Industrial cluster policy and transaction networks:

Evidence from firm-level data in Japan

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Toshihiro Okubo[*], Tetsuji Okazaki[@], and Eiichi Tomiura[#]

Abstract

Cluster policy is designed to facilitate inter-firm networking. We examine industrial clusters in Japan based on firm-level transaction data. Firms in clusters expand transaction networks at a higher speed, but significantly only with firms in the agglomerated core Tokyo, not with local firms within the same region. We confirm the robustness by regional historical background as instruments. By disaggregating firms by their main bank types, we find that cluster firms expanding networks are mainly financed by regional banks, not by banks with nation-wide operations. This suggests the importance of intensive relationship with the main banks for inter-firm network formation.

Keywords: cluster policy; transaction network; relationship banking; firm-level data

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[*] Faculty of Economics, Keio University
[@] Faculty of Economics, University of Tokyo
[#] Faculty of Economics, Hitotsubashi University

1. Introduction

Creating industrial clusters is one of the most popular agenda in regional economic policies of many countries, especially developed countries, such as France, Germany, and Japan just to name a few. Almost all the clusters emphasize inter-firm networks, but empirical investigations of the impact of clusters on transaction networks of firms have been so far limited. This paper examines this issue in the case of Japan based on firm-level transaction data and explores the mechanism behind network formation by focusing on the relationship with financial institutions.

The concept of clusters mainly originates in a series of influential management papers by Michael Porter. For example, Porter (2000) discusses locational advantages and competitive strategies of firms in geographical concentrations of industries. In his famous diamond diagram, Porter emphasizes the importance of networks or linkages between suppliers and customers for creating new businesses. He also distinguishes cluster policy from traditional industrial policy by referring to private sector leadership over targeting and direct subsidization.

The economics topic closely related with clusters is agglomeration economies. While it has traditionally been examined mainly in terms of geographical proximity, the externality spills over to remote locations via transaction networks especially in information or service-intensive sectors. Duranton and Puga (2004) distinguish the following three types of micro-foundations of Marshallian agglomeration: sharing, matching and learning. All these three are obviously connected with networking.

In empirical economic analyses, rich research results have been accumulated on the effect of clusters on innovations by local firms (e.g. Falck et al. 2010 for Germany, Nishimura and Okamuro 2011a for Japan, and Viladecabs-Màrsal and Arauzo-Carod 2012 for Spain). This focus is natural since stimulating innovation is required for policy makers in matured economies. While clusters often put their priority on inter-firm networking (not necessarily patent citations

or technology transfers), no empirical evidence has so far been reported on transaction networks mainly constrained by limited availability of transaction data. Expanding transaction partners should be a vital channel not only for increasing transaction volumes and varieties but also for knowledge spillovers through exchanges of goods and services. This route is important for local firms supplying to multinational enterprises in developing countries and firms in peripheral regions trading with firms in agglomerated cores, such as Tokyo in Japan.

This paper fills a part of this research gap by exploiting firm-level transaction data in Japan and links this transaction dataset with the list of firms participated in industrial clusters targeted by the government. Japanese cluster policy is best suited for this research. Since its start in 2001, Japanese government sets the facilitation of networking as the top priority in cluster policy while providing only limited direct subsidies. To explore potential business partners, firms gather information from various sources. The main bank of a firm is valuable and reliable in this regard, as accumulated literature on the relationship banking suggests (e.g. Berger and Udell 1995, and Inui et al. 2015).[1] As most of the firms in clusters are small-sized or young often located in peripheral regions, professional consulting advice from their main bank based on long-term relationships should be helpful to search for transaction partners in different regions, especially in distant urban agglomeration.

To preview our main results, firms in clusters expand transaction networks at a higher pace than non-cluster firms, but only significantly with firms located in Tokyo if we allow the policy effect to vary with firm characteristics before the cluster policy. To handle potential non-randomness in the selection of regions, we use historical records of other regional development projects in earlier periods as instrumental variables, and confirm the robustness of

[1] Berger and Udell (1995) find that borrowers with longer banking relationships pay lower interest rates. Inui et al. (2015) report that the probability of starting export is higher when a firm is mainly financed by a bank serving many other exporting firms in the Japanese case. Boot (2000) surveys literature on relationship lending/banking.

our main finding. To explore the mechanism behind this finding, this paper disaggregates firms depending on the main bank type and finds that firms expanding networks are mainly financed by regional banks, not by banks with nation-wide and global operations. This suggests that information provided from the main bank in the same region appears critical for cluster firms to expand transaction networks with firms in the agglomeration center Tokyo. To check the robustness of our regression results, we also use propensity score matching.

The rest of this paper is organized as follows. Section 2 briefly overviews industrial cluster policy in Japan, especially focusing on policy objectives. Section 3 describes our dataset. Section 4 reports our empirical results and discusses their implications. Robustness checks and other extensions are summarized in Section 5. Section 6 adds concluding remarks.

2. Overview of industrial cluster policy in Japan

This section briefly overviews the industrial cluster policy in Japan, especially focusing on its policy objectives and policy tools. We do not intend to give a comprehensive documentation of the policy in detail, but provide a quick summary of relevant information necessary for our empirical analysis in Section 4.

Many countries around the globe, especially advanced countries, are actively taking policies for creating industrial clusters, partly inspired by Silicon Valley in the U.S., to realize gains from agglomeration.[2] Japan is no exception. Ministry of Economy, Trade and Industry initiated the industrial cluster policy in 2001.[3] With mid-term reviews, the policy is in the third

[2] By selecting comparable counties based on unique information from a real estate journal, Greenstone et al. (2010) confirm agglomeration spillovers from the opening of a large plant on the productivity of local incumbent plants.

[3] Ministry of Education, Science and Culture started its own cluster policy, named as *Knowledge Cluster*, but the priority is fostering research collaborations of local universities or public research institutions with private business. As this paper focuses on transaction networks, we concentrate on the industrial cluster policy by Ministry of Economy, Trade and Industry.

period at the time of this research (1st period: 2001–5, 2nd period: 2006–10, and 3rd period: 2011–20).[4]

While the ultimate purpose of the Japanese cluster policy is the creation of new business in clusters by activating innovation, the immediate policy target is facilitating inter-firm networking and industry-government-academia collaborations. In the first Industrial Cluster Plan, "the formation of face-to-face networks" was listed as the top among various policy objectives. The main policy tools for network formations are not limited to holding exchange meetings, seminars and exhibitions, dispatching coordinators, developing overseas sales channels with supports from Japan External Trade Organization (JETRO), but also include facilitating business matching between firms in different sectors, and matching with financial institutions.[5] This paper examines transaction networks between firms as well as relationships between firms and financial institutions.

Industrial clusters in Japan are designated from applications by groups of local firms. In preparing applications, members of local Chamber of Commerce and Industry often play pivotal roles. We must note that the clusters in this policy initiative are not strictly defined as geographic spaces with clear boundaries. No minimal or maximal requirement thresholds are imposed on regional characteristics. Firms are not automatically entitled to receive subsidies merely by locating in a cluster area.[6] This marks a sharp contrast against regional development policies in earlier periods strictly tied to targeted locations, as examined by previous research (e.g. Devereux et al. 2007, Martin et al. 2011, and Okubo and Tomiura 2012)[7]. Some of the

4 See also Okubo and Okazaki (2015) for explanations on the Japan's cluster policy in Japanese.
5 For example, the local office of the government acts as intermediary between cluster member firms and trading companies. See Okubo and Okazaki (2015) for other examples.
6 The cluster is defined instead as the membership of registered firms located in and around cluster areas. "Drawing cluster boundaries often is a matter of degree" (Porter 2000, p.17).
7 Cluster projects not only in Japan but also in other countries are based on applications from local firms rather than direct targeting by central government. See Fontagné et al. (2013) for the case of French cluster

clusters spread across prefecture borders under the coordination by the branch office of national government in each regional block. The government actually supports networking not only within each cluster but also with firms outside of the cluster in order to accelerate cross-fertilization of ideas and/or to expand transaction opportunities. As a related study, Ter Wal (2013) reports that inventors in the information technology sector in Sophia-Antipolis cluster in France strengthen connectivity with inventors outside of the cluster.

The emphasis on networks characterizes the recent Japanese industrial policy. In earlier years, the Japanese government directly intervened the location decisions of firms by targeting clearly defined regions for developing new industrial concentrations and/or alleviating congestions in urban cores. Okubo and Tomiura (2012) examine the impact of such industrial relocation policies in the 1980s, including Technopolis and Intelligent Location, on the productivity distributions of plants in Japan, and find that such policy induced relatively low-productivity plants to relocate out of congested cores. While such regional development projects in earlier periods attempted to attract the specific industry (high-tech manufacturing in the case of Technopolis, and software and information service in the case of Intelligent Location) to all the targeted areas, each industrial cluster varies in its focus (e.g. biotechnology, information technology, and recycling-oriented society).

As the industrial policy has shifted from direct intervention to indirect facilitation, the role of subsidy has declined as a policy tool. Although direct supports for R&D are included as a part of the cluster policy package, the public subsidy for clusters is limited to joint R&D projects by industry-government-academia consortia. Nishimura and Okamuro (2011b) compare the impact of direct subsidy with that of indirect coordination support on firm performance, such as sales and profits, and find that the effect of indirect supports is stronger than that of direct subsidy in the Japanese cluster areas. Falck et al. (2010) also confirm that networks are

more important than monetary incentives as transmission channels from the cluster policy to innovations of firms in Bavaria, Germany. This paper focuses on the impacts of the participation in industrial clusters on transaction networks.

3. Data description

This section describes our data used for our empirical analysis. We combine two distinct data sources: the list of member firms in the industrial cluster projects released by the government and the transaction data compiled by a commercial data service company Tokyo Shoko Research (TSR).

The list of firms covers all firms participating in the industrial clusters. While all 24 clusters are included in the original list, this paper focuses on eleven of them by dropping those in the core areas: i.e. the top three dominant large cities (Tokyo, Osaka and Nagoya)[8] and surrounding prefectures.[9] The exclusion of projects in urban agglomeration/concentration is due to intensive networks already established among many firms within the geographical proximity before the cluster policy, from which it is extremely difficult to identify policy-triggered networks.

Among the three periods of the cluster policy, this paper mainly investigates the impacts of cluster policy in the second period (2006–10) to examine network formation.[10] The government designs the first period as the start-up of clusters, the second period as their development phase. The third period is called as the phase for their fiscal independence,

[8] In the population ranking, Yokohama is the second largest but is directly adjacent to Tokyo. No cluster is actually located in Yokohama.

[9] Excluded are (a) prefectures in Greater Tokyo area, or Kanto area, which are Tokyo and surrounding prefectures (Kanagawa, Saitama, Chiba, Ibaraki, Yamanashi, Tochigi, and Gunma), (b) Osaka and surrounding prefectures (Kyoto, Hyogo, Nara, Shiga, and Mie), and (c) Aichi prefecture in which Nagoya City is located.

[10] We also examine the effect of policies in the first period on networking in the second period by the firms remained in clusters during both periods.

indicating that policy supports by the national government is substantially curtailed. All firms participated in the cluster projects from 2006 to 2011 are included in our sample.[11] As the global financial crisis seriously hit Japanese regions during this sample period, it is also worthwhile to investigate impacts of the regional economic policy.

Transaction data assembled by TSR contain information on major transaction partners. All suppliers and customers of each firm are recorded up to 24 firms, respectively. No information on trading value or volume is available in the database. Not all transaction partners are covered if the firm trades with more than 24 firms. In spite of such limitations, this transaction data base is unique, as no comparable data is available in other countries. Furthermore, this transaction data have not yet been used for analyses of clusters.[12] Giuliani (2007) counts local business networks based on an interview question on business interactions with other firms in the same cluster in the case of three wine clusters in Italy and Chile, but collects no information on networking beyond cluster borders. From TSR's comprehensive database, we also derive such basic firm characteristics as the location, the number of employees, sales, and the age of each firm. TSR database covers a wide range of firms in virtually all sectors, as comparable with the government's Economic Census. To analyze changes during the period, we concentrate on firms with data both at 2006 and 2012 available.

Summary statistics are shown in Table 1. The network growth is measured in terms of the change in the number of transaction partners between 2006 and 2012. We disaggregate networks depending on the location of transaction partners: Tokyo, Greater Tokyo Area, Osaka, Greater

[11] Since the Japanese public budget system adopts the fiscal year calendar starting from April, we identify the participation of firms based on the fiscal year. While the member list of industrial clusters includes not only firms but also other entities such as universities or non-profit organizations, we concentrate on firms to link with transaction data.

[12] The same TSR transaction dataset has been used by Todo et al. (2015) for analyzing the impact of an earthquake on supply chains, for example.

Osaka Area, and the same prefecture (expressed as *Local* in the table).[13] Table 1 also reports the growth in the number of employees (*Emp*) and in *Sales* during the same period. The initial level at 2006 for each variable, as well as the firm's age[14] and participation (binary dummy) in a cluster project, is also shown in the same table, as they are used in regressions in the next section. Firms in our sample experienced decline of employment and of sales but expanded transaction networks on average.[15] As standard deviations across firms are relatively large for many variables, however, the investigation at the firm level is critical. As Baldwin and Okubo (2006) theoretically analyze, the heterogeneity of firms is the key in discussing economic geography and regional economic policy. Less than one percent of the firms in our sample participated in cluster projects. We will handle the possible selectivity problem later by instrumental variables and propensity score matching method. More than 344 thousand firms not participated in any cluster are included in our sample for comparisons.

Next, Table 2 divides the sample into two sub-samples depending on the firm's participation in a cluster project. The contrasts between these two groups are clear. The growth rate of networks of participating firms is on average higher irrespective of the location of transaction partners. Even among participating firms, sales dropped during this period, but the decrease rate is less severe. Participating firms expanded employment, while non-participants reduced the number of employees.

Table 2 also reports the number of firms classified by their "main banks." The main bank of a firm is defined by the financial institution of which the loan occupies the largest share in the

13 Greater Tokyo Area consists of Tokyo prefecture and surrounding prefectures in Eastern Japan (Kanagawa, Saitama, Chiba, Ibaraki, Yamanashi, Tochigi, and Gunma), while we define Greater Osaka Area by Osaka and surrounding prefectures in Western Japan (Kyoto, Hyogo, Nara, Shiga, and Mie).

14 The firm's age is defined as years since its establishment, and expressed in logarithm

15 Martin et al. (2011) report that French cluster firms are large-sized but follow a declining trend in productivity.

firm's total borrowing.[16] We derive the main bank data from the same TSR database as we use for transaction data. As reviewed in Boot (2000), accumulated studies of the relationship banking show that the main bank of a firm overcomes asymmetric information between a borrower and a lender by monitoring the firm based on customer-specific, often proprietary, information obtained through repeated interactions with the same customer firm within geographic proximity over a long period of time. Borrowing and monitoring by the main bank serve as a certification before accessing to the capital market or contracting with large customers in distant cores. Firms, especially large-sized firms with complex corporate hierarchies headquartered in urban concentration far from industrial cluster areas, are more likely to start new transactions with unfamiliar firms located in peripheral regions when these new transaction partners are members of government-approved clusters and financed by their main banks rather than unknown firms without these de-fact certifications, as it is often costly to search for and match with high-performing firms in remote locations.

Japanese financial institutions are grouped in the following three categories: city banks, regional banks, and other local financial institutions. We use the terminology "city banks" (*toshi ginko* in Japanese) and "regional banks" (*chiho ginko*) based on regulations imposed by the Ministry of Finance in Japan, although most of the legal restrictions distinguishing these two types of banks were deregulated during the 1990s.

City banks are large commercial banks, actively engaging in international finance, and operate branches across regions nationwide. The historical origin of most of them can be traced back to the core firms in Japanese enterprise groups (*zaibatsu* in pre-war period, and *keiretsu* after the post-war reform). City banks supply loans mainly to long-term clients, which are the

[16] The main bank is normally chosen as a long-term relationship. We have confirmed that cluster firms are not significantly different from non-cluster firms in changing their main banks by estimating binary logit of the main bank switch dummy.

member firms of the same enterprise group or large corporations normally engaged in global business and often headquartered in Tokyo even if they are not member firms.[17] These typical client firms of city banks are not likely to participate in cluster projects, as the policy target is promoting new and growing firms. In the case of a French cluster, Ter Wal (2013) confirms that small firms, such as high-tech startups and spin-off firms, play an important role in creating networks. After great merger waves at the beginning of the 21st century, there are four city banks in Japan: Tokyo-Mitsubishi-UFJ, Sumitomo-Mitsui, Mizuho, and Resona[18]. All these city banks in Japan are owned by multi-bank holding companies and headquartered in urban core areas outside of cluster targeted regions. As a result of the mergers, many local branches especially in rural areas were shut down. These suggest that Japanese city banks have no strong incentives to invest in establishing tight linkages with young firms in peripheral regions by providing consulting advices to them and collecting intangible and unverifiable information from them.

On the other hand, regional banks are relatively smaller commercial banks, operating branches originally in one prefecture. Although there are no longer any legal restrictions on operation areas, regional banks still often concentrate on activities in only one prefecture or neighboring regions, and have advantages in maintaining tight relationships with firms in the same regions. The loan officers at regional banks generally have personal contacts with owners and employees of small local client firms as well as their suppliers and customers and member of the same local community. All regional banks are members of Industrial Cluster Support Finance Council established for supporting the government's initiative of industrial clusters. In some of the clusters, the heads of regional banks hold monthly meetings to discuss financial supports for clusters in the same regions. Some regional banks actually provide loans, called

[17] During the bubble period around 1990, rising collateral value of real estate led city banks to increase loans to small non-member firms, but many of them turned to ill-performing loans after the burst of the bubble economy.

[18] Saitama Bank is included in this category, as it is owned by Resona Holding Company.

Industrial Cluster Support Loans, to firms subsidized by the cluster policy. A regional bank is likely to have relatively strong incentives to finance cluster firms as there are limited opportunities to find growing and promising firms in the same region distant from urban agglomeration.

We categorize all other financial institutions into the last group "other local financial institutions." They are small-sized depository institutions, not allowed to actively engage in risky financial operations and instead mainly concentrate on saving deposit from and loans to member individuals.[19] If a firm has such financial institution as its main bank, it is highly unlikely for the firm to obtain detailed professional consulting advice from the main bank for expanding business networks especially with firms in remote areas. Financial institutions included in this last category are mutual banks (*sougo ginko*),[20] credit associations (*shinyo kinko*),[21] credit unions (*shinyo kumiai*), and agricultural or fishery cooperatives (*nokyo or gyokyo*).[22]

This paper tries to relate the differences across categories of financial institutions with network formation by firms in clusters. A firm having a commercial bank as its main bank compared with those financed by local financial institutions, even if the firm is located in a peripheral area with few firms nearby, are likely to expand its inter-firm networks with firms located in urban areas, facilitated by consulting and advices given by the main bank. Even when

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19 In terms of corporate organization, both city banks and regional banks are joint-stock companies.

20 Mutual banks were converted to second-tier regional banks in 1989. The category labelled as "regional banks" in this paper are first-tier regional banks in the conventional classification of Japanese financial institutions. Even if we combine mutual banks with regional banks, our principal findings on the main bank effect are robust. Regression results with this alternative definition of "regional banks" are available upon request. We also include trust and banking corporations (*shintaku ginko*) and long-term credit banks (*choiki shinyo ginko*) into this last category.

21 In this last category, we also include *Shoko Chukin*, which is owned by the government but in transition toward privatization and mainly involved in loans to small and medium-sized firms.

22 We also include labor banks (*rokin*), which provide financing for labor unions and other organization operated by workers. Although labor banks organize their national association as in the case of *nokyo* or *gyokyo*, each labor bank serves local members in the same area.

local financial institutions give advices to lending firms, their advices are likely to be limited in geographic scope or not directly based on contacts with firms in distanced urban cores. As a related study on the Japanese main bank as a conduit for information, Inui et al. (2015) report that a firm is more likely to start exporting when the firm mainly borrows from a bank lending more to other exporting firms. As many of the firms participated in cluster projects are small and/or young with relatively narrow geographic scope of activities, information provided by their main banks should be particularly valuable for exploring new business opportunities. Stein (2002) argues that small-business lending relies heavily on "soft" information such as personal character and reliability of the firm's owner, which cannot be easily quantified and directly verified by third parties, rather than "hard" information derived from standard financial statements. This indicates that banks gather information through tight contacts with borrowers when they finance small firms. Based on such rich soft information, the main bank can provide the firm with detailed business consulting advices. As the main banks thus accumulated detailed soft information not contained in official documents, the mere fact that a cluster firm is financed by its main bank can be a reliable positive signal for potential transaction partners, especially large firms with complex corporate organization, in remote locations to decide whether or not to start new transactions with the cluster firm.

Among 1,208 firms participated in a cluster project, only 86 firms (seven percent) have city banks as their main banks, suggesting that the roles of city banks are limited for firms in clusters. Such low share of city banks for cluster firms is in line with the argument that their lending decisions made in complex hierarchical organizations with geographically dispersed branches are normally based on objective standard accounting information verifiable at distant corporate headquarters.[23] On the other hand, 794 firms have regional banks as their main banks,

[23] Previous studies, such as Keeton (1995), reports that large banks especially with complex

while other local financial institutions serve 328 firms in our sample.

Table 3 reports transitions of main banks between 2006 and 2012. The upper panel displays firms participated in clusters, while the lower panel shows non-cluster firms. In all types of financial institutions, the switches of main banks are extremely rare. As the patterns are similar among cluster firms and non-cluster firms, the cluster policy appears to have no discernible impact on the firm's choice of its main bank. This confirms that the main bank relationship in Japanese firms during this period is actually a long-term relation, as literature on relationship banking assumes.

Table 4 displays the number of firms participated in each cluster across prefectures. Clusters located in the three largest core regions are again excluded. Although the firms participated in two clusters in Hokkaido or one cluster in Okinawa are exclusively from the same prefecture, all other clusters widely attract firms across prefectural borders. We must note that Hokkaido and Okinawa are isolated islands with no directly contiguous prefectures. Consequently, as noted previously, the industrial cluster policy thus covers multiple prefectures beyond the jurisdiction of local governments.

4. Estimation results

4.1. Baseline results

This sub-section explains our baseline specification and reports its estimation results. As our baseline specification, we estimate the following:

$$Growth_j = \alpha_1 + \alpha_2 CLST_j + x_j \alpha_3 + u_j . \qquad (1)$$

Firms are indexed by *j*. The dependent variable *Growth* is the growth rate (between 2006 and

corporate organizations (e.g. owned by out-of-state holding companies) are inactive in small business lending.

2012) of transaction network, measured in terms of the number of firms having transactions with the firm *j*. We compare the following previously introduced alternative measures of networks: the number of all transaction partners combined, those in Tokyo, and in the same prefecture. We alternatively use networks with firms in Greater Tokyo Area for a robustness check purpose. As a comparison, we also estimate (1) with growth in sales and in employment. Our key variable *CLST* is the binary dummy taking the value one if the firm participated in a cluster project during the second period, and zero otherwise. All the firms with their firm data both at 2006 and 2012 available and located outside of the core are included in our regressions. To focus on the impact of the policy in the second period, however, firms participated in a cluster during the first period are excluded from our regressions. Firm characteristics before the cluster policy, at 2006, are summarized by the vector *x*. The error term is denoted by *u*. The parameters to be estimated are expressed as α.

Firm-level variables included in *x* are as follows: the number of employees, sales, age of the firm, and the firm's initial level of transaction network. Added also to the regression are prefecture dummies and industry dummies defined at the two-digit level.

The results from estimating the baseline specification (1) are reported in Table 5. Robust standard errors, clustered by 12 industrial clusters to handle potential intra-cluster correlations, are shown in parentheses for all regressions in this paper. In all cases in the table, the cluster dummy is significantly positive, indicating faster growth of cluster firms compared with firms not participated in clusters. This result is after controlling for the firm's initial conditions such as firm size and transaction networks observed before the cluster policy.[24] Table 5 also shows that the growth rate of network tends to be significantly higher in larger firms (in sales or

[24] Fontagné et al. (2013) discover that the exporting premium of cluster firms relative to non-cluster firms in France becomes mostly insignificant once their regressions control for firm characteristics such as size and productivity.

employment), suggesting that larger firms are likely to have richer opportunities for contacting with other firms in their transactions. On the other hand, the same table reports significantly negative coefficients on initial levels of networks in any region, indicating a sort of decreasing returns in network formation.

While the estimation results reported above are informative as a preliminary analysis, the effect of cluster policy may vary depending on the firm's initial condition. To consider this potential variation, we add interaction terms (firm variables at 2006 interacted with the cluster dummy) as follows.

$$Growth = \beta_1 + \beta_2 CLST + x'\beta_3 + CLST \cdot x'\beta_4 + v\,. \qquad (2)$$

The firm suffix *j* is omitted from the above. The error term in this case is denoted by *v*. The same set of variables as in (1) remains included in *x* here. If we find β_4 significant, the policy effect is sensitive to the initial conditions of participating firms. We omit to report the regression results with sales or employment as the dependent variable, as we find no significant relation.[25]

The results with such interaction terms, as reported in Table 6, show that the cluster policy has a significantly positive impact of the growth of transaction networks with firms located only in Tokyo.[26] The results on overall networks and on networks with firms in Greater Tokyo Area appear to be driven by this strong effect on networks with firms in Tokyo.[27] Our previous finding of significant policy effect on networks might be influenced by variations in initial conditions of firms before the cluster participation. As the share of Tokyo in the Japanese

[25] No significant impact of regional policy on local employment is also reported by Bondonio and Engberg (2000) in the case of five U.S. enterprise zones.

[26] We have confirmed that the networking with firms in Osaka or in Greater Osaka Area is not significantly related with the cluster policy. The regression results with Osaka networks are reported in Appendix Table A-1. Osaka was once the center of West Japan, especially as the center of commerce and trade, but its share in GDP declined substantially. Osaka was surpassed by Yokohama in the population ranking.

[27] This regression result is in line with anecdotal evidence. For example, according to Nikkei newspaper, a firm specializing in the development of electronic medical record system in Sapporo city started a joint development project with a medical information company in Tokyo, and outsourcing maintenance works to other firms in Tokyo.

economy remains markedly high (around 18 % of GDP in Japan's 47 prefectures during our sample period), as Tokyo is the dominant center in Japan for political, financial, or information functions, and as many globalized large firms have their corporate headquarters in Tokyo,[28] the formation of networks with Tokyo firms should be valuable for young and small firms, such as those participated in clusters, in regions distant from economic cores. As Japan is not a federated country, the national government located in Tokyo has a strong control over a wide range of policies even including regional economic policy such as cluster policy. Nishimura and Okamuro (2011a) find that R&D probability increases not by the participation in the cluster project itself, but by collaboration with firms in distanced areas. The study of a cluster in Chile by Giuliani and Bell (2005) shows that firms well connected with external knowledge sources are active creators of knowledge in their own right.[29] In what follows, this paper investigates how the cluster policy induces firms to expand networks with firms in Tokyo.

We also find from Table 6 that the policy effect on networks is weaker if the firms already had larger number of transaction partners before the participation into cluster projects, as indicated by the interactive terms *Network*CLST*. This finding suggests decreasing returns to scale in network formation.

To investigate further the impact on networks with firms in Tokyo, we disaggregate all firms[30] by their network levels at 2006 and check how changes during 2006-2012 vary. Such grouping is useful as our network measure (number of transaction partners) is in integer numbers. Figure 1 displays the share of changes for each group. As confirmed in the bar charts, it is not obvious that firms with smaller initial number of transaction partners necessarily

[28] Since TSR database records transactions at the firm level, the location of a transaction partner is identified by the address of the corporate headquarter of each firm, not of plants or offices.
[29] Giuliani (2007) finds that only a limited number of firms are connected through knowledge networks, though business interactions are pervasive among cluster wineries in Italy and Chile.
[30] As in regressions, the firms located in core regions are excluded.

expand networks more. Firms initially trading with more firms tend to be active in establishing new networks but also in terminating past networks. Cluster firms are generally more active in expanding networks than non-cluster firms, but the rightmost bar graph for firms initially with more than five transaction partners shows no discernible difference between cluster firms and non-cluster firms. Furthermore, the share of firms expanding Tokyo networks is around the same irrespective of the initial network level among cluster firms, while more than eighty percent of firms with no transactions with Tokyo at 2006 remain outside of Tokyo networks at 2012 among non-cluster firms. These suggest the importance of the cluster participation for firms having no experience of trading with firms in Tokyo.

4.2. Relations with main banks

To explore why and how the cluster policy is effective in accelerating network formation with firms located in Tokyo, this section examines the relationships with their financial institutions. Main banks, especially those active in financial services for regional firms, are likely to provide firms with information for searching for or matching with potential business partners beyond neighborhood. For this purpose, this section reports estimation results from the following regression:

$$Growth = \mu_1 + \mu_2 CLST + MB'\mu_3 + CLST \cdot MB'\mu_4 + x'\mu_5 + CLST \cdot x'\mu_6 + \varepsilon . \quad (3)$$

The main bank dummy *MB* is a vector of binary dummies, with the first and second component taking the value one if the firm's main bank is a city bank and a regional bank respectively, and zero otherwise. Hence, the coefficient μ_3 captures the differential from local financial institutions. We consider that the policy effect may change with the firm's main bank by introducing the interaction term. The error term is denoted by ε in (3).

The estimation results with the main bank dummies are displayed in Table 7. As shown by

the interaction term *CLST*MB*, the policy effect on network formation with partners located in Tokyo is significant only when a regional bank is the firm's main bank. We confirm that the policy has no impact on networking with local firms within the same region even after taking account of the interaction between policy and main bank relation. We also observe that firms mainly financed by city banks or regional banks tend to expand networks at significantly higher speed compared with firms mainly financed by local financial institutions, as indicated by *MB* without interactions. However, the cluster policy has no particular effect on firms mainly financed by city banks, as the insignificant interactive term implies. The policy effect declines with the initial level of networks for firms served by regional banks, as the triple interactive term shows (*Regional*Total Net*CLST*). The third column of Table 8 shows that if a firm is mainly financed by a city bank, the networking with local firms significantly declined while those by regional banks expanded.

These findings of the strong role of regional banks compared with city banks are consistent with previous results on small-business lending (e.g. Berger and Udell 2002, DeYoung et al. 1999, and Keeton 1995).[31] As predicted by relationship lending models, regional banks provide cluster firms with advices for business networking based on detailed soft information accumulated through tight borrower-lender relationships within geographical proximity. On the other hand, local financial institutions, most of which are depository institutions, often lack professional business consulting skills, while city banks, of which have complex hierarchical organizations with geographically dispersed braches, have no strong incentive to gather soft information through costly intensive contacts with young and/or small cluster firms located in regions distant from the banks' corporate headquarters in urban core.

[31] DeYoung et al. (1999) find that a bank tends to be inactive in small-business lending when the bank is part of a multi-bank holding company. Keeton (1995) reports that banks owned by out-of-state holding companies are inactive in small-business lending. In our sample, all the Japanese city banks are owned by stock-holding companies headquartered in urban core areas.

Our finding of the significant impact of financing by regional banks on transactions with firms in Tokyo, not in the same region, suggests that firms in Tokyo, distant from cluster areas with rich concentrations of competing potential transaction partners, tend to rely, in choosing their transaction partners, heavily on the fact that the firm is a member of government-sponsored cluster project and is financed by its main bank in the same region. In contrast, firms in the same region may directly collect soft information on potential transaction partners and hence rely less on signals from the government or the main bank.

5. Robustness checks and extensions

This section summarizes results from robustness checks and extensions. First, while we have focused on cluster firms, this section examines spillover effect of cluster policy on firms not participated in any industrial cluster. Second, for a robustness check purpose, we explore instrumental variables (IV) and conduct propensity score matching.

5. 1. Spillover effect on non-cluster firms

While we have investigated the effect of cluster policy on participating firms, it is also useful to evaluate the impact on other firms connected through transactions. In order to capture indirect effect of cluster policy, we estimate whether and how much transaction networks of firms not participated in any cluster project differ when they trade with cluster firms.

The estimation results for firms not participated in any cluster project show that non-cluster firms tend to significantly rapidly expand networks, especially with firms in Tokyo, if they have transactions with cluster firms. The regression results are reported in Appendix Table A2 and A3.[32] This finding indicates that the effect of cluster policy spills over from

[32] Table A2 adds the binary dummy, taking the value one if a non-cluster firm has transaction with a cluster firm, and zero if the firm has no transaction with any cluster firm. Table A3 estimates the

cluster member firms to non-member firms via transaction networks. We also find that the indirect impact on non-cluster firms through transactions with cluster firms is naturally smaller in magnitude than the direct impact on cluster firms (reported in Table 5). While it is difficult to quantitatively trace all these indirect transmissions, the spillover effect cannot be neglected in evaluating the impact of cluster policy.[33]

5.2. Earlier policies as instrumental variables

The regressions in the previous section depend on the assumption that regions with equal characteristics are randomly assigned to industrial clusters. However, some regions might be more likely to be selected in priority projects by the government compared with other regions, possibly due to tighter connections with policy makers or active political lobbying. Although it is difficult to perfectly control for regional variations in this dimension, one clue is found in historical experiences of each region in the past policy projects. In almost all the regional policies in earlier periods, all firms in the targeted regions are automatically entitled to subsidies. This leads us to use regional selection in such early policy projects as IV. By assigning past experiences of a region in earlier policy projects as IV for the selection of the region into a current cluster, our IV results can be regarded as estimates after controlling for cross-regional variations in local attitudes toward national policy projects. Estimation with IV also alleviates the potential problem of reverse causality (firms in regions with active networking often selected as clusters).

The first policy project we use as IV is Intelligent Location (*zuno ritti* in Japanese) conducted during 1988 and 1998.[34] This project was designed to attract software and

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effect of the number of cluster firms among transactions of a non-cluster firm.

[33] The column (4) of Table A3 also shows that non-cluster firms located closer to cluster firms tend to expand networks more with local firms, suggesting geographical spillovers.

[34] As the original Japanese names of policy programs (shown in parentheses) have been translated

information service industries for creating new industrial complexes. Eligible regions intensively competed each other to be designated as the targeted regions, facing the serious decline of manufacturing, especially heavy petrochemical industries dependent on imported oil, after the oil price hikes in the late 1970s. The historical context is naturally distinctively different from the current situation, but this project shares regional development purpose with the cluster policy. The political capital accumulated for such early regional development projects could induce people in these regions toward actively making connections with policy makers in Tokyo, and thus might influence the selection of cluster regions.

To check the robustness of this IV, we also consider another earlier project as an alternative instrument.[35] The project we pick up this time is Technopolis, which started in 1983 as a direct precursor project of Intelligent Location. Both share the policy objective of creating new industrial complexes away from congested urban cores, but Technopolis attempted to attract high-tech manufacturing such as production of machinery. All the firms in targeted industries located in the designated Technopolis areas are automatically entitled to receive policy supports. The validity of Technopolis as IV in our context is as clear as in the case of Intelligent Location project. The comparison of two projects enables us to examine whether our results are sensitive to the choice of IV.

To be nominated as an industrial cluster, firms located nearby need to organize meetings and to prepare applications for subsidies. Chamber of Commerce and Industry in each region is certainly one of the suitable catalysts for such local coordinating activities. For example, active

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by the authors, some of the English names are not officially authorized.

[35] We also consider, as an alternative IV, Coal Mining Areas (san tan chi-iki in Japanese) starting in 1961. After the structural shift in Japan's energy consumption from domestic coal to imported petroleum since late 1950s, coal-mining areas, populous and rich in the past, drastically turned to decline. The national government supported them by providing substantial funds to promote other local industries, typically manufacturing. The results with this project in a very early period are qualitatively similar, though with weaker statistical significance, to those with other instruments, and thus omitted from the tables.

lobbying by the chamber in Hamamatsu, of which the leading regional industry shifted drastically from textiles to transport equipment and music instruments, has led the region to be selected by many national projects, including Technopolis.[36] Trade associations of local firms, not necessarily in the form of the chamber of commerce, have played key roles in political lobbying in such various regional industries as those from silk in pre-war Japan to surgical instrument in a recent developing country, as documented by Matsumoto (1993) and Nadvi (1999).[37] As industrial clusters are not mechanically defined by any administrative boundaries or quantitative criteria, active local organization may be pivotal in forming a cluster. Kodama (2008) confirms that cluster activities are "autonomously directed and managed by representatives from private firms, universities and local authorities in the region" (p.1226).[38] As the selection of targeted regions in Intelligent Location or Technopolis was in the 1980s, however, it is quite unlikely that this regional selection should have any direct impact on transactions of individual firms in our sample after nearly three decades.[39]

Before estimating the equation (1) or (2), we estimate the following firs-stage regression of the industrial cluster dummy as the dependent variable on the Intelligent Location variable *IL* along with all the second-stage right-hand side variables *x*. For *IL*, we use the duration of years for which the region was targeted as Intelligent Location to capture the lobbying ability of the region, since some of the targeted regions actually have long experiences in past national

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[36] Hamamatsu was a famous success case of Technopolis led by local initiatives, as noted by Nishino (2009) for example.

[37] Matsumoto (1993) emphasizes that trade associations formed bargaining powers toward the government for attracting national training and inspection facilities to their regions in the development process of Japanese textiles and other traditional industries during the inter-war period. Nadvi (1999) reports that the trade association of local manufacturers mobilized the government for establishing a testing laboratory and a technical training facility in the surgical instrument cluster in Pakistan in response to the tightened requirement of quality standards by the U.S. during the 1990s.

[38] TAMA cluster analyzed by Kodama (2008) is not in our sample since it is located in Tokyo, but the important role of local actors characterizes many cluster projects.

[39] Based on the firm age, we have also confirmed that no identical firm participated both in industrial cluster and Intelligent Location.

projects.

$$CLST = \gamma_1 + \gamma_2 IL + x'\gamma_3 + \omega . \qquad (4)$$

The error term is expressed as ω in (4). The model is just identified by introducing *IL*. When we use Technopolis as IV, the variable for that project is defined exactly in the same way.

For estimating the equation (2) at the second stage, however, we additionally need to provide instruments for interactive terms as follows.[40]

$$CLST \cdot Network = \delta_1 + \delta_2 IL + x'\delta_3 + \delta_4 IL \cdot Emp + \xi . \qquad (5)$$

We interact *IL* with the firm size in employment, as larger firms tend to be more active in political lobbying, as confirmed by Bombardini (2008) for the U.S., and thus more likely to be selected in policy projects. By the addition of this interactive term *IL*Emp*, the model is again just identified. The error term in (5) is denoted by ξ.[41] In the case of Technopolis, we follow the same procedure by using the interactive term with *Emp*.

Table 8 for Intelligent Location and Table 9 for Technopolis report the estimation results from the second stage. F statistics at the first stage, shown in the bottom row of each column, is high in all four cases, assuring that our regression is not seriously plagued by weak instruments. The first-stage regression results for each policy project are reported in Appendix Table A4 and Table A5, respectively. As shown in the two tables, the cluster dummy remains positive and significant after instrumented.[42] We also confirm that the cluster dummy interacted with network variables is negative. Therefore, both Table 8 and Table 9 combined demonstrate that

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[40] If we construct the interactive term *CLST*Network* with *CLST* estimated from the first stage (4) instead of additionally estimating (5), the second-stage IV estimates are inconsistent due to the problem of forbidden regression.

[41] While we report IV results of (1) and (2) below, we have not estimated (3) with IV due to increasing number of required instruments, identification problem, weak instruments, and difficulty in interpreting estimates.

[42] The *CLST* coefficient estimated by IV is larger than that by OLS in our case. This direction of bias in the OLS estimator is in line with our prior; if a firm's networking is affected by negative rather than positive disturbances, the firm is more likely to become a member of a cluster project. This suggests that the participation in clusters is partly driven by bad shocks on the firm's transactions.

our main findings are robust even if we use historical experiences of each region in the past policy projects as IV.

5.3. Propensity score matching

While all the regressions reported in this paper cover all firms outside of the core,[43] firms in cluster projects may differ from other firms in their observable characteristics even before the participation. For example, Baldwin and Okubo (2006) theoretically show that firms with different initial performance levels respond to the same policy initiative differently (low-productivity firms more sensitive to policy incentives). Martin et al. (2011) find that declining firms are more likely to participate in French clusters. If such self-selection cannot be ignored, our simple comparison between cluster firms and non-cluster firms could be biased. To respond to this potential problem, we employ the propensity score matching technique.[44]

Table 10 reports the matching results. To check the robustness of our main finding, we conducted several ways of comparisons as follows. The first portion of Table 10 shows the gap between cluster firms and non-cluster firms. In the first stage, with the selection into a cluster as the left-hand side variable, we estimate binary logit model on the firm's initial characteristics,[45] sector dummies, and prefecture dummies. In the second stage, we compare cluster firms with non-cluster firms in the logarithm difference from 2006 to 2012. Figures in the table confirm that, even if we concentrate on comparable firms among a large number of non-cluster firms, the transaction networks of cluster firms expanded significantly faster than those of non-cluster firms. While the previous simple regressions shown in Table 5 detect it significant, on the other hand, the difference between cluster firms and non-cluster firms in the growth rate of sales or

[43] Firms participated in clusters in the first period are also excluded.
[44] Caliper is set at 0.5 in our matching.
[45] Included as the firm characteristics are the network with all firms combined, that with firms in Tokyo, in Greater Tokyo Area, Osaka, Greater Osaka Area, and in the same prefecture, as well as the firm's sales, employment and age. Main bank dummies (city bank and regional bank) and their interactions with the total network are also included.

employment turns out to be insignificant if we select matched firms from non-participating firms. This suggests that, while cluster firms tend to expand firms size at faster speed compared with non-cluster firms, these rapidly growing firms are more likely to actively participate in cluster projects. If we control for this difference in prior firm characteristics by propensity score matching, i.e. if we focus on firms with comparable propensity to participate in a cluster, the growth rate in firm size barely differs between cluster firms and non-cluster firms.

The second part of Table 10 concentrates on cluster firms and examines the gap between firms with different main banks. As consistent with our previous results from regressions, the growth rate of network with Tokyo is significantly higher if the firm's main bank is a regional bank compared with firms having other categories of financial institutions (city banks or local financial institutions in this case) as their main banks. The growth of networks with firms in Greater Tokyo Area is also higher for these firms, though its statistical significance is weaker. Firms mainly financed by regional banks, however, are not significantly different in the growth of networks with all firms combined or with local firms. On the other hand, no significant difference is detected for firms served by city banks or by local financial institutions. These results from propensity score matching confirm the robustness of our principal finding on the role of regional banks in the cluster policy effect on network formation.

As a further robustness check, the third part of Table 10 focuses on firms having no transactions at all with Tokyo firms before the cluster project. Compared with firms already experienced transactions with Tokyo, these firms with zero initial Tokyo network have a significantly higher growth of network with Tokyo after the cluster project if they are mainly financed by regional banks. Their network with firms located in Greater Tokyo Area also expanded at a higher speed. No such difference is found for firms served by city banks. We must note that these comparisons are on firms of which the main bank is in the same category.

Consequently, if a regional bank is the main bank of a firm, then, the participation in a cluster leads the firm with no prior experience of trading with Tokyo to expand networks with Tokyo significantly more than the firms having some experience of Tokyo transactions. This extensive margin result might suggest that the consulting advice given by a regional bank as the main bank is particularly valuable for cluster firms newly entering into transactions with firms located in Tokyo. In other word, city banks or local financial institutions are not discernibly helpful for such de novo entrants to newly break into transaction networks with firms in Tokyo.

6. Concluding remarks

Cluster policies have been actively carried out by many countries around the world. Studies on the impact of innovation have been accumulated, but little evidence has been reported for the relation with transaction networks. As the formation of inter-firm network is among the top priorities in Japanese industrial cluster policy, this paper has examined how cluster firms differ from non-cluster firms in network formation based on firm-level data on transactions. Firms participated in cluster projects tend to expand transaction networks with firms located in Tokyo at a significantly higher speed. We have confirmed the robustness of our main finding by propensity score matching or IV based on historical records of early policy projects. Participation in cluster projects or relationship with nation-wide city banks or small local saving unions alone appears insufficient for a firm in a cluster region to expand business network all the way to Tokyo, but relationships with regional banks appears to contribute to expanding network formation of cluster firms. These findings indicate that the government's targeting of clusters with virtually no substantial direct subsidies, only if combined with a financing decision of the main bank in the same region, facilitates transaction networking with firms located in Tokyo, urban agglomeration distant from cluster areas.

While this finding is informative for policy makers and academia, there remain several issues for future work. For example, it will be useful to link this transaction dataset with corporate financial data for discussing the role of main bank. Investigating the effect of network formation on performance of cluster firms will be another important topic.

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Table 1: Basic statistics

		mean	sd	min	max	N
Growth	Network growth	0.122054	0.440698	−2.48491	3.135494	345,893
	Network Tokyo growth	0.074934	0.394865	−2.83321	2.833213	345,893
	Network GTokyo growth	0.099358	0.407388	−2.89037	2.944439	345,893
	Network Osaka growth	0.020341	0.270065	−2.3979	2.564949	345,893
	Network GOsaka growth	0.028738	0.29005	−2.3979	2.639057	345,893
	Network Local growth	0.131067	0.491518	−2.77259	3.258096	345,893
	Emp growth	−0.04812	0.475615	−6.23048	7.438384	344,390
	Sales growth	−0.19625	0.599462	−9.665	10.16579	343,388
Firm characteristics	Network	1.668173	0.646063	0.693147	3.89182	345,893
at 2006	Network Tokyo	0.498169	0.619794	0	3.258096	345,893
	Network GTokyo	0.537921	0.643365	0	3.496508	345,893
	Network Osaka	0.191016	0.402541	0	2.995732	345,893
	Network GOsaka	0.228833	0.442823	0	2.995732	345,893
	Network Local	1.111357	0.713015	0	3.465736	345,893
	Emp	2.095508	1.219881	0	9.849348	345,166
	Sales	11.96789	1.495411	0	21.33908	345,649
	Cluster	0.003492	0.058993	0	1	345,893
	Age	3.40567	0.464899	1.791759	4.912655	313,641

Table 2: Comparisons of firms in and outside of clusters

Participation in a cluster	Network growth	Network Local growth	Network Tokyo growth	Network GTokyo growth	Sales growth	Emp growth	# Firms	# Firms w/ city banks	#Firms w/ regional banks	#Firms w/ other local fin. inst.
Yes	0.173774	0.152521	0.1173	0.143907	−0.05695	0.0153859	1,208	86	794	328
No	0.121872	0.130992	0.074786	0.099202	−0.19674	−0.048346	344,685	11,505	201,475	131,705

Table 3: Transition of main banks

Cluster firms

at 2006 \ at 2012	City banks	Regional	Other	Total
City banks	56	19	11	86
	4.64	1.57	0.91	7.12
Regional	14	740	40	794
	1.16	61.26	3.31	65.73
Other	6	47	275	328
	0.50	3.89	22.77	27.16
Total	76	806	326	1,208
	6.30	66.72	26.99	100

Non-cluster firms

at 2006 \ at 2012	City banks	Regional	Other	Total
City banks	9,274	1,474	757	11,505
	2.69	0.43	0.22	3.34
Regional	895	192,631	7949	201,475
	0.26	55.89	2.31	58.46
Other	627	8357	122,721	131,705
	0.18	2.42	35.60	38.19
Total	10,796	202,462	131,427	344,685
	3.13	58.74	38.12	100

Notes) Upper row in each cell shows the number of firms. Lower row represents percentage.

Table 4: Number of firms in each cluster

Prefecture	Cluster code 1	2	3	4	5	6	7	8	9	10	11	12	Total
Hokkaido	23	26	0	0	0	0	0	0	0	0	0	0	49
Aomori	0	0	0	0	0	0	40	0	0	0	0	0	40
Iwate	0	0	0	0	0	0	67	0	0	0	0	0	67
Miyagi	0	0	0	0	0	0	58	0	0	0	0	0	58
Akita	0	0	0	0	0	0	27	0	0	0	0	0	27
Yamagata	0	0	0	0	0	0	36	0	0	0	0	0	36
Fukushima	0	0	0	0	0	0	91	0	0	0	0	0	91
Niigata	0	0	0	0	0	0	6	0	0	0	0	0	6
Toyama	0	0	0	0	97	0	0	0	0	0	0	0	97
Ishikawa	0	0	0	0	126	0	0	0	0	0	0	0	126
Fukui	0	0	0	0	19	0	0	0	0	0	0	0	19
Nagano	0	0	0	0	0	14	0	0	0	0	0	1	15
Shizuoka	0	0	0	0	0	56	0	0	0	0	0	0	56
Wakayama	0	0	0	0	0	0	0	0	0	0	0	1	1
Tottori	0	0	24	18	0	0	0	0	0	0	0	0	42
Shimane	0	0	3	9	0	0	0	0	0	0	0	0	12
Okayama	0	0	9	37	0	0	0	0	0	0	0	0	46
Hiroshima	0	0	25	36	0	0	0	0	0	0	0	1	62
Yamaguch	0	0	19	34	0	0	0	0	0	0	0	2	55
Tokushima	0	0	0	0	0	0	0	0	0	23	0	0	23
Kagawa	0	0	0	0	0	0	0	0	0	17	0	0	17
Ehime	0	0	0	0	0	0	0	0	0	34	0	0	34
Kochi	0	0	0	0	0	0	0	0	0	16	0	0	16
Fukuoka	0	0	0	0	0	0	0	9	0	0	17	29	55
Saga	0	0	0	0	0	0	0	2	0	0	2	2	6
Nagasaki	0	0	0	0	0	0	0	1	0	0	58	6	65
Kumamoto	0	0	0	0	0	0	0	5	0	0	15	11	31
Oita	0	0	0	0	0	0	0	1	0	0	2	11	14
Miyazaki	0	0	0	0	0	0	0	2	0	0	21	0	23
Kagoshima	0	0	0	0	0	0	0	3	0	0	12	3	18
Okinawa	0	0	0	0	0	0	0	0	1	0	0	0	1
Total	23	26	80	134	242	70	325	23	1	90	127	67	1,208

Notes: All firms participated in any cluster, excluding those in core areas, are included. Prefectures with no clusters are omitted.

Code	Name of cluster
1	Hokkaido IT Innovation Strategy
2	Hokkaido BioTech Industry Growth Strategy
3	Project to form Recycling-oriented & Environmental Society
4	Project to form Next-generation Key Industries
5	Project to Create Manufacturing Industry in Hokuriku
6	Regional Industry Revitalization Project (Support Activities for Networks in San-en-nanshin District)
7	Tohoku Manufacturing Corridor
8	Kyushu Bio Cluster
9	Okinawa Industry Promotion Project
10	Shikoku Techno Bridge Plan
11	Kyushu Recycle & Environmental Industry Plaza
12	Kyushu Sillicon Cluster

Table 5: Baseline regressions

	1		2		3		4		5		6	
	Network growth		Network Tokyo growth		Network GTokyo growth		Network Local growth		Emp growth		Sales growth	
		std dev		std dev		std dev		std dev		std dev		std dev
Cluster	0.0787262	0.026577 ***	0.0680604	0.021801 ***	0.0706421	0.021619 **	0.0299019	0.035162 **	0.124847	0.016142 ***	0.0684157	0.014996 ***
Network	−0.3650326	−0.00025 ***	−0.0094497	0.000245 ***	−0.0058469	0.000249 ***	−0.059322	0.000467 ***	−0.00605	0.000112 ***	0.0286392	0.000144 ***
Network Tokyo			−0.2303172	0.000205 ***								
Network Gtokyo					−0.2315276	0.000194 ***						
Network Local							−0.264968	0.000412 ***				
Emp	0.0214342	0.000126 ***	0.0103278	0.000075 ***	0.0143487	7.71E−05 ***	0.0187367	0.000242 ***	−0.21395	0.000259 ***	0.1409816	0.00036 ***
Sales	0.0745793	0.000218 ***	0.0509526	5.73E−05 ***	0.0511742	0.00009 ***	0.0441789	9.09E−05 ***	0.141209	0.00012 ***	−0.09679	0.000427 ***
Age	−0.0020799	0.000208 ***	−0.0137716	0.000164 ***	−0.0141622	0.000172 ***	0.0190464	0.000335 ***	−0.07405	0.000164 ***	−0.160367	0.000212 ***
# Observations	312840		312840		312840		315429		314639		313190	
F	1418.48		662.45		664.8		1024.22		1024.22		1024.22	
R-sq	0.2262		0.1164		0.1233		0.1731		0.0997		0.0559	

Notes)

1. Prefecture dummies and sector dummies are included in all cases.
2. std dev is clustered-robust standard error. Cluster errors use 12 cluster projects (see Table 4)
3. Statistical significance is denoted by asterisk: *** 1%, ** 5%, * 10%.

Table 6: Regressions with interactions

	1		2		3		4	
	Network growth		Network Tokyo growth		Network GTokyo growth		Network Local growth	
		std dev		std dev		std dev		std dev
Cluster	0.5862853	0.138089 ***	0.2148839	0.156712 ***	0.3132481	0.16322 *	0.1977716	0.150176
Network	-0.364856	4.77E-05 ***	-0.0092723	5.11E-05 ***	-0.0056872	6.58E-05 ***	-0.0589461	6.87E-05 ***
Network Tokyo			-0.2301748	6.25E-05 ***				
Network GTokyo					-0.2313437	8.16E-05 ***		
Network Local							-0.2651691	8.03E-05 ***
Network*CLST	-0.059831	0.033056 *	-0.0546243	0.022424 **	-0.0538718	0.024411 **	-0.0822552	0.04125 **
Network Tokyo*CLST			-0.012125	0.02731				
Network Gtokyo*CLST					-0.0180637	0.023547		
Network Local*CLST							0.0203576	0.044703 *
Emp	0.0214756	6.48E-05 ***	0.0102829	2.83E-05 ***	0.0142986	3.23E-05 ***	0.0188508	0.000101 ***
Sales	0.0747813	3.28E-05 ***	0.0509699	1.99E-05 ***	0.0512361	2.45E-05 ***	0.0442725	3.02E-05 ***
Age	-0.002185	6.26E-05 ***	-0.0137687	4.34E-05 ***	-0.0141928	4.73E-05 ***	0.0188276	0.00005 ***
Emp*CLST	-0.00445	0.012268	0.0101539	0.022103	0.013979	0.022769	-0.0301929	0.017964
Sales*CLST	-0.040097	0.015373 **	-0.0043536	0.017499	-0.0153048	0.020809	-0.0133068	0.012257
Age*CLST	0.0539767	0.047296	0.0039488	0.045674	0.0168661	0.046006	0.0804313	0.057651
# Observations	312,840		312,840		312,840		315,429	
F	1418.48		662.45		664.8		1024.22	
R-sq	0.2263		0.1164		0.1235		0.1731	

See notes to Table 5.

	5			6		
	Emp growth			Sales growth		
		std dev			std dev	
Cluster	0.323089	0.213114		0.8256049	0.533252	
Network	-0.006015	4.49E-05	***	0.0286978	5.28E-05	***
Network*CLST	-0.003094	0.021861		-0.0229388	0.033666	
Emp	-0.214094	6.79E-05	***	0.1408512	0.000109	***
Sales	0.1412744	3.99E-05	***	-0.0964964	0.000066	***
Age	-0.074039	5.53E-05	***	-0.1603903	9.48E-05	***
Emp*CLST	0.0437198	0.037457		0.0473088	0.073191	
Sales*CLST	-0.024767	0.024706		-0.0718009	0.058769	
Age*CLST	-0.004132	0.042838		0.0276717	0.049373	
# Observations	314,639			313,190		
F						
R-sq	0.0997			0.056		

Table 7: Regressions with the main bank dummy

	1			2			3		
	Network Tokyo growth			Network GTokyo growth			Network Local growth		
		std dev			std dev			std dev	
Cluster	-0.02618	0.1979539		0.04222	0.202425		0.189633	0.18354	
Total Network	-0.00556	0.0000488	***	0.00082	5.89E-05	***	-0.04939	6.7E-05	***
Network Tokyo	-0.23049	0.0000651	***						
Network GTokyo				-0.2314	8.15E-05	***			
Network Local							-0.26675	7.6E-05	***
TotalNet*CLST	0.052726	0.0388344		0.06581	0.039486		-0.08637	0.04395	*
TotalNet*CityBank	-0.0176	0.0000318	***	-0.0284	4.66E-05	***	-0.01783	5.2E-05	***
TotalNet*RegBank	-0.00434	7.05E-06	***	-0.0086	8.40E-06	***	-0.01339	2.3E-05	***
NetTokyo*CLST	-0.01335	0.0284265							
NetGTokyo*CLST				-0.0183	0.024092				
NetLocal*CLST							0.019245	0.04425	
Emp	0.010145	0.0000278	***	0.0142	2.98E-05	***	0.019009	9.6E-05	***
Sales	0.050686	0.0000204	***	0.05103	2.33E-05	***	0.044991	2.9E-05	***
Age	-0.01442	0.0000468	***	-0.0148	5.03E-05	***	0.018967	4.9E-05	***
Emp*CLST	0.011695	0.0204892		0.01542	0.021219		-0.02972	0.01683	
Sales*CLST	-0.00783	0.0174973		-0.0179	0.020664		-0.01208	0.01228	
Age*CLST	0.004324	0.0474193		0.01656	0.046673		0.075808	0.05712	
City bank	0.058507	0.0000924	***	0.0758	0.000136	***	-0.01739	8.5E-05	***
Regional bank	0.014227	0.0000551	***	0.01946	4.45E-05	***	0.024141	4.9E-05	***
CityBank*CLST	0.284269	0.2274197		0.23779	0.222634		0.127311	0.25935	
RegiBank*CLST	0.395553	0.1300876	***	0.43243	0.131038	***	-0.00481	0.07252	
CityBank*Net*CLST	-0.11057	0.0862608		-0.0991	0.086711		-0.06706	0.1039	
RegBank*Net*CLST	-0.14806	0.0482741	***	-0.1689	0.04866	***	0.015386	0.02817	
# Observations		312,840			312,840		315,429		
F		583.68			586.04		903.68		
R-sq		0.1166			0.1237		0.1735		

See notes to Table 5.

Table 8: Historical project as IV (Intelligent Location)

	1		2		3		4	
	Network growth		Network Tokyo growth		Network growth		Network Tokyo growth	
		std dev		std dev		std dev		std dev
Cluster	2.31976	0.568702 **	2.319597	0.551473 ***	18.20095	7.604865 **	11.32578	3.206095 ***
Network	−0.32515	0.002308 ***	−0.02602	0.001712 ***	−0.30389	0.008401 ***	−0.02515	0.002236 ***
Network Tokyo			−0.1925	0.002438 ***			−0.14287	0.01409 ***
Network*CLST					−6.60307	2.958115 **		
Network Tokyo*CLST							−8.482	2.583896 ***
Emp	0.013754	0.002327 ***	0.002562	0.002265 ***	0.010113	0.004062 **	0.007014	0.002837 ***
Sales	0.059503	0.000979 ***	0.049454	0.000982 ***	0.061337	0.001475 ***	0.049053	0.00128 ***
Age	−0.00974	0.001923 ***	−0.00511	0.001901 ***	−0.00562	0.003402 *	−0.00676	0.002596 **
# Observations	312,840		312,840		312,840		312,840	
F	8967.74		3488.75		4838.47		1242.95	
F (1st-stage)	118.2		118.6		59.39, 59.24		59.61, 35.56	

Notes) 2nd-stage regression results are shown. Constant term is included in all cases but omitted from the table.
At the 1st-stage, cluster dummy is regressed on the Intelligent Location duration and other right-hand side variables.
As IV for interactive term, the Intelligent Location duration is interacted with Emp.

Table 9: Historical project as IV (Technopolis)

	1		2		3		4	
	Network growth		Network Tokyo growth		Network growth		Network Tokyo growth	
		std dev		std dev		std dev		std dev
Cluster	3.668782	0.348231 **	2.375162	0.234297 ***	10.40929	0.942967 ***	1.69166	0.364737 ***
Network	−0.3293	0.001432 ***	−0.026114	0.000348 ***	−0.31925	0.002885 ***	−0.02598	0.000294 ***
Network Tokyo			−0.192693	0.001522 ***			−0.19542	0.003809 ***
Network*CLST					−2.89955	0.549966 ***		
Network Tokyo*CLST							0.535145	0.446372 ***
Emp	0.008896	0.001893 ***	0.0023604	0.001251 *	0.008137	0.00195 ***	0.002497	0.001208 ***
Sales	0.059753	0.000137 ***	0.049483	0.00013 ***	0.060515	0.000244 ***	0.049448	0.000128 ***
Age	−0.00806	0.001357 ***	−0.005033	0.000948 ***	−0.00654	0.001485 ***	−0.0051	0.000908 **
# Observations	312,840		312,840		312,840		312,840	
F	7870.26		3462.02		6111		2915.82	
F (1st-stage)	152.13		127.6		128.27, 123.51		110.57, 88.00	

Notes) 2nd-stage regression results are shown. Constant term is included in all cases but omitted from the table.
At the 1st-stage, cluster dummy is regressed on the Techno duration and other right-hand side variables.
As IV for interactive term, the Techno duration is interacted with Emp.

Table 10: Propensity-score matching

1) Cluster firms vs. Non-cluster firms

	Difference	t	
Network	0.086612	3.88	***
Network Tokyo	0.08935	3.73	***
Network GTokyo	0.077589	3.25	***
Network Local	0.03433	1.14	
Sales	0.003812	0.13	
Emp	0.038273	1.66	*

Excluding firms having transactions with cluster firms.

	Difference	t	
Network	0.089111	3.83	***
Network Tokyo	0.059444	2.39	**
Network GTokyo	0.062157	2.51	**
Network Local	0.059007	1.89	*
Sales	0.02697	0.86	
Emp	0.088013	3.31	***

Firms with vs. without networks with cluster firms (among non-cluster firms)

	Difference	t	
Network	0.068478	5.23	***
Network Tokyo	0.029861	2.14	**
Network GTokyo	0.022137	1.58	
Network Local	0.072951	3.57	***
Sales	0.013175	0.77	
Emp	0.019312	1.25	

Notes) The second stage compares the log difference between 2006 and 2012. PS matching with caliper 0.5
The first-stage logit is cluster dummy on total network, network Tokyo, GTokyo, Osaka,GOsaka,Local, emp, sales, age, city bank, regional bank, city bank*network, regional bank*network, prefecture dummies, and sector dummies.
Statistical significance denoted by asterisk: *** 1%, ** 5%, * 10%

2) Different main banks among cluster firms

		Difference	t
Regional bank	Network	0.07	1.56
	Network T	0.1	2.05
	Network G	0.08	1.63
	Local	0.03	0.54
City bank	Network T	0.04	0.48
Local institution	Network T	−0.1	−1.5
	Local	−0	−0.7

Notes) The second stage compares the log difference between 2006 and 2012.
The first stage logit is the main bank type dummy on total network, sales, employment and age. PS matching with caliper 0.5

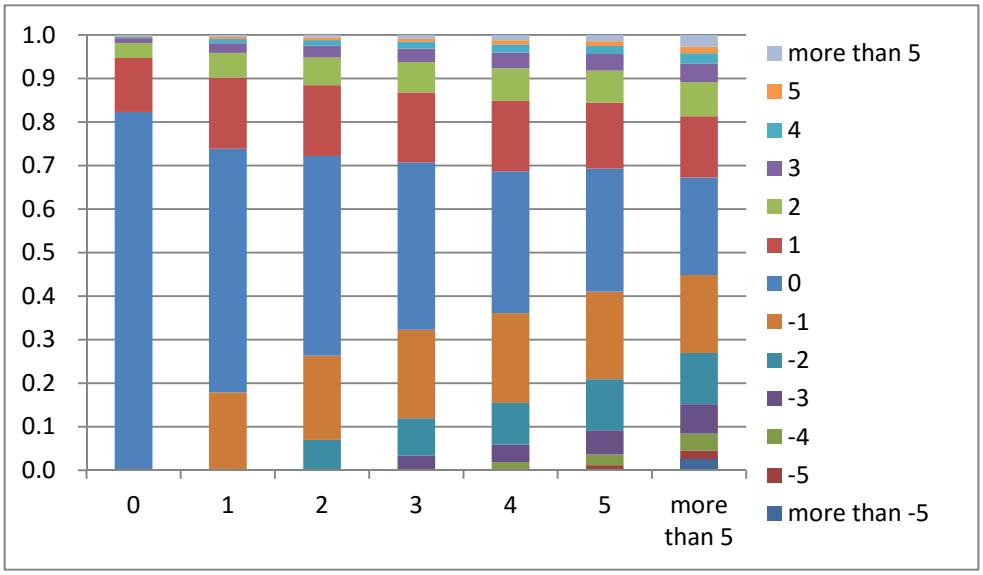
3) Firms previously without vs. with Network Tokyo

		Difference	t	
Regional bank	Network Tokyo	0.4	4.31	***
	Network GTokyo	0.38	3.92	***
City bank	Network Tokyo	0.19	0.57	
	Network GTokyo	−0.4	−0.9	

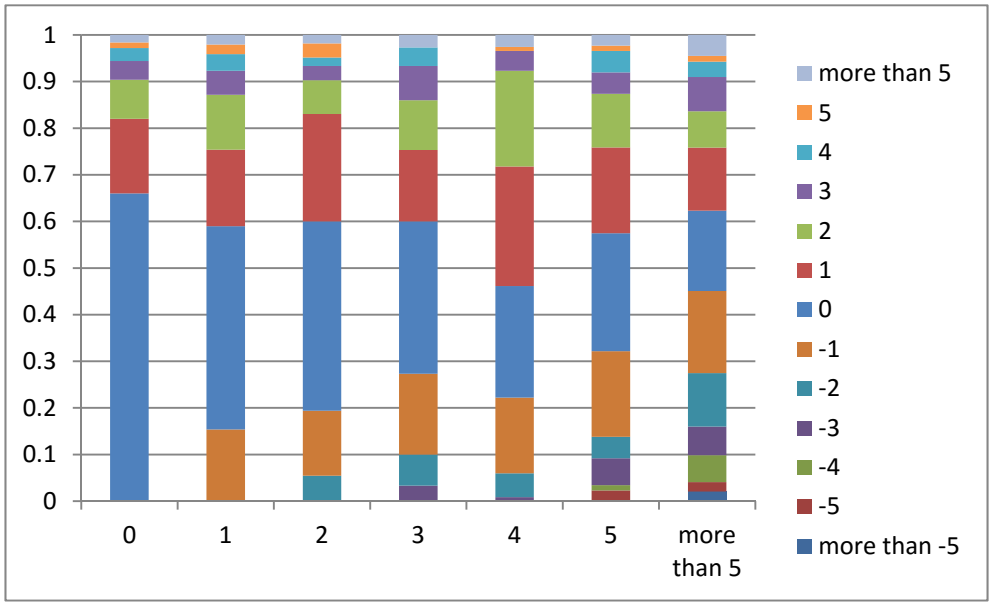
Notes) The second stage compares the log difference between 2006 and 2012.
Firms trading with Tokyo firms are compared with firms not trading with Tokyo firms.
The upper two rows concentrate on firms having regional banks as main banks.
The lower two rows include only firms having city banks as main banks.
The first-stage logit: main bank type interacted with no transaction with Tokyo dummy is regressed on total network, sales, employment and age.

Figure 1: Changes in network with Tokyo, disaggregated by initial network

Non-cluster firms



Cluster firms



Notes) Firms are grouped by their number of transaction partners in Tokyo at 2006.
Shown are the share of 2006-2012 changes in the number of transaction partners in Tokyo.

Appendix Table A-1 Network with Osaka

	1		2		3		4	
	Network Osaka growth		Network GOsaka growth		Network Osaka growth		Network GOsaka growth	
		std dev		std dev		std dev		std dev
Cluster	0.057283	0.027381 ***	0.068381	0.028121 ***	-0.08638	0.106646	0.1290207	0.19437
Network	-0.00523	0.00011 ***	-0.00936	0.000129 ***	-0.0051393	4.37E-05 ***	-0.0092758	4.42E-05 ***
Network Osaka	-0.24031	0.000422 ***			-0.2401106	0.000184 ***		
Network GOsaka			-0.23014	0.000347 ***			-0.2300439	0.000239 ***
Network*CLST					-0.0243406	0.018208	-0.0323904	0.025824
Network Osaka*CLST					-0.0205285	0.026773		
Network GOsaka*CLST							0.0011642	0.015789
Emp	0.003578	8.62E-05 ***	0.005152	0.000103 ***	0.003587	5.29E-05 ***	0.0051896	6.66E-05 ***
Sales	0.014675	7.78E-05 ***	0.018112	0.000105 ***	0.0146412	4.51E-05 ***	0.0181316	5.27E-05 ***
Age	-0.00413	0.000132 ***	-0.0056	0.000171 ***	-0.0042655	0.000109 ***	-0.0056441	0.000146 ***
Emp*Cluster					-0.0059988	0.013275	-0.0109676	0.017758
Sales*Cluster					0.0072865	0.011769	-0.0010739	0.015039
Age*Cluster					0.0374115	0.030235	0.0190884	0.037726
# Observations	312,840		312,840		312,840		312,840	
F	446.45		469.62		446.45		469.62	
R-sq	0.1126		0.1093		0.1126		0.1093	

Notes) See notes to Table 5.

Table A2: Spillover effect (transaction with cluster firms)

	1		2		3		4	
	Network growth		Network Tokyo growth		Network GTokyo growth		Network Local growth	
		std dev		std dev		std dev		std dev
Cluster_connect	0.013055	0.005607 **	0.012085	0.006038 **	0.005521	0.006077	0.015706	0.006734 **
Network	−0.36497	0.001593 ***	−0.00927	0.001524 ***	−0.00565	0.001589 ***	−0.05906	0.002328 ***
Network Tokyo			−0.23033	0.001524 ***				
Network GTokyo					−0.23146	0.001539 ***		
Network Local							−0.2652	0.001984 ***
Emp	0.021448	0.00122 ***	0.010212	0.001158 ***	0.014281	0.001193 ***	0.01884	0.001393 ***
Sales	0.074565	0.001045 ***	0.050793	0.000983 ***	0.051142	0.001014 ***	0.04402	0.001177 ***
Age	−0.00221	0.001721	−0.01381	0.001668 ***	−0.01419	0.001709 ***	0.018749	0.001984 ***
# Observations	311,642		311,642		311,642		314,223	
F	1414.67		659.57		662.35		1020.69	
R-sq	0.226		0.1167		0.1238		0.1731	

Notes) "Cluster_connect" is the dummy, taking one if the firm has transaction with a cluster firm at 2006, and zero otherwise. All non-cluster firms are covered. See notes to Table 5.

	5			6		
	Emp growth			Sales growth		
		std dev			std dev	
Cluster_connect	0.04782	0.006581	***	0.061447	0.00764	***
Network	−0.00629	0.001605	***	0.028342	0.002078	***
Emp	−0.21443	0.001884	***	0.140411	0.002546	***
Sales	0.140583	0.001487	***	−0.09736	0.002416	***
Age	−0.07428	0.002137	***	−0.16067	0.002777	***
# Observations		313,433			311,994	
F		398.03			140.67	
R-sq		0.0999			0.0558	

Table A3: Spillover effect (number of cluster firms in transactions)

	1		2		3		4	
	Network growth		Network Tokyo growth		Network GTokyo growth		Network Local growth	
		std dev		std dev		std dev		std dev
# Cluster Firms	0.04515	0.01194 ***	0.034058	0.012885 ***	0.03672	0.012976 ***	0.038901	0.014518 ***
Distance to Cluster	0.005884	0.003618 *	0.005772	0.003934	0.007178	0.003977 *	−0.00938	0.004534 **
Network	−0.35897	0.015781 ***	−0.03649	0.015586 **	−0.03674	0.016024 **	−0.09018	0.019172 ***
Network Tokyo			−0.21051	0.011781 ***				
Network GTokyo					−0.21113	0.012197 ***		
Network Local							−0.23837	0.014373 ***
Emp	0.032176	0.009877 ***	0.035653	0.010397 ***	0.041753	0.010521 ***	0.024145	0.011647 **
Sales	0.018227	0.00848 **	0.024265	0.008867 ***	0.020073	0.008986 **	0.000383	0.009688
Age	0.02573	0.015278 *	0.035167	0.016151 **	0.028648	0.016068 *	0.018994	0.01811
Nob	5,468		5,468		5,468		5,483	
F	16.11		12.58		12.22		15.57	
R-sq	0.2632		0.1276		0.1361		0.1777	

Notes) "# Cluster Firms" is the number of cluster firms having transactions with the firm.
"Distance to Cluster" measures the average distance to cluster firms. Both are in logarithm.
We include non-cluster firms which are outside of core regions and had transactions with cluster firms at 2006. See notes to Table 5.

	5			6		
	Emp growth			Sales growth		
		std dev			std dev	
# Cluster Firms	0.018847	0.011394	*	0.005077	0.014025	
Distance to Cluster	−0.00372	0.004137		0.007297	0.004723	
Network	0.001498	0.011385		0.00152	0.015901	
Emp	−0.11354	0.013403	***	0.151006	0.028288	***
Sales	0.090772	0.011094	***	−0.10183	0.02661	***
Age	−0.04735	0.017761	***	−0.04323	0.02257	*
Nob		5,475			5,422	
F		3.41			2.7	
R-sq		0.1914			0.1658	

Table A4: 1st-stage regression results for IV (Intelligent Location)

	1		2		3a		3b	
Dependent variables	Cluster		Cluster		Cluster		Cluster*Network	
		std dev		std dev		std dev		std dev
Intelligent Location (IL)	0.001216	0.000112 ***	0.001217	0.000112 ***	−0.00166	0.000263 ***	−0.00477	0.00068 ***
IL*Emp					0.001287	0.00015 ***	0.003442	0.000394 ***
Networks	0.003052	0.000206 ***	0.001582	0.000198 ***	0.003058	0.000207 ***	0.010577	0.000517 ***
NetworkTokyo			0.0035	0.000257 ***				
Emp	0.003566	0.000176 ***	0.003585	0.000177 ***	0.002589	0.000193 ***	0.005411	0.000457 ***
Sales	−0.00016	0.000126	−0.0005	0.000129 ***	−0.00022	0.000125 *	−0.00025	0.000295
Age	−0.00124	0.00025 ***	−0.00144	0.000252 ***	−0.00126	0.00025 ***	−0.00242	0.000564 ***
R-sq	0.0109		0.0118		0.0117		0.0133	
F	118.2		118.6		59.39		59.24	

	4a		4b	
Dependent variables	Cluster		Cluster*NetworkTokyo	
		std dev		std dev
Intelligent Location (IL)	−0.00167	0.000262 ***	−0.00267	0.000425 ***
IL*Emp	0.00129	0.00015 ***	0.001772	0.000245 ***
Networks	0.001585	0.000198 ***	0.001787	0.000213 ***
NetworkTokyo	0.003508	0.000257 ***	0.009578	0.000441 ***
Emp	0.002605	0.000193 ***	0.002985	0.000285 ***
Sales	−0.00056	0.000128 ***	−0.00065	0.000177 ***
R-sq	0.0126		0.0124	
F	59.61		35.56	

Notes) The dependent variable is shown in the top row. Constant term is included but omitted from the table. 312,840 firms are covered in all cases.

Table A5: 1st-stage regression results for IV (Technopolis)

	1		2		3a		3b	
Dependent variables	Cluster		Cluster		Cluster		Cluster*Network	
		std dev		std dev		std dev		std dev
Techno	0.001216	0.0001118 ***	0.000459	0.0000456 ***	−0.000043	0.0000675	−0.00057	0.000154 ***
Techno*Emp	0.000461	0.0000456			0.0002291	0.0000506 ***	0.000748	0.000115 ***
Networks	0.003049	0.0001394 ***	0.001581	0.0000332 ***	0.0030484	0.0001394 ***	0.010554	0.000485 ***
NetworkTokyo			0.003496	0.0003296 ***				
Emp	0.0036	0.0001891 ***	0.003619	0.0001905 ***	0.0034388	0.0002203 ***	0.007581	0.00046 ***
Sales	−0.00017	0.0000459 ***	−0.00051	0.0000246 ***	−0.000174	0.0000462 ***	−0.00014	0.0001
Age	−0.00125	0.0002757 ***	−0.00145	0.0002929 ***	−0.001255	0.0002752 ***	−0.0024	0.000505 ***
R-sq	0.0105		0.0114		0.0105		0.0119	
F	152.13		127.6		128.27		123.51	

	4a		4b	
Dependent variables	Cluster		Cluster*NetworkTokyo	
		std dev		std dev
Techno	−4.3E−05	0.0000673	−0.00041	0.0001203 ***
Techno*Emp	0.000228	0.0000505 ***	0.000455	0.0000834 ***
Networks	0.001581	0.0000331 ***	0.001775	0.0000433 ***
NetworkTokyo	0.003496	0.0003297 ***	0.009562	0.000716 ***
Emp	0.003458	0.0002217 ***	0.004047	0.0003362 ***
Sales	−0.00051	0.0000247 ***	−0.00059	0.0000427 ***
Age	−0.00145	0.0002924	−0.00174	0.0003599 ***
R-sq	0.0114		0.0141	
F	110.57		88	

Notes) The dependent variable is shown in the top row. Constant term is included but omitted from the table. 312,840 firms are covered in all cases.