances, reaching a maximum of about 40% of all manufacturing industries at the distance of 70km. That share remains more or less unchanged for distances between 70 and 100km. Taken together the results shown in Figures 7(a) and (b) imply that, for the short distance range (0–40k), transaction relationships are more localized than the manufacturing industry average in some industries (about 40% of all manufacturing industries), while they are more dispersed in others (about 15-25% of them). Thus, although Figure gave the impression that there exists substantial inter-industry heterogeneity in terms of transaction relationship localization, we find that the majority of in-

dustries (about 35-45%) are neither more localized nor more dispersed than the manufacturing sector as a whole.

Figures 7(a) and 7(b)

#### 4.4 Industrial Localization and Localization of Transaction Relationships

It has been widely argued that interfirm transactions are one of the most important reasons for industrial localization (Rosenthal and Strange (2001); Ellison, Glaeser, and Kerr (2010)). Therefore, in this subsection we empirically examine this view by focusing on the relationship between industrial localization and the localization of interfirm relationships.

In order to illustrate how the two are related, we start by looking once again at the industries considered in the preceding subsections. In the previous subsection, we saw that transaction relationships in Ophthalmic Goods including Frames (JSIC316) were localized at small scales, while in Leather Footwear (JSIC214) they were dispersed. However, both of these industries were found to be localized in the study by Nakajima, Saito, and Uesugi (2010b), which applied the procedure proposed by Duranton and Overman (2005). Thus, taking the results obtained by Nakajima, Saito, and Uesugi (2010b) and those in this study together, it appears that while firms in Leather Footwear are located in close geographic proximity, their transaction relationships are dispersed. This suggests that, at least for some industries, industrial localization and the localization of transaction relationships do not coincide.

Another way to look at the relationship between industrial localization and the localization of transaction relationships is to compare the corresponding indices, that is, the index for the extent of industrial localization ( $\Gamma'_A$ ) and the index for the extent of localization of transaction relationships ( $\Gamma_A$ ). Note that we employ the relationship-based counterfactual for calculating  $\Gamma_A$ . Thus,  $\Gamma_A$  and  $\Gamma'_A$  respectively sum up the extent of departure from the overall tendency of transaction relationships and locations to be localized in manufacturing industry as a whole.  $\Gamma'_A$  sums up  $\Gamma'_A(d)$  for all distances  $d$ , in which case the latter formula represents the difference between the  $K$ -density of all the pairwise distances of firms in a particular industry and the upper bound of the global confidence bands.<sup>6</sup> Definitions of  $\Gamma_A$ , which measures the extent of localization of transaction relationships, are provided in Section 3. In order to see the relationship

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<sup>6</sup>A detailed explanation of the definition of  $\Gamma'_A$  is provided in Duranton and Overman (2005) and Nakajima, Saito, and Uesugi (2010a).

between the two variables, we first plot a scattered graph and calculate a correlation coefficient. We find that the coefficient is 0.25 and different from zero at the significance level of 1%, indicating that these two variables are positively correlated. However, there appears to be many outliers in Figure 8.

Figure 8

Next, we examine heterogeneity across industries regarding the relationship between  $\Gamma_A$  and  $\Gamma'_A$ . Tables 3 and 4 present the top twenty industries in terms of the highest values of  $\Gamma_A$  and  $\Gamma'_A$ , respectively. Several industries are included in both of these tables. These are Ophthalmic goods including frames (JSIC316), Physical and chemical instruments (JSIC314), Precious metal products including jewel (JSIC321), Bookbinding and printed matter (JSIC163), and Industrial plastic products (JSIC193). Firms in these industries are not only geographically localized but also localized in their transaction relationships. Two of them belong to precision instruments and machinery industry. However, there appears to be no clear tendency which two-digit industry is more likely to have a strong positive association between  $\Gamma_A$  and  $\Gamma'_A$  than others. Further,  $\Gamma_A$  is zero and  $\Gamma'_A$  is positive in some industries, while  $\Gamma'_A$  is zero and  $\Gamma_A$  is positive in some other industries.

Tables 3 and 4

In Tables 3 and 4, there are seven such industries with  $\Gamma_A$  being zero and  $\Gamma'_A$  being positive: Cosmetics toothpaste and toilet preparations (JSIC177), Handbag and small leather cases (JSIC217), Oil and fat products (JSIC175), Leather footwear (JSIC214), Baggage (JSIC216), Electric bulbs and lighting fixtures (JSIC273), and Miscellaneous leather products (JSIC219). Firms in these industries are geographically agglomerated but their transaction relationships are not localized. Four out of these seven belong to leather processing industries and two to chemical and allied products industries. We speculate that there are some other reasons to agglomerate than minimizing transaction costs with trading partners. For leather processing industries, a historical background, in which people who used to reside in segregated areas and made their living with their livestock as butchers or leather crafters, may explain their agglomeration. If this speculation is correct, reduction of transaction costs with their trading partners is not necessarily the primary reason for localization.

There are six industries with  $\Gamma'_A$  being zero and  $\Gamma_A$  being positive: Cement and its products (JSIC222), Paving materials (JSIC184), Sliding doors and screens (JSIC143), Fabricated constructional and architectural metal products (JSIC254), Canned and preserved fruit and vegetable products (JSIC93), and Sawing-planing mills and wood products (JSIC131). All of these industries belong to different two-digit industries. However, there appear to be common characteristics among them. Their products are bulky (e.g. paving materials and wood products) or heavy (e.g. constructional metal products). Locations of their suppliers are likely to be dispersed since they are located in places with the first nature where inputs they use (e.g. fruit and vegetables and lime stones) are abundant. Though firms in these industries tend to transact with neighboring trading partners in order to reduce the costs for transacting heavy and bulky inputs and products, they are not motivated enough to agglomerate in certain areas. Rather, they locate close to their suppliers whose locations are tied to places with the first nature.

In sum, there exists a positive association between  $\Gamma_A$  and  $\Gamma'_A$ , they are, the extent of localization of transaction relationships and the extent of industry agglomeration, respectively. However, it should be emphasized that there exist a number of exceptions. Some industries are geographically localized, while their transaction partners are remotely located. Some others have their transaction partners in their neighborhood, but firms in these industries are not agglomerated. We can speculate the possible reasons for these exceptions. These include historical backgrounds and a location constraint in which suppliers and their customers face.

## 5 Conclusion

In this paper we have examined physical distances of inter-firm transaction relationships in the Japanese manufacturing businesses to find the following. First, using the counterfactual that uses the location information of firms and their potential transaction partners, which we call the location-based counterfactual, we find that almost all the 150 three-digit industries are found to be localized in their transaction relationships at short scales. Among a number of candidate transaction counterparts, firms in almost any manufacturing industry tend to choose the counterparts that are closely located. This strongly evidences for the importance of location proximity between trading partners as a driver for firms to localize. Second, about one-third of 150 three-digit manufacturing industries have their transaction relationships localized relative to the relationship-based counterfactual that represents the overall tendency for transaction re-



relationships to localize. In other words, firms in these industries are more likely to have their trading partners in neighboring areas than the industry average. Third, industrial agglomeration is positively associated with localization of transaction relationships with a number of outlier cases. On the one hand, leather processing industries tend to geographically localize in certain areas but their transaction partners locate themselves only remotely. On the other hand, industries with bulky or heavy products using raw materials as inputs have their transaction partners in their neighborhood. However, the motivation to reduce transaction costs is not strong enough for the firms in these industries to localize, making their locations rather dispersed. We have speculated possible reasons for these outlier industries.

Using the data on firms' locations and their transaction relationships, which is scarce not only in Japan but also in other countries, several extensions are possible. First, even though we have focused mainly on manufacturing industries following the practice of the previous literature, we are able to extend our focus to non-manufacturing industries. There appears to be significant heterogeneity in the way non-manufacturing firms establish transaction relationships with others since they are so diverse in their characteristics. Giant financial companies as well as small local pa-and-ma stores are classified as non-manufacturing businesses. Moreover, how transaction relationships in these non-manufacturing businesses differ from relationships in manufacturing can possibly be another research topic.

Second, we may be able to examine the relationship between transaction relationships and industry localization in a different manner. In this paper, we have focused on bilateral transaction relationships and their distances in order to examine how they are related to industry localization. However, each bilateral transaction relationship constitutes one big network of transactions. Hence, as Nakajima, Saito, and Uesugi (2010b) have already started examining, interactions between transaction networks and the evolution of industry agglomeration may be one of the next intriguing research topics to be closely examined.

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Table 1: Top 10 manufacturing industries with the smallest median transaction relationship distances

JSIC	Industry name	median	mean	25 percentile	75 percentile	standard deviation
105	TOBACCO MANUFACTURES	4	93.81	3	199	132.98
169	SERVICE INDUSTRIES RELATED TO PRINTING TRADE	6	96.66	2	40	197.90
124	JAPANESE STYLE APPAREL AND “TABI” - SOCK	6	106.04	1	119	183.02
163	BOOKBINDING AND PRINTED MATTER	9	81.81	4	27	172.49
316	OPHTHALMIC GOODS- INCLUDING FRAMES	10	108.78	3	161	173.99
162	PLATE MAKING FOR PRINTING	10	120.29	3	149	209.38
161	PRINTING	12	120.98	4	140	212.43
216	BAGGAGE	15	151.20	5	324	224.93
219	MISCELLANEOUS LEATHER PRODUCTS	16	170.57	5	402	228.78
321	PRECIOUS METAL PRODUCTS- INCLUDING JEWEL	17	117.64	4	112	189.22

Table 2: Top 10 manufacturing industries with the largest median transaction relationship distances

JSIC	Industry name	median	mean	25 percentile	75 percentile	standard deviation
111	SILK REELING PLANTS	335	333.91	63	541	266.97
117	ROPE AND NETTING	206	251.42	43	375	250.55
151	PULP	169	271.92	17	495	283.07
174	CHEMICAL FIBERS	163	191.21	12	321	184.00
121	TEXTILE OUTER GARMENTS AND SHIRTS- INCLUDING BONDED FABRICS AND LACE- EXCEPT JAPANESE STYLE	139	213.28	9	389	233.81
202	RUBBER AND PLASTIC FOOTWEAR AND ITS FINDINGS	137	222.58	7	399	253.32
112	SPINNING MILLS	136	176.70	18	298	176.61
123	UNDERWEAR	135	208.50	14	390	216.04
122	KNITTED GARMENTS AND SHIRTS	135	191.23	8	384	200.12
115	KNIT FABRICS MILLS	134	180.24	32	292	169.55

Unit: kilometers

Table 3: Top 20 manufacturing industries with the highest degrees of industry localization

JSIC	Industry names	$\Gamma'$ (index of industry localization)	$\Gamma$ (index of transaction relationship localization)
316	OPHTHALMIC GOODS- INCLUDING FRAMES	0.418	0.100
215	LEATHER GLOVES AND MITTENS	0.332	0.005
314	PHYSICAL AND CHEMICAL INSTRUMENTS	0.277	0.067
315	OPTICAL INSTRUMENTS AND LENSES	0.272	0.035
321	PRECIOUS METAL PRODUCTS- INCLUDING JEWEL	0.270	0.045
163	BOOKBINDING AND PRINTED MATTER	0.245	0.213
177	COSMETICS- TOOTHPASTE AND TOILET PREPARATIONS	0.235	0.000
112	SPINNING MILLS	0.217	0.003
217	HANDBAGS AND SMALL LEATHER CASES	0.213	0.000
113	TWISTING AND BULKY YARNS	0.213	0.017
118	LACE AND OTHER TEXTILE GOODS	0.210	0.028
175	OIL AND FAT PRODUCTS- SOAPS- SYNTHETIC DETERGENTS- SURFACE-ACTIVE AGENTS AND PAINTS	0.192	0.000
214	LEATHER FOOTWEAR	0.190	0.000
216	BAGGAGE	0.179	0.000
273	ELECTRIC BULBS AND LIGHTING FIXTURES	0.171	0.000
114	WOVEN FABRIC MILLS	0.170	0.015
224	POTTERY AND RELATED PRODUCTS	0.165	0.000
193	INDUSTRIAL PLASTIC PRODUCTS	0.165	0.073
311	MEASURING INSTRUMENTS- ANALYTICAL INSTRUMENTS AND TESTING MACHINES	0.165	0.018
219	MISCELLANEOUS LEATHER PRODUCTS	0.163	0.000

Note: Masked with blue when gamma(index of transaction relationship localization) is zero

Table 4: Top 20 manufacturing industries with the highest degrees of localization of transaction relationships

JSIC	Industry names	$\Gamma'$ (index of industry localization)	$\Gamma$ (index of transaction relationship localization)
163	BOOKBINDING AND PRINTED MATTER	0.245	0.213
161	PRINTING	0.063	0.111
116	DYED AND FINISHED TEXTILES	0.135	0.108
222	CEMENT AND ITS PRODUCTS	0.000	0.105
255	METAL MACHINE PARTS AND TOOLING PRODUCTS	0.080	0.102
316	OPHTHALMIC GOODS- INCLUDING FRAMES	0.418	0.100
256	METAL COATING- ENGRAVING AND HEAT TREATING- EXCEPT ENAMELED IRONWARE	0.057	0.099
184	PAVING MATERIALS	0.000	0.078
259	MISCELLANEOUS FABRICATED METAL PRODUCTS	0.082	0.075
193	INDUSTRIAL PLASTIC PRODUCTS	0.165	0.073
314	PHYSICAL AND CHEMICAL INSTRUMENTS	0.277	0.067
162	PLATE MAKING FOR PRINTING	0.149	0.066
143	SLIDING DOORS AND SCREENS	0.000	0.053
254	FABRICATED CONSTRUCTIONAL AND ARCHITECTURAL METAL PRODUCTS- INCLUDING FABRICATED PLATE WORK AND SHEET METAL WORK	0.000	0.049
93	CANNED AND PRESERVED FRUIT AND VEGETABLE PRODUCTS	0.000	0.049
275	ELECTRIC MEASURING INSTRUMENTS	0.130	0.048
269	MISCELLANEOUS MACHINERY AND MACHINE PARTS	0.054	0.047
223	STRUCTURAL CLAY PRODUCTS- EXCEPT THOSE OF POTTERY	0.003	0.046
321	PRECIOUS METAL PRODUCTS- INCLUDING JEWEL	0.270	0.045
131	SAWING- PLANING MILLS AND WOOD PRODUCTS	0.000	0.045

Note: Masked with blue when gamma(index of industry localization) is zero

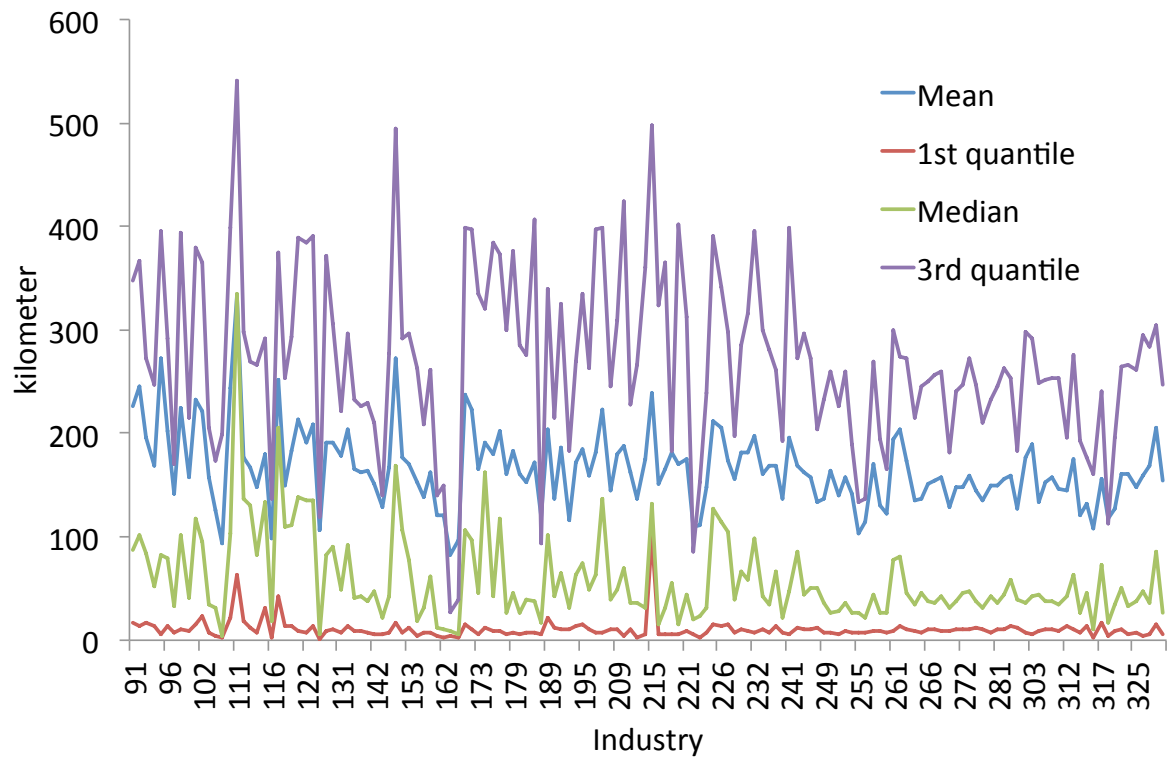


Figure 1: Summary statistics of transaction relationship distances

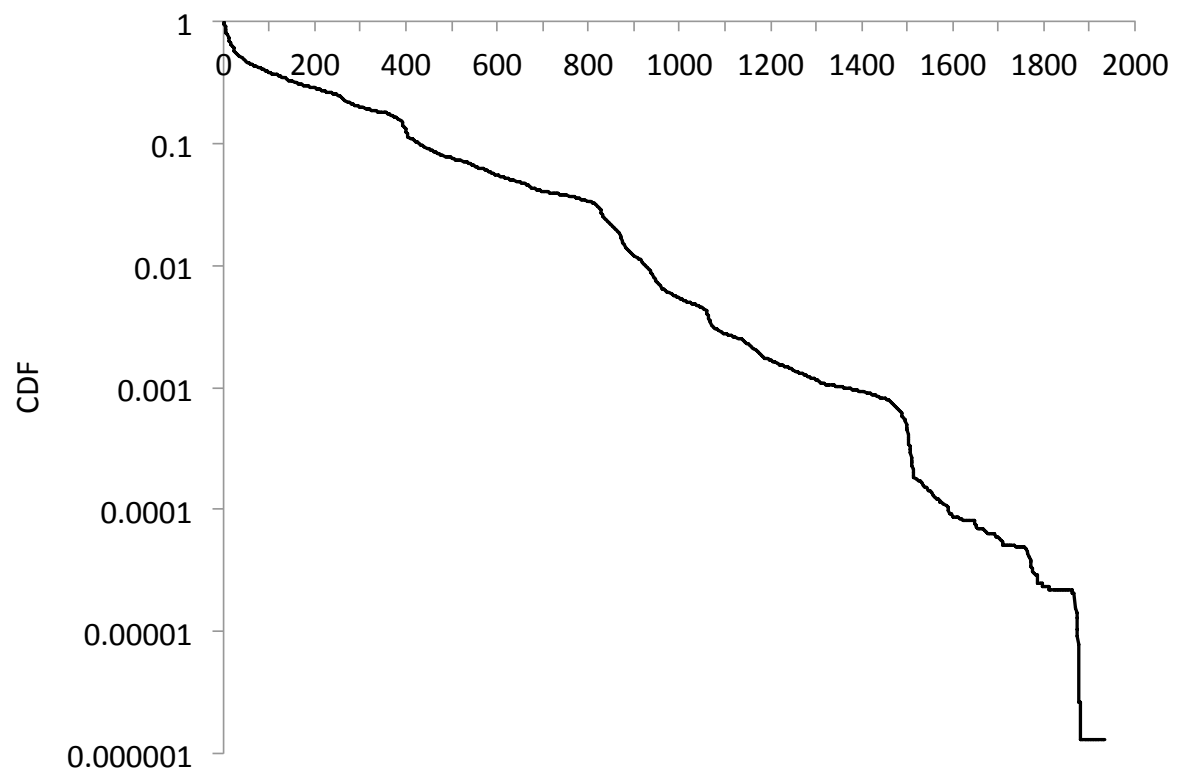


Figure 2: Cumulative distribution function of transaction relationship distances

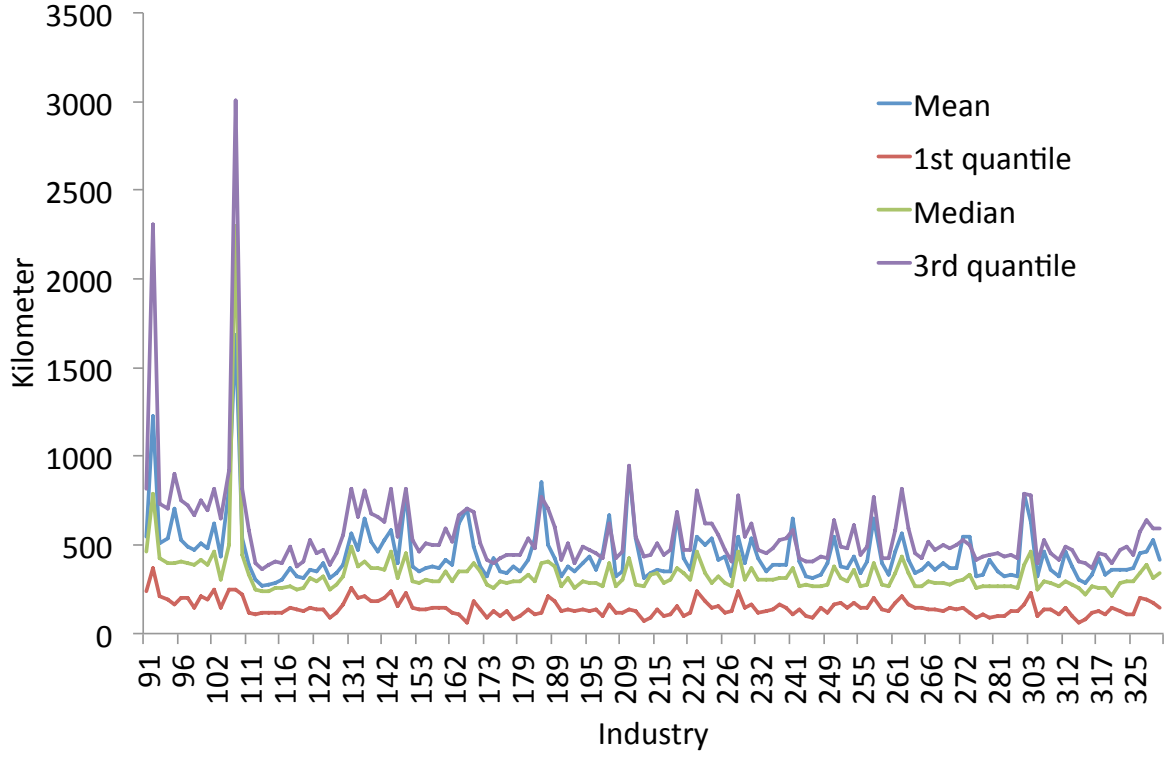


Figure 3: Summary statistics of transaction relationship distances between firms and their potential partners

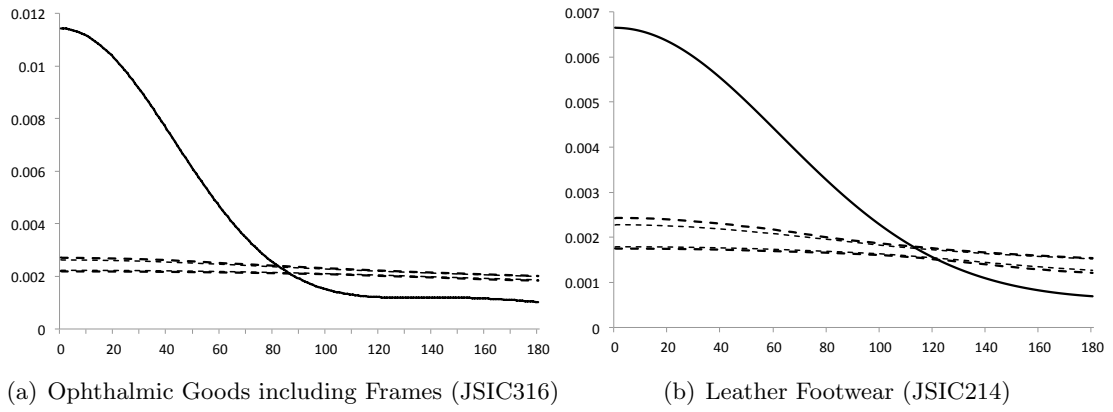


Figure 4:  $K$ -densities relative to the location-based counterfactual

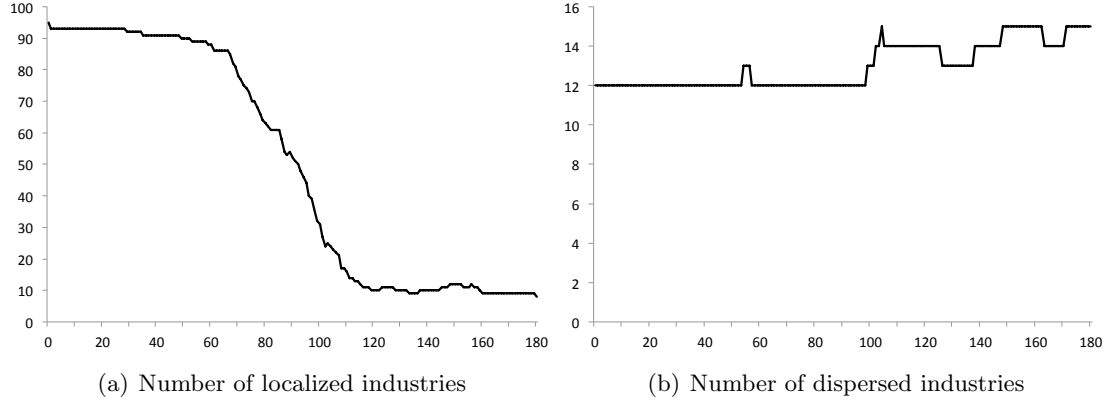


Figure 5: Number of localized and dispersed industries using location- based counterfactual

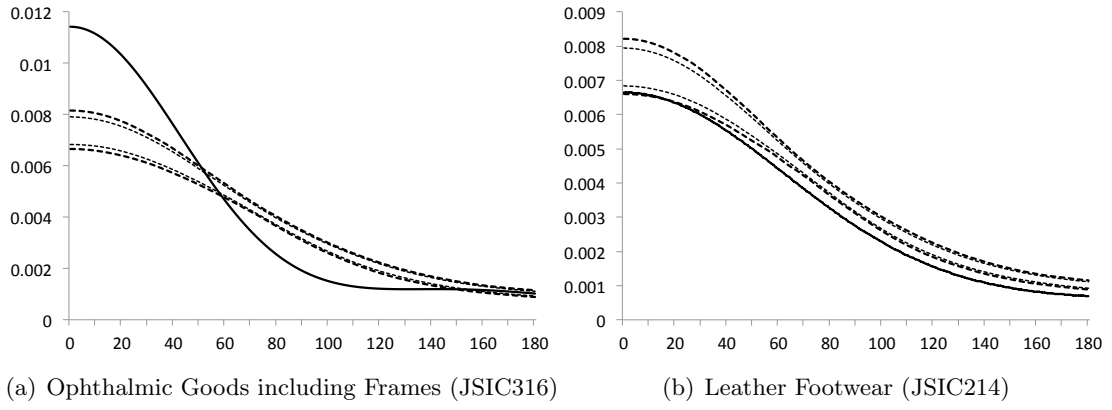


Figure 6:  $K$ -densities relative to the relationship-based counterfactual

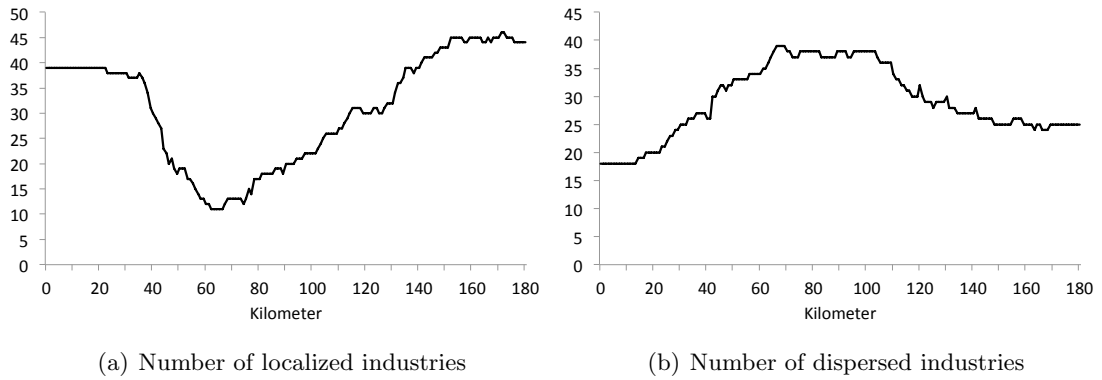


Figure 7: Number of localized and dispersed industries using the relationship-based counterfactual



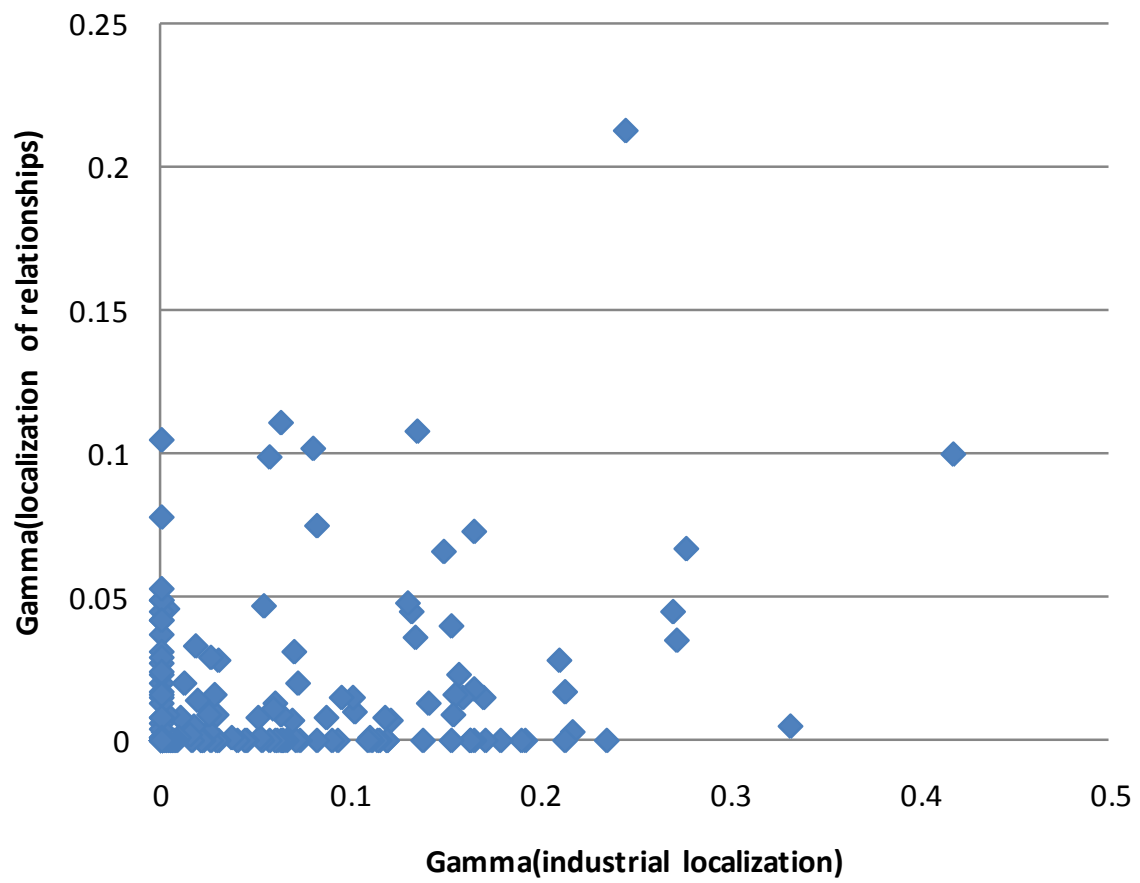


Figure 8: Relationship between  $\Gamma$  and  $\Gamma'$