KEIO/KYOTO JOINT
GLOBAL CENTER OF EXCELLENCE PROGRAM
Raising Market Quality-Integrated Design of “Market Infrastructure”

KEIO/KYOTO GLOBAL COE DISCUSSION PAPER SERIES

DP2011-011

Industrial relocation policy, productivity and heterogeneous plants: Evidence from Japan

Toshihiro Okubo*
Eiichi Tomiura**

Abstract

Do regional policies for promoting periphery development attract high- or low-productivity firms? Though whether policies improve the core-periphery productivity gap hinges on this question, no consensus is found in theoretical models. This paper uses plant-level data covering all regions in Japan during the period of active relocation policies. Our estimation results from plant-level regressions and propensity-score matching show that the average productivity of plants is significantly low in regions targeted by relocation policy programs. By comparing productivity distributions across plants before and after the start of each policy program, we find that low-productivity plants are attracted to targeted regions.

*Toshihiro Okubo
Faculty of Economics, Keio University
**Eiichi Tomiura
Department of Economics, Yokohama National University

KEIO/KYOTO JOINT GLOBAL COE PROGRAM

Raising Market Quality-Integrated Design of “Market Infrastructure”

Graduate School of Economics and Graduate School of Business and Commerce,
Keio University
2-15-45 Mita, Minato-ku, Tokyo 108-8345, Japan

Institute of Economic Research,
Kyoto University
Yoshida-honmachi, Sakyo-ku, Kyoto 606-8501, Japan

Industrial relocation policy, productivity and heterogeneous plants: Evidence from Japan

Revised: September 2, 2011

Toshihiro Okubo* and Eiichi Tomiura**

Abstract

Do regional policies for promoting periphery development attract high- or low-productivity firms? Though whether policies improve the core-periphery productivity gap hinges on this question, no consensus is found in theoretical models. This paper uses plant-level data covering all regions in Japan during the period of active relocation policies. Our estimation results from plant-level regressions and propensity-score matching show that the average productivity of plants is significantly low in regions targeted by relocation policy programs. By comparing productivity distributions across plants before and after the start of each policy program, we find that low-productivity plants are attracted to targeted regions.

JEL classifications: R12; R58; H32

Keywords: industrial relocation policy; subsidy; productivity; plant-level data

* Corresponding author: Faculty of Economics, Keio University, 2-15-45 Mita, Minato, Tokyo.
E-mail: okubo@econ.keio.ac.jp; Phone: +81-3-5418-6589.
** Department of Economics, Yokohama National University.

1. Introduction

Uneven development of regions within a country has been a serious social concern. To alleviate this problem, governments often adopt policies that promote the relocation of firms from industrial centers to undeveloped areas. The effect of industrial relocation policy, however, remains largely unknown, especially its implications to intra-country productivity gaps across regions. Are regional policy programs successful in attracting productive plants to peripheral regions? This paper investigates this issue by exploiting plant-level data derived from manufacturing censuses during the period of active relocation policies in Japan.

In a new economic geography (NEG) model with firm heterogeneity, Baldwin and Okubo (2006) show that relocation subsidies for increasing the share of industry in peripheral regions "attract the least productive firms since they have the lowest opportunity cost of leaving the agglomerated region" (p.2). If this prediction is true, regional policies unintentionally widen the productivity gap between core and periphery.[1] On the other hand, Okubo (2011) proves that anti-agglomeration subsidy attracts productive firms to periphery as their profitability gains are relatively large. As no consensus view has been derived from theoretical models, we need empirical evidence on this important issue.

The Japanese industrial relocation policy can be regarded as a rare and suitable case for testing the theoretical predictions. First, Japan has accumulated experience in many regional policy programs, and has maintained rich regional data sets at the plant level. As discussed in the next section, the Japanese government actively tried to relocate plants from crowded industrial centers to peripheral regions particularly in the 1970s and 1980s. This makes Japan a good case to investigate regional policy impacts. In addition, the Japanese government has been consistently collecting comprehensive information on all manufacturing plants across all

[1] The productivity gap is not always widened, but widened when plant productivities in core and in periphery are substantially overlapped as in the Japanese case examined in this paper.

regions of the country. By making use of plant-level data derived from consecutive waves of manufacturing censuses, we can empirically measure the effects of policies in Japan. Second, Japan is *not* a federated country; instead, regional and local administrative units possess only limited fiscal and judicial autonomy. This institutional fact implies that we can safely study the effects of relocation policy on plants in the country by investigating the programs undertaken by the national government alone. In other developed countries, various layers of public authority (e.g., state and federal governments in the U.S.A., and the nations and the European Commission of Europe) undertake their respective regional policies.

While the list of global policy experiences over time is long, the impact of regional policy remains a vital issue in many countries. The EU Structural Funds have been intended to facilitate the relocation of industries to peripheral countries in the last decade. More generally, the recent issue of the World Bank's influential *World Development Report* (2009), titled "Reshaping Economic Geography," argues that the side effects of regional development policy are becoming more serious in the age of globalization. When a country becomes more open to international trade "without changing the level of permissible subsidies to firms in remote regions, the subsidies will lead to an increasing distortion of the spatial allocation for industry" (Baldwin et al., 2003, p. 478). In this sense, while we examine the case of Japan during 1978-90, this investigation of a traditional relocation policy has far broader significance for our age.

The main results of our study are as follows. The regional policy programs attract plants to targeted regions. However, plants located in these regions on average have below-average productivity. By using a matching technique to select comparable plants from non-targeted regions, we confirm the results from plant-level regressions. By comparing plant productivity distributions before and after the start of each program, we find that the regional policies appear to attract low-productivity plants.

The remainder of this paper is divided as follows. Section 2 briefly reviews related literature. Section 3 offers a brief overview of the history of relocation policies in Japan. Section 4 describes the plant-level data acquired for our study. Section 5 explains our empirical methods and reports the estimation results. Section 6 presents the conclusions.

2. Literature review

This section briefly reviews related literature on the effect of relocation policy, especially focusing on its effect on productivity gaps of firms/plants between core and periphery. By applying firm heterogeneity trade model to economic geography, Baldwin and Okubo (2006) theoretically show that relocation subsidies end up with more low-productivity firms attracted to periphery because productive firms have higher opportunity cost of leaving the agglomeration. This prediction challenges the orthodox presumption in regional policy, since relocation subsidy unintentionally widens the core-periphery productivity gap.

The conclusion is, however, sensitive to the assumption. Baldwin and Okubo (2006) consider a specific subsidy for per-relocation (fixed amount of subsidy for each firm), while Okubo (2011) assumes that a subsidy is proportional to firm's profit. In the latter case, the first firms to respond to a relocation subsidy are the most profitable firms. As a result, the impact of relocation subsidy on core-periphery productivity differentials sharply differs between these two models.[2] The conclusion on productivity gap, however, does not solely depend on the assumption on subsidy scheme. For example, Dupont and Martin (2006) theoretically show that subsidies to poor regions proportional to firms' profits financed by national taxes *increase* cross-regional income inequality within a country. Their argument rests on the observation that

[2] The same issue is reflected in theoretical literature on tax competition/harmonization. Baldwin and Krugman (2004) assume the proportional tax and show that the core region can keep high tax rate without losing its agglomeration, while Egger and Falkinger (2006) consider a subsidy for a firm's fixed costs and prove the over-provision of subsidies as in tax competition.

the effect of subsidy spills over to rich regions, where many owners of capital (beneficiary of subsidized profits) reside. Consequently, we need to explore empirical evidence since theoretical predictions are sensitive to assumptions on various aspects of policy schemes.

Empirical studies have also been accumulated. Mohl and Hagen (2010) summarize studies on the impact of EU structural funds on economic growth and convergence, but their results are mixed.[3] For policies carried out in individual country, Devereux et al. (2007) find that U.K. regional assistance grants have stronger impacts on firms' locations in areas which have already attracted economic activities due to co-location benefits. Bondonio and Greenbaum (2007) discover that U.S. enterprise zones attract low-paying and low-skilled workers. Martin et al. (2011) find that French industrial cluster policy has no major effect on productivity of firms. Bernini and Pellegrini (2011) detect productivity decline in Italian subsidized firms. None of these empirical studies, however, have examined distributional changes of productivity across plants/firms as current heterogeneous-firm NEG models on relocation subsidies theoretically uncover (Baldwin and Okubo, 2006 and Okubo, 2011).

3. Overview of the relocation policy in Japan

This section, a historical summary of Japan's industrial relocation policy after World War II, is not presented as a comprehensive history but as a brief and sketchy background explanation for our estimations. It centers on the policy experience of Japan during the 1970s and 1980s, which provides us with a valuable opportunity to test the theoretical predictions.

During the decades of high economic growth and adaptation to oil price hikes, the 1960-80s, the Japanese government was involved in a series of active initiatives designed to

[3] Midelfart-Knarvik and Overman (2002) find that Ireland is the only successful case in attracting R&D intensive sectors. Boldrin and Canova (2001) and Dall'erba and Gallo (2007) find no positive impacts of EU regional policies on productivity and economic growth.

encourage the relocation of firms from heaving manufacturing centers to undeveloped periphery regions. While it gradually shrank during the high economic growth of the 1960s and early 1970s, the wide income gap between the core (the Pacific Industrial Belt, especially Tokyo and Osaka) and the periphery remained one of the top priorities in the economic policy package. Social concerns, such as air pollution, commuting congestion, and soaring housing prices in core regions, promoted public supports for nationwide industrial repositioning. The government's long-term regional policy plan emphasized "balanced development" across regions. As Japan is not a federated nation, the central national government has a strong authority in many policy arenas, including regional development policy. Under the leadership of the central government, transport infrastructures, such as highways and railroads, have been developed to facilitate the relocation from high-density central regions. The industrial relocation programs considered in this paper are among these grand strategy packages.

Figure 1 shows the Gini coefficients of two-digit manufacturing sectors for 47 prefectures from the 1970s.[4] Cross-regional variations are measured in terms of the number of plants, employees, and value added. All three Gini coefficients decline over time. In particular, the Gini coefficients in plants and employees steadily decline until the mid-1990s. This indicates that manufacturing became geographically dispersed across Japanese regions because of such factors as improved highway networks as well as regional development policies.

(Figure 1)

In this paper, we investigate the following two regional development policy initiatives: Technopolis and Intelligent Locations. First, we examine the program Technopolis, started in 1983 and designed to form high-technology industrial complexes (e.g., machinery sectors). During the 1960s, Japan encouraged heavy industries, including petrochemicals, which

[4] The data are from METI's published *Manufacturing Census Report by Industries* for each year.

depended on cheap imported oil. However, the national government, after the oil price hikes in the 1970s, tried to shift the country's industrial configuration from heavy to high-technology industries. The Technopolis plan was expected to play a pivotal role in transforming the countrywide industrial structure, while, at the same time, encouraging more balanced growth across regions through the establishment of new industry complexes in undeveloped areas. As products in high-tech industries, typically electronics, are less costly to transport, the locations of manufacturing plants were dispersed away from congested Pacific coast core regions.

We must note that this regional policy initiative was *not* intended to promote economic development of the *least* developed peripheral regions. Technopolis regions were selected from peripheral regions with rich potentials for development, which can be realized by policy supports.[5] The selected regions needed to already have at least certain level of manufacturing activities and a local university with an engineering department[6], and originally expected to be located within one-day trip distance from the three economic centers (Tokyo, Osaka, and Aichi) in Japan.[7] The selection of these regions with rich potentials was based on the view that relocation policy would be ineffective in extremely undeveloped regions.[8] This program was not intended to increase average per-capita income in all rural regions but to foster new industrial clusters.[9]

As the second regional policy program, we examine Intelligent Location (*zuno ritti* in Japanese), started in 1988.[10] This program was designed as a follow-up on the preceding Technopolis project in strengthening the promotion of high-tech manufacturing (machinery in

5 The main policy supports were tax incentives. No direct subsidy was provided.
6 Each Technopolis was also required to have its "metropolis" with 200-300 thousand residents.
7 In later years, regions outside of this distance were additionally included into the program.
8 Devereux et al. (2007) confirm that regional assistance grants are more effective in regions with more existing economic activities among assisted area in the U.K.
9 Regional policies in other countries are carried out for different objectives (e.g. the four Structural Funds and the Cohesion Fund to fight against unemployment and stimulate economic growth in the poor regions in member countries and to support the transition of Eastern Europe into the EU).
10 This English name is translated by the authors and thus not officially authorized.

the industrial classification). While Technopolis directly focused on high-tech manufacturing itself, Intelligent Location was intended to promote industrial activities supporting high-tech manufacturing, such as software and information services. Among 26 regions already supported by Technopolis, 15 regions were also targeted by Intelligent Location program (Figure 2). As a result, both programs were designed to relocate manufacturing plants away from congested cores and to develop new high-tech manufacturing clusters during the period of industrial structure transition to high-tech manufacturing more dispersedly located across regions.

(Figure 2)

As we examine these two policies, both mandated by national law, the targeted regions are explicitly defined by public ordinance documents. Whether or not the region is selected by each policy is identified at the most basic geographical unit (village, town, or city). Any region in Japan belongs to one village, town, or city exclusively. No more meticulous official geographical unit exists in the Japanese system. While most of the previous studies depend on broader prefecture or state-level data, our identification of target regions at the city/town/village level is more complete and precise.

4. Description of plant-level data

This section describes the data used in our study. We derive plant-level data from Japan's *Census of Manufacturers*. Basic plant characteristics, such as output (shipment), employment (number of regular workers), and expenditures on materials, are included in this census for virtually all plants across all manufacturing industries.

4.1. Coverage of plants

Although the annual survey covers plants above the given size threshold, small-sized plants are only included in the "census years" (year with 0, 3, 5, or 8 as its last digit). We concentrate on the census years to avoid truncations due to the sampling of plants. Plant-level data are maintained only for the plants with no less than four employees in the original micro-data files of the central government, even for the most recent census. Since plants employing less than four employees produce negligible volumes of output, their omission is unlikely to affect our conclusion on economic geography.

Among the available plant-level data, this paper focuses on plants owned by multi-plant firms.[11] We look at multi-plant firms because they are likely to relocate their plants more responsively to variations in the government's subsidy. By focusing on these relatively "footloose" plants, this paper sheds light on the possible effects of the relocation policy on plant productivity. Our sample of plants owned by multi-plant firms includes 48 thousand plants in 1978 and then steadily grows to 66 thousand by 1990, as shown in Appendix Table.

4.2. Sample period

Our sample period consists of the following six consecutive census years: 1978, 1980, 1983, 1985, 1988, and 1990. We selected these years for the following reasons. First, as mentioned in Section 3, the 1970s and 1980s were the heyday of Japan's active relocation policies. From the 1990s onwards, the policy objective has changed as Japanese economy becomes matured and globalized. Among various changes, the focus of Japanese regional initiatives shifted from manufacturing to non-manufacturing activities. Although this shift naturally reflected changing shares in the national economy, the government's efforts on

[11] The census captures whether or not each plant is a part of a multi-plant firm, although no identifier is available for linking plants under the same ownership. Hence, the aggregation of our plant-level data to the firm level is impossible.

gathering data on non-manufacturing (service) sectors are generally insufficient when compared to the extensive censuses carried out on the manufacturing sector. Public support programs have also begun to concentrate more on functions, such as R&D, rather than on specific geographical locations. Furthermore, greater emphasis was placed on strengthening the roles of Tokyo as a global financial center, especially during the Bubble boom period around 1990. After the bubble burst, public construction projects were actively financed in rural areas as part of macroeconomic stimulus during the 1990s but without the policy objective of industrial relocation. Consequently, to avoid these various contaminations in recent years, we focus on the pre-1990 period when policy programs for relocating manufacturing plants from crowded core areas to undeveloped periphery areas were actively undertaken.[12]

Second, the 1970s and 1980s are suitable periods to measure the impact of regional policy on firm relocation across Japan. From the 1990s onward, unprecedented exchange rate appreciation led factories to relocate to low-wage Asian countries through foreign direct investment. More recently, production processes and firm organization have become much more complex. Many Japanese firms build production networks linked to domestic and overseas production by intermediate input purchase, foreign direct investment, and outsourcing. Since complete data sets covering location information of oversea affiliates are not available, we cannot appropriately examine regional policies in such a globalized era. To circumvent the statistical difficulties that arise from the complexity of firm organization and oversea production/relocation, we focus on the 1970s and 1980s.

[12] Technopolis and Intelligent Location programs were officially terminated by the abolition of the special laws by the parliament in 1999.

Finally, within this sample period, we can investigate the impacts of Technopolis and Intelligent Locations, the former started in 1983 and the latter in 1988. The productivity of plants before and after the start of each program will be clearly compared within 1978-90.[13]

(Table 1)

During this period, the regions targeted by policies actually attracted plants. The number of plants located in targeted regions increased substantially (from 3,423 plants in 1985 to 6,210 plants in 1988 for Technopolis, and from 536 plants in 1988 to 6,159 in 1990 for Intelligent Locations, as shown in Table 1). As this growth in the targeted regions is higher than the national average, the share of target regions in Japan rose during the sample period (from six to ten percent in Technopolis and from 0.9 to nine percent in Intelligent Locations). However, the mere rise in the number and share of plants does not imply the success of these relocation policies. Thus, our next question is whether targeted regions can successfully attract productive plants or not. We will examine their impacts on productivity, especially at the plant level.

As no plant identifier tracing micro-data over time is available, our data set is unfortunately in the format of repeated cross-sections. As a result, we cannot discuss causality direction or dynamic effects on entry/exit or on productivity growth. In addition, without any longitudinal identifier, we cannot estimate the total factor productivity of each firm. Furthermore, previous research in related fields shows that the choice of productivity measure is unlikely to affect results.[14] Therefore, we measure productivity by value added per worker.

5. Empirical results

13 Although several other regional policies had been undertaken prior to these two programs, plant-level data before the mid-1970s are not maintained even in the original government data files.

14 For example, Bernard and Jones (1996) report that the difference between TFP and labor productivity is relatively small when countries are compared. Syverson (2004) also confirms that his result from TFP on the plant-level relation between productivity and spatial competition is robust even if labor productivity is used.

This section explains the empirical methods used to estimate the impact of relocation policies on plant productivity, and report our results. We take three different approaches. First, we estimate the regressions with the policy dummy variable. Second, we select comparable plants on the basis of the propensity score matching method. Finally, we compare productivity distributions of plants across regions and years.

5.1. Policy premium

In the first approach, to estimate the policy premium on plant productivity, we consider the following plant-level reduced-form regression:

$$DPROD_j = const + \alpha_1 SIZE_j + \alpha_2 MAT_j + \alpha_3 LABOR_j + \beta \cdot POLICY + \gamma \cdot IND + \varepsilon_j \,. \qquad (1)$$

The plant is indexed by *j*. As no longitudinal plant identifier linking plants over time is available, all the regressions are in a cross-sectional format. The dependent variable is the relative productivity *DPROD*, which is defined by the value added per worker[15] in terms of the deviation from the 4-digit industry mean. In all the analyses in this paper (propensity score matching and distribution comparisons as well), we consistently choose this definition of productivity. Included on the right-hand side of the regression are plant characteristics and the relocation policy dummy (*POLICY)*, along with a vector of industry dummies (*IND)*.[16] Plant-level variables included in (1) are the plant size *SIZE* (the number of regular workers), the intensity of material used *MAT* (expenditures on materials divided by output, both in yen), and the labor intensity *LABOR* (labor inputs [total wage paid] divided by output, both in yen). All variables are in logarithmic form.[17] These three plant characteristics are included because

15 The denominator is the number of regular employees. The numerator is output (shipment) minus the consumption tax, depreciation, and raw material costs.
16 Region dummy is not included as the policy we analyze is region-specific.
17 For *MAT* and *LABOR*, the value of one is added before taking logarithm.

productivity is strongly linked with plant size and the productivity measure used in this paper (labor productivity) is inevitably affected by factor input intensity. Plant-level data on capital (tangible fixed assets), however, are unavailable for small-sized plants, which occupy an overwhelming share in our census data.[18] Industry dummies are defined at the 2-digit level. The error term is expressed by ε in (1). *POLICY* takes the value of one when the plant is located in the region (city, town, or village) targeted by Technopolis or Intelligent Locations.[19] If the coefficient on the policy dummy is negative, the plants located in the regions targeted by the policy are*, on average*, less productive than those located in other regions after controlling for plant characteristics and industry effects. We must note, however, that we should not interpret equation (1) as indicating the direction of causality.

The OLS regression results are reported in Table 2a. We estimate cross-sectional regressions for all years in our sample period irrespective of the starting period of each policy, with the policy dummy variable consistently taking the value of one for the targeted regions. The results shown in Table 2a demonstrate that the plants located in the regions targeted by the policy tend to have significantly lower productivity compared with plants located in regions not promoted by the policy, even after plant and industry characteristics are controlled for.

(Table 2a)

As a robustness check, we further introduce an alternative definition of a targeted region. In the above regressions, we have defined targeted regions as those targeted consistently through the sample period since the start of the policy program. We now alternatively define them as the regions targeted at each year (not necessarily targeted in other years). The former definition concentrates on the narrower groups of regions common across years, but the latter

18 We have confirmed that our principal results are qualitatively unaffected even if capital-labor ratio is included, but the sample size is severely reduced.

19 The policy dummy is time-invariant. We will discuss an alternative time-dependent definition.

definition includes newly targeted regions in regressions on later years. The estimation results based on this alternative definition are shown in Table 2b. The regressions based on the latter definition are naturally limited to the years after the start of each policy program, though the regression based on the former can be estimated in any year during the sample period, as shown in the previous table. In both programs, the productivity of plants in the targeted regions after the initiation of each policy program is, on average, significantly lower in all the years except only at the first year in Intelligent Location program. Thus, this additional regression result basically confirms our principal conclusion.

(Table 2b)

5.2. Matching technique (treatment effect)

While the regression discussed above is straightforward, we also employ the matching technique to select a pair of comparable plants from our sample. The matching technique has been used in previous studies in this context, including Martin et al. (2011) on French regional clusters and Bernini and Pellegrini (2011) on Italian subsidy. The aims for our use of matching technique are two-fold.

First, we must note that the number of plants located within the targeted regions is severely limited. As previously shown in Table 1, merely around 5 -10 % of the plants in our sample are located in Technopolis regions. This implies that the policy premium estimated from the regression is based on the comparison of limited numbers of plants located in the narrowly targeted regions with far larger numbers of much more heterogeneous plants in wide non-targeted regions. While the theoretical models often consider two regions in a country, regions in the real world are actually tremendously heterogeneous in many dimensions. The matching technique leads us to concentrate, among many plants located in non-targeted regions, on plants relatively similar with those in targeted regions.

Second, plants located in targeted regions and those in non-targeted regions may differ due to factors unobservable for econometricians. While theoretical models assume that regional policy is chosen based on economic conditions such as per-capita income, decisions in the real world can be affected by other factors such as political influences. To tackle this potential bias, the matching technique helps us compare similar plants in and outside of targeted regions.

The causal effect of the treatment is estimated as the mean difference in productivity between the treated and the untreated groups. The treated group is composed of the plants located in the targeted regions. On the other hand, the non-treated group is a set of all plants outside the target regions. The average effect of the treatment on the treated group, ATT, is given by $E(y^1 - y^0 \mid D = 1)$, where D is the policy dummy variable (D = 1 if plants are treated, and 0 otherwise). y^1 and y^0 denote treated and non-treated plant-level productivity respectively. We assume that the non-treated outcomes are independent of treatment status, conditional on observable plant characteristics $X \in (Size, Mat, Labor)$. Then, we adopt the propensity score matching as in Rosenbaum and Rubin (1983). The probability of treatment, *p(X)*, defined as the propensity score ($0 < p < 1$), given the observables is specified as $p(X) \equiv p(D = 1 \mid X)$. The propensity score is estimated by probit regression using *X*.[20] The expected difference between matched pairs is given by $E(y \mid D = 1, p(X)) - E(y|D = 0, p(X)) = E(y^1 - y^0|p(X))$. By iterated expectations, the average across the distribution of propensity scores gives $ATT = E(y^1 - y^0)$.

[20] We use caliper matching at the level of δ=0.05 and involve one-to-one matching with replacement with common support. As we impose the common support, the treated units whose propensity score is higher than the largest propensity score in the non-treated group can remain unmatched. When none of the non-treated units are within δ from treated plant *i*, the plant remains unmatched. .

Table 3 reports ATT in the matching result.[21] The values are all significantly negative for entire periods. Even after starting programs, the negative values remain unchanged. Therefore, we can conclude that both programs fail to attract significantly productive plants, as consistent with our previous regression results. This finding is also in line with the previous firm-level results from France by Martin et al. (2011) and from Italy by Bernini and Pellegrini (2011).[22]

We must note, however, that the negative value consistently observed during the sample period implies low productivity of targeted regions on average *even before* the policy. The regression results reported as Table 2a in the previous section confirm this point. Both ATT and OLS results indicate that the government appears to pick up unproductive regions for policy supports but the two regional programs fail to raise their average productivity level.

(Table 3)

To check the robustness of our results, we calculate ATT based on alternative samples. The results for 1980, 85, and 90 are displayed as Table 4 due to a limited space. First, we concentrate on the machinery sectors, which were targeted in the two policy programs. The estimates from the machinery sectors confirm our results from all sectors.

As an additional robustness check inspired by the regression discontinuity design, we also compare targeted regions and their adjacent (non-subsidized) regions to isolate the policy effect from unobservable, possibly geographic, factors common to nearby regions. While the significantly negative value reported previously is relative to non-targeted regions in all Japan, here we observe ATT mostly insignificant, suggesting that the productivity of targeted regions is not noticeably different from that in neighboring regions. This implies that the policy fails to improve the productivity of targeted regions relative to regions with similar geographic factors.

---

21 Balance tests pass in all independent variables used in the probit estimation for both policy programs. Representative test results are in the discussion paper version.

22 Although they find that firms in industrial clusters on average exhibit lower productivity, their matching result shows statistically insignificant differences among firms in and outside of clusters.

Finally, endogeneity might, however, affect the results given in Table 3. It is possible that the government intentionally subsidizes lower wage regions as a policy response to cross-regional income inequality. On the other hand, plants in high-wage sectors are likely to locate their plants in these regions to save labor costs. The low-wage regions, which are likely to be subsidized, attract high-wage sectors, but not necessarily because of the subsidy. To control for this possible bias, the treatment probability by the probit estimation now takes into account not only plant characteristics with two-digit sector dummies as in Table 3, but also the average wage in the region (city/town/village) where the plant is located and the average wage in the four-digit industry to which the plant belongs.[23] ATT based on thus revised propensity scores are also shown in Table 4. While treatment effects are smaller, most ATTs remain significantly negative. Thus, we confirm that the plants in targeted regions tend to have lower productivity.

(Table 4)

5.3. Comparisons of productivity distributions

The previous two sections have focused on the mean comparisons, but distributional information is critical in discussing regional policies. As heterogeneous firm models squarely examine productivity variations across firms within the same industry (i.e. different responses to regional policy depending on productivity of firms), we need to derive richer distributional information from our plant-level data.[24]

(Table 5)

Table 5 shows cumulative frequency distribution, which is an empirical counterpart of cumulative distribution function (CDF), of productivity across plants. The regions targeted by Technopolis or by Intelligent Location program are compared with the core regions, which are

---

[23] To save space, the probit results are omitted, but available upon request.
[24] This section is inspired by the anonymous referee's comment.

defined as the three largest industrial centers (Tokyo, Osaka, and Aichi) and surrounding prefectures.[25] The comparison with the core, rather than with all non-targeted regions in general, is motivated by the following two reasons.

First, non-targeted regions are widely heterogeneous, because the regional policy programs select relatively similar regions for promotions. Although theoretical models often consider simplified two-region setting, national economies in the real world are composed of many distinct regions. Technopolis and Intelligent Locations targeted regions not with the lowest productivity but with rich potentials for future development. As a result, non-targeted regions contain both productive regions, proximate to the core level, and extremely unproductive regions. Therefore, this paper concentrates on the comparison with core.

Second, the core regions have never been promoted by any relocation policies.[26] The alleviation of congestions in core has been a serious objective of Japanese regional policies. Some of the regions outside of the core have been targeted by policies not discussed in this paper (e.g. Industrial Relocation Subsidy since 1972). This contaminates the comparison with all non-targeted regions in identifying the impact of Technopolis and Intelligent Location.

The notable findings from Table 5 are as follows.[27] As the productivity is measured in *DPROD* (deviation from the industry's mean), negative values imply productivity levels lower than the average. The column titled as "Gap" displays CDF of core minus that of targeted regions. For the sake of brevity, the distributions are shown only for 1980, 85, and 90.

The first finding is that the productivity of plants in regions targeted by Technopolis or Intelligent Location program is densely distributed within relatively narrow ranges around the mean, while the core attracts plants at widely-ranging productivity levels. We observe not only

---

[25] Kanagawa, Chiba, Saitama, Kyoto, and Hyogo are included as "surrounding prefectures."
[26] No region in core was targeted by these two programs, explicitly prohibited by the laws.
[27] We must note that percentages in targeted regions are sensitive to individual plants, since the total number of plants located in these targeted regions is limited.

productive plants possibly due to agglomeration externality, but also unproductive plants in the core, of which the productivity levels are so low that no plants with comparable productivity are found in targeted regions. The contrast is particularly evident in earlier years. This implies that these regional policy programs appear to be designed to promote regions mostly composed of mid-productivity plants.[28] This observation is consistent with the policy objectives of the two programs explained in Section 3.

The second finding is that the difference between productivity distribution in the targeted regions and that in the cores becomes somewhat narrower in later years, as displayed in the Gap column in this table. As the distributions in the core appear stable over years, the change should be mainly driven by evolutions in targeted regions, especially by higher percentage of low-productivity plants in targeted regions. After the policy, the gap becomes negative in every productivity intervals, indicating that low-productivity firms are more likely to locate in targeted regions in the stochastic dominance sense. By the addition of these plants with widely variable productivity, the productivity distribution in targeted regions becomes closer to that in the core.

As suggested by these two findings, low-productivity plants are attracted to targeted regions after the initiation of regional policy program. Even if we strictly define the targeted regions as regions actually targeted after the policy start, as in the case of alternative definition of policy dummy in regressions, CDF gap from the core is barely altered.[29] Though we cannot trace individual plants over time in longitudinal format, this change over time between core and targeted regions appears to be consistent with the prediction by Baldwin and Okubo (2006). Although the government picked up regions overwhelmed by mid-productivity plants for policy promotion, the initiation of regional policy program appears to end up with attracting

---

28 As a related finding, Devereux et al. (2007) discover that U.K. regional assistance grants are more effective in relatively developed regions among assisted areas.

29 CDF graphs based on this alternative definition are available upon request.

low-productivity plants. While the average productivity remains lower than that in core, the distribution in targeted regions after the policy has longer tail over low-productivity ranges.

This interpretation is in line with previous results from micro data in other countries. For example, from French firm-level longitudinal data, Martin et al. (2010) find that the average productivity of firms in targeted clusters becomes significantly lower relative to non-targeted firms over time. Bondonio and Greenbaum (2007) report that plants in U.S. enterprise zones expand employment and outputs but reduce per-worker payroll, indicating that the zones attract low-skilled workers. Bernini and Pellegrini (2011) detect a productivity decline in subsidized Italian firms based on difference-in-difference matching. All these analyses, however, concentrate on the evolution of averages and include no distributional information.

By combining further our previous results from OLS and ATT with this distributional change, we can conclude that regional policy programs fail to have no significantly positive impacts on the average productivity level of plants in targeted regions but appear to have changed the productivity distribution of these plants after the programs. The average productivity, estimated both by OLS and ATT, is significantly lower in targeted regions. However, the average productivity in targeted regions is consistently low even before the policy start. Consequently, targeted regions remain relatively unproductive even after the policy initiatives. The distributional information suggests that, behind unchanged average productivity levels, plants with wider productivity ranges, especially with low-productivity, are attracted to targeted regions after the initiation of each program.

6. Concluding remarks

This paper has examined how the productivity of plants in targeted regions differs in the case of two relocation policy programs in Japan. Both programs attract firms, both in the number and the share of plants, to targeted regions. This may contribute to diversification across Japanese regions. However, low-productivity plants are attracted to targeted regions. This finding is consistent with the theoretical prediction by Baldwin and Okubo (2006). We have confirmed the robustness of these principal findings by the propensity score matching and by comparing productivity distributions before and after the initiation of each policy program.

Although we have found no significantly positive effects of relocation policy on plant productivity, this paper is not intended to deny the role of policy in shaping economic geography. The policy programs examined in this paper actually result in the location of more plants in targeted regions. Since the high unemployment rate in undeveloped regions has been a serious policy issue in many mature countries, the activated relocations of plants should not be negatively evaluated.[30] The variety of policy schemes is another issue left for future. "The reality is that besides place-based incentives, governments have far more potent instruments for integration. They can build institutions that unify all places and put in place infrastructure that connects some places to others" (World Bank, 2009, p.xxiii). Even within our sample, various policy measurers support targeted regions, not necessarily by subsidy. A more detailed analysis that distinguishes individual support schemes will enrich our results in the future.

Acknowledgement

The authors deeply acknowledge valuable comments from the Editor, two anonymous referees, and participants of seminars and conferences. This research is partly financed by Grant-in-Aid for Scientific Research and Japan's Research Institute of Economy, Trade, and Industry (RIETI). The access to official micro-data was arranged by RIETI. Officials at the Ministry of Economy,

30 On the other hand, as discussed by Midelfart-Knarvik and Overman (2002), regional policies result in attracting R&D-intensive sectors to periphery regions with less skilled labor endowments in the EU. This acts as a counter to comparative advantage. As this paper focuses on programs promoting high-tech manufacturing, we cannot deny this possibility.

Trade and Industry (METI), especially Yuji Hosoya, helped us collect historical documents on relocation policies. Views expressed in this paper are not those of RIETI or METI.

References

Baldwin, R., Forslid, R., Martin, P., Ottaviano, G., and Robert-Nicoud, F., 2003. Economic Geography and Public Policy. Princeton University Press.

Baldwin, R., and Krugman, P., 2004. Agglomeration, integration and tax harmonization.. European Economic Review 48, 1-23.

Baldwin, R., and Okubo, T., 2006. Heterogeneous firms, agglomeration and economic geography: spatial selection and sorting. Journal of Economic Geography 6, 323-346.

Bernard, A., and Jones, C., 1996. Comparing apples to oranges: productivity convergence and measurement across industries and countries. American Economic Review 86, 1216-1238.

Bernini, C. and Pellegrini, G., 2011. How are growth and productivity in private firms affected by public subsidy? Evidence from a regional policy. Regional Science and Urban Economics 41, 253-265.

Boldrin, M., and Canova, F., 2001. Inequality and spillovers in regions: Evidence from European regional policies. Economic Policy 32, 205-253.

Bondonio, D., and Greenbaum, R., 2007. Do local tax incentives affect economic growth? What mean impacts miss in the analysis of enterprise zone policies. Regional Science and Urban Economics 37, 121-136.

Dall'erba, S and Gallo, J.L., 2008. Regional convergence and the impact of European structural fund over 1989–1999: A spatial econometric analysis. Papers in Regional Science 87, 219-244.

Devereux, M., Griffith, R., and Simpson, H., 2007. Firm location decisions, regional grants and agglomeration externalities. Journal of Public Economics 91, 413-435.

Dupont, V., and Martin, P., 2006. Subsidies to poor regions and inequalities: Some unpleasant arithmetic. Journal of Economic Geography 6, 223-240.

Egger, H., and Falkinger, J., 2006. The role of public infrastructure and subsidies for firm location and international outsourcing. European Economic Review 50, 1993-2015.

Fujita, M., and Tabuchi, T., 1997. Regional growth in postwar Japan. Regional Science and Urban Economics 27, 643-670.

Martin, P., Mayer, T., and Mayneris, F., 2011. Public support to clusters: A firm level study of French "Local Productive Systems". Regional Science and Urban Economics 41, 108-123.

Midelfart-Knarvik, K.H., and Overman, H., 2002 Delocation and European integration. Economic Policy 17, 322-359.

Mohl, P., and Hagen, T., 2010. Do EU structural funds promote regional growth? New evidence from various panel data. Regional Science and Urban Economics 40, 353-365.

Okubo, T., 2011. Antiagglomeration subsidies with heterogeneous firms. Journal of Regional Science, forthcoming.

Rosenbaum, P., and Rubin, D., 1983. The central role of the propensity score in observational studies of causal effects. Biometrika 70 (1), 41-55.

Syverson, C., 2004. Market structure and productivity: A concrete example. Journal of Political Economy 112, 1181-1222.

World Bank, 2009. World Development Report: Reshaping Economic Geography. World Bank, Washington D.C.

Table

Figure 1: Gini Coefficient

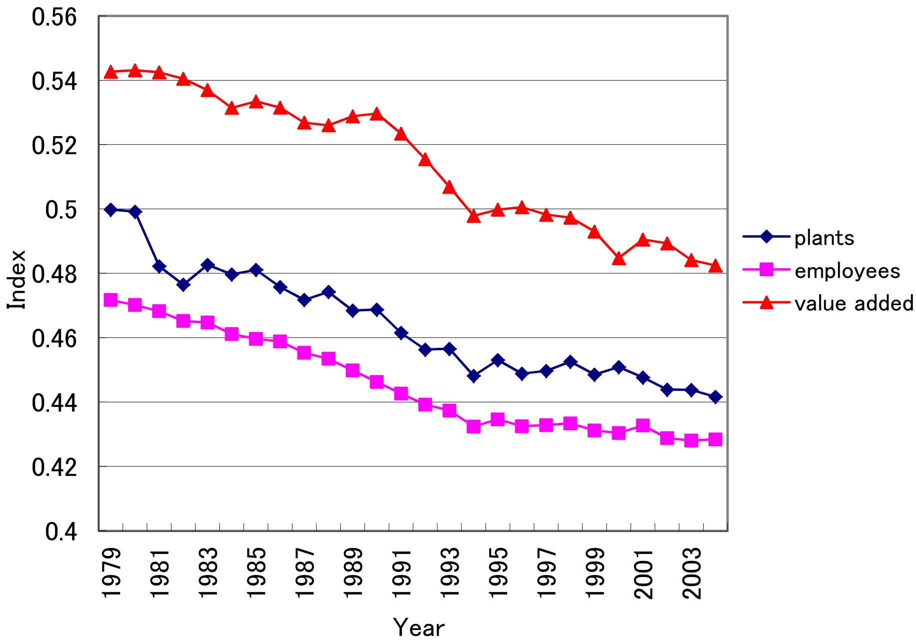
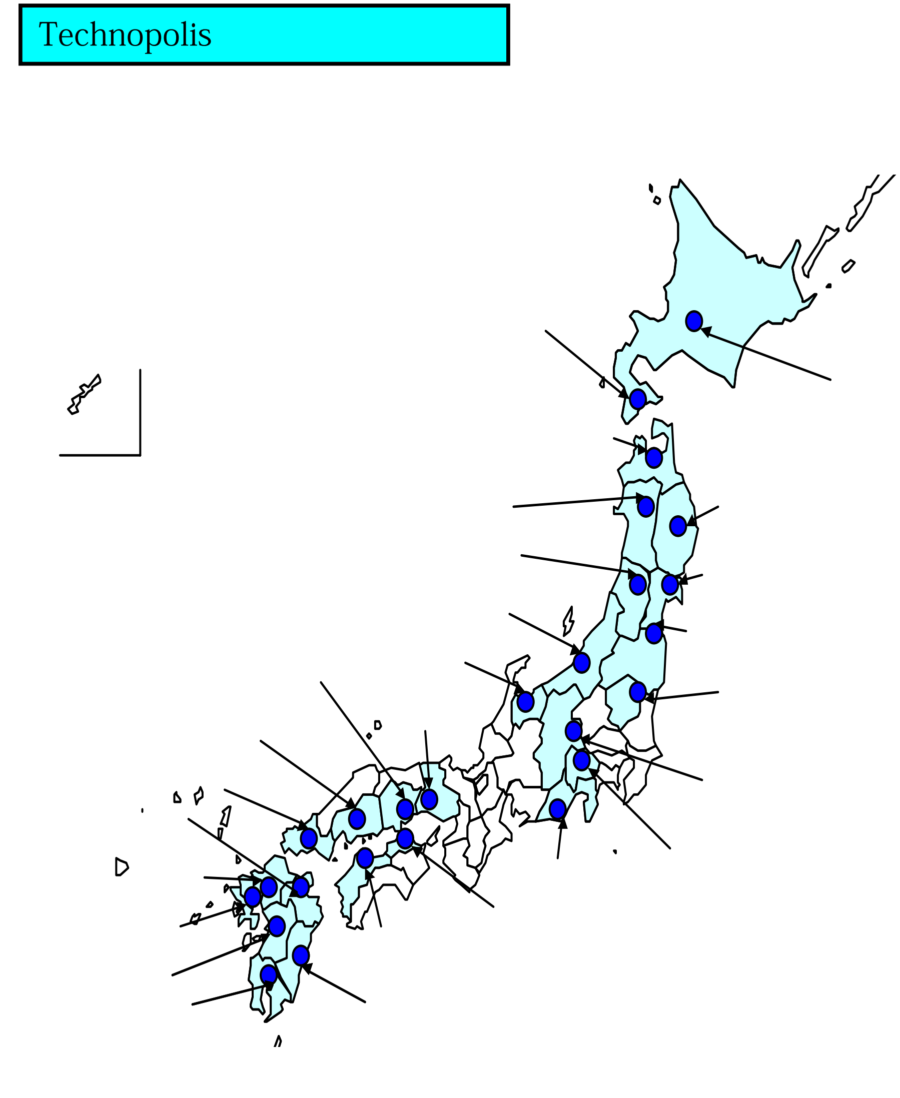


Figure 2 Locations of targeted regions



Intelligent Location

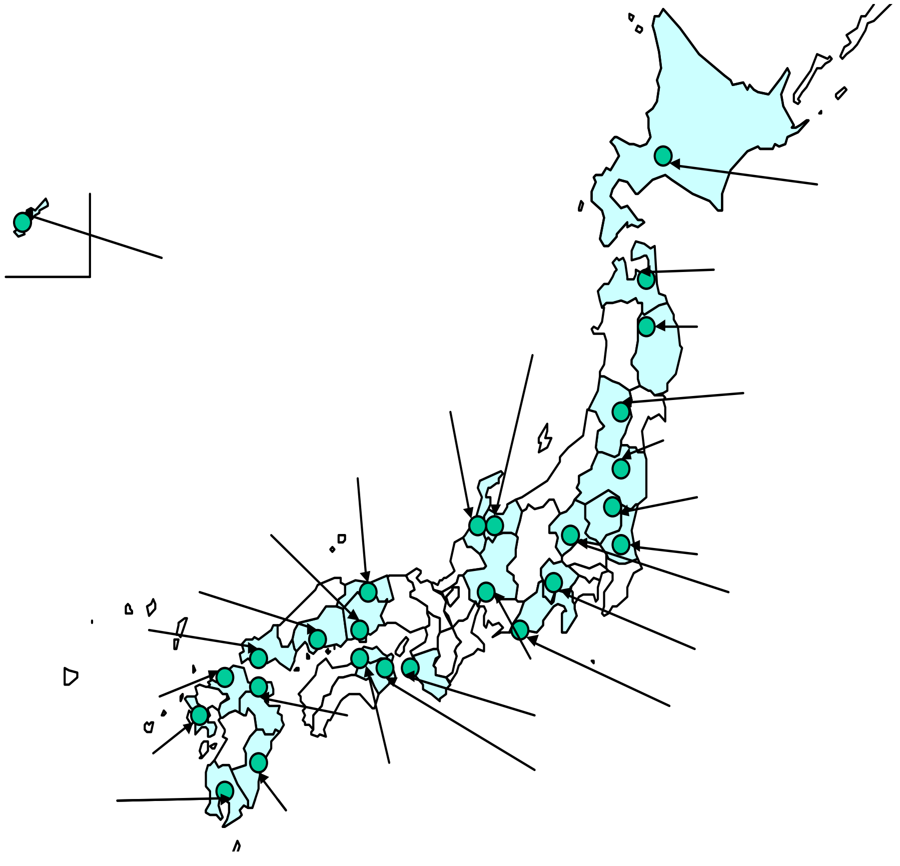


Table 1: Number of Firms in Targeted Areas

Number of plants located in the targeted areas

	1978	1980	1983	1985	1988	1990
Technopolis (targeted in respective year)				3423	6210	4053
Intelligent Location (targeted in respective year)					536	6159
Technopolis (targeted in all years)	5085	4954	5469	5938	6531	7032
Intelligent Location (targeted in all years)	7684	7787	8569	9344	10300	10947
Total Number in total Japan	48040	48559	53655	57942	61726	66093

Share of plants located in the targeted area in total Japan

				1985	1988	1990
Technopolis (targeted in respective year)				0.059076	0.100606	0.061323
Intelligent Location (targeted in respective year)					0.008684	0.093187
Technopolis (targeted in all years)	0.105849	0.10202	0.101929	0.102482	0.105806	0.106396
Intelligent Location (targeted in all years)	0.15995	0.160362	0.159706	0.161265	0.166866	0.16563

Table 2a: OLS Results 1

	1978	1980	1983	1985	1988	1990
Technopolis	−0.105	−0.081	−0.148	−0.12	−0.099	−0.114
	(−7.26)***	(−5.24)***	(−9.91)***	(−8.45)***	(−2.99)***	(−8.63)***
Size	0.067	0.079	0.087	0.081	0.095	0.128
	(18.20)***	(20.22)***	(22.80)***	(22.06)***	(27.01)***	(36.71)***
Labor	−0.46	−0.447	−0.442	−0.443	−0.534	−0.004
	(−21.48)***	(−19.60)***	(−20.38)***	(−21.61)***	(−27.93)***	(−11.74)***
Mat	0.022	0.046	0.031	0.097	0.173	−0.635
	(1.05)	(2.16)**	(1.46)	(4.86)***	(9.08)***	(−52.87)***
Number of Obs	48040	48559	53655	57942	61726	66093
R−squared	0.03	0.03	0.03	0.03	0.04	0.06

	1978	1980	1983	1985	1988	1990
Intelligent Location	−0.079	−0.093	−0.109	−0.088	−0.075	−0.086
	(6.51)***	(−7.29)***	(−8.81)***	(−7.53)***	(−6.76)***	(−7.82)***
Size	0.067	0.08	0.087	0.082	0.096	0.128
	(18.29)***	(20.38)***	(22.89)***	(22.12)***	(27.04)***	(36.74)***
Labor	−0.461	−0.447	−0.443	−0.443	−0.535	−0.004
	(−21.52)***	(−19.62)***	(−20.46)***	(−21.62)***	(−27.95)***	(−11.73)***
Mat	0.023	0.046	0.03	0.097	0.174	−0.634
	(1.07)	(2.14)**	(1.42)	(4.86)***	(9.12)***	(−52.77)***
Number of Obs	48040	48559	53655	57942	61726	66093
R−squared	0.03	0.03	0.03	0.03	0.04	0.04

Note: ***; 1% significance, **: 5 % significance, *: 10% significance
Sector dummies and constant are omitted to report

Table 2b: OLS Results 2

	1983	1985	1988	1990
Technopolis (targeted in respective year)	−0.395	−0.112	−0.109	−0.081
	(−3.68)***	(−6.11)***	(−7.94)***	(−4.77)***
Size	0.086	0.081	0.096	0.127
	(22.55)***	(21.94)***	(27.03)***	(36.52)***
Labor	−0.443	−0.444	−0.534	−0.004
	(−20.45)***	(−21.66)***	(−27.91)***	(−11.81)***
Mat	0.031	0.098	0.173	−0.634
	(1.47)	(4.91)***	(9.05)***	(−52.77)***
Number of Obs	53655	57942	61726	66093
R−squared	0.03	0.03	0.04	0.05

	1983	1985	1988	1990
Inteligent Location (targeted in respective year)			0.003	−0.065
			(0.07)	(−4.68)***
Size			0.095	0.127
			(26.78)***	(36.53)***
Labor			−0.536	−0.004
			(−28.00)***	(−11.77)***
Mat			0.175	−0.634
			(9.17)***	(−52.76)***
Number of Obs			61726	66093
R−squared			0.04	0.06

Note: ***; 1% significance, **: 5 % significance, *: 10% significance
Sector dummies and constant are omitted to report

Table 3: ATT results

	1978	1980	1983	1985	1988	1990
Technopolis	−0.0661	−0.0723	−0.1645	−0.0966	−0.0398	−0.0978
	(−2.80)***	(−2.87)***	(−6.40)***	(−3.93)***	(−1.73)*	(−4.32)***
Technopolis (targeted in respective year)			−0.4687	−0.1432	−0.0899	−0.0622
			(−2.76)***	(−4.53)***	(−3.90)***	(−2.07)**
Intelligent	−0.0686	−0.1025	−0.1439	−0.0924	−0.0826	−0.0908
	(−3.40)***	(−4.59)***	(−6.68)***	(−4.54)***	(−4.34)***	(−4.66)***
Intelligent (targeted in respective year)					0.0326	−0.0674
					(0.39)	(−2.70)**

Note: ***; 1% significance, **: 5 % significance, *: 10% significance

Table 4: Robustness for ATT

	1980	1985	1990
Technopolis (Machinery)	−0.0967	−0.0962	−0.1271
	(−2.11)**	(−2.07)**	(−2.16)**
Intelligent (Machinery)	−0.0923	−0.1024	−0.0859
	(−2.33)**	(−2.71)**	(−1.61)*
Technopolis (Adjacent)	0.0709	0.0263	0.0366
	(1.99)**	(0.79)	(1.11)
Intelligent (Adjacent)	−0.0317	0.0006	−0.0002
	(−1.00)	(0.02)	(−0.01)
Technopolis (Endogeneity)	−0.0505	−0.0587	−0.0541
	(−2.03)**	(−2.34)**	(−2.28)**
Intelligent (Endogeneity)	−0.0382	−0.0435	−0.0651
	(−1.52)	(−2.08)**	(−3.31)***

Note: ***; 1% significance, **: 5 % significance, *: 10% significance

Table 5: CDF and CDF gap

Technopolis

	1980			1985			1990		
DPROD	Core	Technopolis	Gap	Core	Technopolis	Gap	Core	Technopolis	Gap
−5.5	0	0	0	0.01	0	−0.01	0	0	0
−5	0.09	0	0.09	0.04	0.06	−0.02	0.01	0.05	−0.04
−4.5	0.11	0	0.11	0.08	0.11	−0.03	0.01	0.14	−0.13
−4	0.15	0	0.15	0.15	0.11	0.04	0.03	0.23	−0.2
−3.5	0.18	0	0.18	0.22	0.11	0.11	0.15	0.27	−0.12
−3	0.4	0.16	0.24	0.35	0.28	0.07	0.33	0.73	−0.4
−2.5	0.57	0.82	−0.25	0.56	0.56	0	0.6	1.14	−0.54
−2	0.94	1.55	−0.61	1.25	1.68	−0.43	1.2	2.36	−1.16
−1.5	2.51	4.98	−2.47	3.14	5.84	−2.7	3.52	8.14	−4.62
−1	8.35	17.81	−9.46	9.77	17.45	−7.68	10.69	22.42	−11.73
−0.5	26.44	44.44	−18	27.94	43.27	−15.33	28.08	45.93	−17.85
0	58.45	70.75	−12.3	58.57	70.54	−11.97	57.61	71.71	−14.1
0.5	83.09	87.75	−4.66	82.89	89.28	−6.39	83.28	88.86	−5.58
1	94.37	95.59	−1.22	94.28	95.85	−1.57	94.2	95.73	−1.53
1.5	98.17	98.45	−0.28	98.19	98.54	−0.35	98.23	98.5	−0.27
2	99.58	99.51	0.07	99.36	99.49	−0.13	99.44	99.41	0.03
2.5	99.91	99.67	0.24	99.89	99.83	0.06	99.87	99.95	−0.08
3	99.98	100	−0.02	99.93	99.94	−0.01	99.93	100	−0.07
3.5	100	100	0	99.97	100	−0.03	99.99	100	−0.01
4.5	100	100	0	100	100	0	100	100	0

Intelligent Location

	1980			1985			1990		
DPROD	Core	Intelligent Loc	Gap	Core	Intelligent Loc	Gap	Core	Intelligent Loc	Gap
−5.5	0	0	0	0.01	0	0.01	0	0	0
−5	0.09	0	0.09	0.06	0.04	0.02	0.01	0.03	−0.02
−4.5	0.11	0.05	0.06	0.1	0.11	−0.01	0.01	0.06	−0.05
−4	0.14	0.05	0.09	0.17	0.11	0.06	0.03	0.13	−0.1
−3.5	0.18	0.16	0.02	0.23	0.15	0.08	0.16	0.32	−0.16
−3	0.4	0.36	0.04	0.36	0.29	0.07	0.35	0.6	−0.25
−2.5	0.56	0.68	−0.12	0.58	0.55	0.03	0.63	1.13	−0.5
−2	0.94	1.93	−0.99	1.26	1.69	−0.43	1.26	2.24	−0.98
−1.5	2.59	4.68	−2.09	3.2	5.44	−2.24	3.68	6.74	−3.06
−1	8.7	16.96	−8.26	9.92	17.3	−7.38	11.01	20.45	−9.44
−0.5	26.92	41.94	−15.02	28.23	41.81	−13.58	28.65	41.87	−13.22
0	58.74	69.67	−10.93	58.81	69.8	−10.99	57.99	69.19	−11.2
0.5	83.14	87.77	−4.63	83	88.02	−5.02	83.41	86.8	−3.39
1	94.4	96.15	−1.75	94.31	95.59	−1.28	94.19	95.27	−1.08
1.5	98.2	98.75	−0.55	98.19	98.53	−0.34	98.22	98.27	−0.05
2	99.59	99.38	0.21	99.37	99.45	−0.08	99.41	99.53	−0.12
2.5	99.91	99.69	0.22	99.89	99.63	0.26	99.87	99.87	0
3	99.98	99.84	0.14	99.93	99.96	−0.03	99.93	99.91	0.02
3.5	100	99.95	0.05	99.97	100	−0.03	99.99	100	−0.01
4	100	99.95	0.05	100	100	0	99.99	100	−0.01
4.5	100	100	0	100	100	0	100	100	0

Appendix Table: Basic Statistics

Year	Variable	Observation	Mean	Std. Dev.	Min	Max
1978	DPROD	48040	0.2325563	0.9888748	−6.789446	4.631919
	SIZE	48040	3.316469	1.280155	1.386294	9.781207
	LABOR	48040	0.2345804	0.1613151	0	3.793714
	MAT	48040	0.3865969	0.17278	0	5.542666
1980	DPROD	48559	0.2178509	1.041141	−7.229967	4.751758
	SIZE	48559	3.310036	1.272666	1.386294	9.795791
	LABOR	48559	0.2255405	0.1594183	0	2.939515
	MAT	48559	0.3944476	0.1736848	0	3.026459
1983	DPROD	53655	0.2166903	1.063889	−7.21698	5.31005
	SIZE	53655	3.276194	1.264586	1.386294	10.05096
	LABOR	53655	0.238533	0.1669842	0	3.813525
	MAT	53655	0.3843739	0.1739884	0	2.918972
1985	DPROD	57942	0.2183504	1.048042	−7.880318	5.419785
	SIZE	57942	3.31352	1.244825	1.386294	10.1092
	LABOR	57942	0.2389843	0.165001	0	4.167595
	MAT	57942	0.3820283	0.1736199	0	4.973279
1988	DPROD	61726	0.2098915	1.038907	−7.510431	5.286505
	SIZE	61726	3.302714	1.230873	1.386294	9.922604
	LABOR	61726	0.2429936	0.1755346	0	8.39841
	MAT	61726	0.3713824	0.1767701	0	11.35772
1990	DPROD	66093	0.2012308	1.074271	−7.745213	6.205487
	SIZE	66093	3.299687	1.21973	1.386294	9.943429
	LABOR	66093	0.2383255	0.1720533	0	7.920083
	MAT	66093	0.3680061	0.1729084	0	3.832807