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Abstract
Rapid population growth in large cities in Japan was seen from the mid 50's to 60's. This situation led to the enactment of the *Act concerning the Industry Restriction (AIR*) which mainly restricted manufacturing activity to avoid congestion and environmental problems in the central area of Metropolitan region and the central area of the Kinki region in Japan. Given the legislation's concentrated impact in areas highly dependent on the manufacturing sector, deregulating the AIR thus assumes a similar effect in the Kinki. We conduct causal inference on this place-based policy to assess whether such an deregulation take effect. Our results support this view.

Keywords: Restriction act; place-based policy; deregulation; program evaluation; Japan
JEL classification: C23; R3; R52

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1 Introduction

Rapid population growth occurred in large cities in Japan in the mid-1950s to the 1960s. During 1955–1960, the Tokyo metropolitan area population increased from approximately 7 million to 8.3 million, whereas the population of Osaka city increased from approximately 2.6 million to 3 million (National Census). These increases in these two main economic areas in Japan are attributable to a population influx from other areas (National Land Development Council, 2001). In addition to this, Japan experienced high economic growth from the mid-1950s until the mid-1970s, which led to the concentration of industries into large cities. According to such rapid growth of population and high economic growth, large cities such as Tokyo and Osaka and their surrounding areas became overcrowded; environmental problems ensued. At the same time, under a national policy of geographically well-balanced national development, the "Comprehensive National Development Plan" was set in 1962 and was enforced until 2000.

These changes led to the enactment of the law called the "Act concerning the Industry Restriction" (hereafter AIR). The AIR restricted new construction of factories and universities and expansion of existing factories and universities in congested areas. Policymakers judged the cause for the rapid population growth as newly constructed and expanded factories and universities.

Targeted areas of the AIR were the central area of the Metropolitan area including Tokyo (hereafter central Metro) and the central area of the Kinki region including Osaka (hereafter central Kinki).[3,4] Therefore, the AIR is a kind of "place-based policy," by which the policy execution is limited to some area (place). The AIR comprised two specific laws: the "Act concerning the Industry Restriction in the Built-up Area of the National Capital Region" (enacted in 1959, hereafter AIR in Metro) and the "Act concerning the Industry Restriction in the Built-up Areas of the Kinki Region" (enacted in 1964, hereafter AIR in Kinki)

At that time, the economy of central Kinki was more highly dependent on the manufacturing sector when compared with central Metro. Because no data are available to assess the respective sectoral shares of economic activity for covering areas of central Kinki and central Metro, we substitute central Kinki and central Metro, respectively, for Osaka prefecture and Tokyo Metropolis. Using nominal GDP from "*Annual Report on Prefectural Accounts (Kenmin Keizai Keisan)*" by the Cabinet Office, the share of the manufacturing sector in Osaka was 42% in Tokyo was 35% in 1958: the year before the

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[3] The Metropolitan area for purposes of this paper includes Saitama, Chiba, Tokyo, and Kanagawa prefectures.
[4] The Kinki region for purposes of this paper includes Shiga, Kyoto, Osaka, Hyogo, Nara, and Wakayama prefectures.

enactment of AIR in Metro. Through the 1980s and the 1990s, central Metro has enjoyed centralization of service, finance, and information technology (IT) and communication sectors because of the transformation in the industrial structure in Japan: from manufacturing to tertiary industries. Using nominal GDP, again, the share of the sum of service, finance, and transportation and communications sectors in Osaka were 26% in 1985 and 36% in 1999, whereas the share of the sum of service, finance, and transportation and communications sectors in Tokyo were 34% in 1985 and 46% in 1999.[5]

Until the repeal of the AIR in 2002, the AIR was believed to exert a stronger negative effect especially on central Kinki because the AIR mainly restricted manufacturing activity. Anecdotal evidence from Hatta (2008) and Sawai (2019) characterize the AIR as overly restrictive, likely inhibiting AIR-restricted areas in central Kinki to experience lower growth than expected during the over-restricted period.

Actually, the economy of central Kinki is more deprived than that of central Metro. Fukui (2014) argues that the share of nominal GDP of Osaka prefecture compared to all of Japan was 10.2% in 1970, but it declined to 7.3% in 2010. By comparison, the share of nominal GDP of Tokyo metropolis compared to all of Japan was 17.1% in 1970 and increased to 18.4% in 2010. Many possible factors can account for this deterioration of economy in Osaka (or in Kinki as in Fukui, 2014); a main reason is probably the AIR.[6] Therefore, the effect of deregulation of AIR is expected and closer inspection of the effects of AIR is expected to be important for regional economic policy.

As described herein, we investigate whether deregulation of legal restrictions take effect of the restricted areas or not, especially in central Kinki. To implement regional program evaluation for verifying the deregulation effects, we set a treatment group (restricted area) and a control group (unrestricted area) to conduct causal inference. Treatment in this paper is repeal of the law.

To verify the causal inference of place-based policies (Neumark and Simpson, 2014), a program evaluation method has been developed in the field of microeconomics (Blundell and Costa-Dias, 2009; Imbens and Wooldridge, 2011). A usual and familiar ways of identifying the effect of these programs is using the difference-in-differences (DID). However, spatial dependence is strongly suspected in place-based policies. Under spatial dependence, unobserved heterogeneity exists. Unobserved heterogeneity is comprised of many economic or social factors vary across regions and time. Moreover, because these factors evolve in a complicated way, the standard DID cannot capture such an unobservable factor.

[5] IT and communication sectors are included in the transportation and communications sector.

[6] Another important possibility is high-speed bullet trains, Shinkansen, which commenced operations in 1964. Shinkansen trains pass mainly between Tokyo and Osaka..

Bai (2009) proposes "interactive-effects model" or "linear factor model" for panel data. Bai's model is useful for our empirics. A few studies have specifically examined regional program evaluation using interactive effect model constructed on DID (Hsiao et al., 2012; Kim and Oka, 2014; Gobillon and Magnac, 2016; and Givord et al., 2018).

Additionally, to cope with the inherent difficulties in generating valid counterfactuals to evaluate impacts of place-based policy, we utilize propensity score matching (PSM, Rosenbaum and Rubin, 1983) as means to fill this gap. Therefore, our analytical framework takes the shape of elaborate models, a combination of PSM with DID or Bai's DID.

To date, Kakumu and Fukushige (2003) and Kotani (2017) appear the only studies to have investigated the question of whether or not the AIR is indeed overregulating the areas it restricts. Kakumu and Fukushige (2003) use a production function to assess the respective productivities of restricted and unrestricted areas before repeal of the law (2002). They conclude that the laws led to overregulation. However, they do not investigate causality. They merely compare productivity before treatment in 2002, so that the conclusion is provisional. In limiting investigation of the effect of AIR's deregulation to Yokohama city, Kotani (2017) find causal effect of AIR's deregulation, but his setting of treatment and control groups are not plausible, with spatial dependence strongly suspected given his choice of control area adjacent to treatment area, thus biasing the estimated causal effect.

The importance of this study is twofold. Although great doubt persists about the obstruction of the growth of larger cities, especially for central Kinki, because of the law, and deregulation of AIR is expected, the influence of the AIR has received less attention in the literature. Ours is the first comprehensive study that assesses the effect of the AIR's deregulation on the restricted area. Moreover, given that accurate place-based policy evaluation is important for regional policy making, we investigate the issue at hand using elaborate models to tackle spatial dependency—an interactive effect model with DID—and thus provide more precise results.

The paper is organized as follows. Section 2 proposes a quick review of the literature on place-based policy evaluation. Section 3 provides an explanation of AIR. Section 4 is a brief discussion of causal inference and place-based policy. Section 5 presents steps for causal inference. Section 6 proposes an empirical strategy and data description. Section 7 explains empirical results and discussion, followed by Section 8, which presents conclusion.

2 Literature review of place-based policy evaluation

Many recent studies have evaluated the effects of policies that are specific to the regional units. Papke (1994) analyzes the effect of the Indiana, U.S. Enterprise Zone (EZ) program on local employment and investment. Using DID, positive effects are found. Hanson (2009) assesses the effects of the federal EZ on employment and poverty; IV estimation shows no effect of the program. Neumark and Kolko (2010) specifically examine California's EZ program with establishment level data: no effects are detected. Accetturo and Blasio (2012) evaluate the effectiveness of government sponsored programs. Using a difference-in-differences with propensity score matching, their results show that the program has no effect on economic growth.

Freedman (2013) explores the effects of a Texas EZ program using regression discontinuity. A positive effect is verified. Wang (2013) investigates the effect of Special Economic Zones in China and finds that the program increases foreign direct investment. Schminke and Biesebroeck (2013) evaluate the program effectiveness of Economic and Technological Development Zones (ETDZ) in China. Results demonstrate that firms located in ETDZ achieve much higher export values. Kline and Moretti (2014) assess the long-run effects of a development program in the U.S.: the Tennessee Valley Authority (TVA). They find that the TVA led to growth in agricultural employment, and agricultural employment growth fell after the scaling down of programs while manufacturing employment continued to grow.

Harger and Ross (2016) examine the effects of a New Market Tax Credit on business activity. They find an increase in retail employment. Ahlfeldt et al. (2017) assess the effects of a revitalization policy which was implemented in Berlin, Germany because of the partition between West and East Germany until 1989. Results show that the policy reduced the buildings to poor conditions. Givord et al. (2018) use Bai's method to investigate the French "Enterprise Zone" (EZ) initiative implemented in 1997. Long-term estimates suggest that this program is not effective for sustaining economic development. Conclusions are diverse depending on the period to be evaluated or the method to be used for estimation.

Similar to our study, there exists some study that has investigated the effects of regulation on manufacturing plant location as means to prevent air pollution. Gray (1997) focuses on varieties of U.S. state-level regulation, showing that the difference affect the location of manufacturing plant. Becker and Henderson (2000) extrapolate from Gray, using the same data but further distilling the regional unit of study from state to county. In their work, they show that a county's quality attainment status influences plant birth.

List et al. (2003) use county-level data for the State of New York, evaluate via a difference-in-differences with propensity score matching, to state pollution intensity as key to the ultimate response to the regulation.

Program evaluation in this paper is slightly different from many research papers that have presented investigations in this area. Usual place-based policies are that a law or system is implemented for some period to improve some aspect of economic activity. For example, an economic zone initiative is implemented in revitalizing distressed areas for improvement of business location. However, we interpret a law repeal as an implementation of policy. Law repeal is the treatment under place-based policy for our case. Actually, law repeal was intended to avoid over-restriction for the restricted area because the original purpose of the law was presumably accomplished. Our study casts new light on evaluation of place-based policy.

3 About the Act concerning the Industry Restriction

The AIR in Metro and Kinki restricted new construction and expansion of factories. With these restrictions, the law was aimed at improving urban congestion and environmental problems by preventing population influx from the other areas.

Specifically examining AIR in Kinki, restricted areas are the greater part of Osaka city, approximately half of Amagasaki city, part of Kyoto city, Kobe city, Ashiya city, Nishinomiya city, Sakai city, Higashiosaka city, and Moriguchi city. The total area was approximately 461 square kilometers (Figure 1).

AIR's statutes restrict maximum size of factories to 1,000 square meters, for Kinki, and 500 square meters, for Metro.[7] The classroom size for university and technical colleges is restricted to 1,500 square meters at most. The classroom size for technical school and schools of various kinds is restricted to 800 square meters at most. Construction of factories or classrooms larger than these restrictions is fundamentally prohibited under AIR.

A noteworthy exception is that if the new construction or expansion is judged not to accelerate the expansion of population, then the prefectural governor or mayor of designated city can approve new construction or expansion of factories or classrooms greater than the restriction.[8] However, approval was granted under the AIR valid period

[7] The factory size restriction in Higashiosaka and Amagasaki city, where are the agglomerated areas of small and medium sized enterprises was relaxed to 1,500 square meters.

[8] For new construction or expansion of a factory over 3,000 square meters or university, irrespective of square measure, approval is needed from the Minister of Land, Infrastructure and Transport.

in Kinki only for 14 factories and one university.[9]

After 1965, the population of urban areas in Kinki (only Osaka, Hyogo, and Kyoto city) decreased from 5.74 million in 1965 to 5.49 million in 1995 (National Census). The share of enterprises of the manufacturing sector in the whole economy in Japan decreased from 15.8% in 1966 to 11.1% in 1999. The enrollment in universities and colleges showed a downward trend from 810 thousand at its peak in 1993 (National Land Development Council, 2001). From such a transition of economic background, both AIR in Metro and AIR in Kinki were repealed in July 2002.

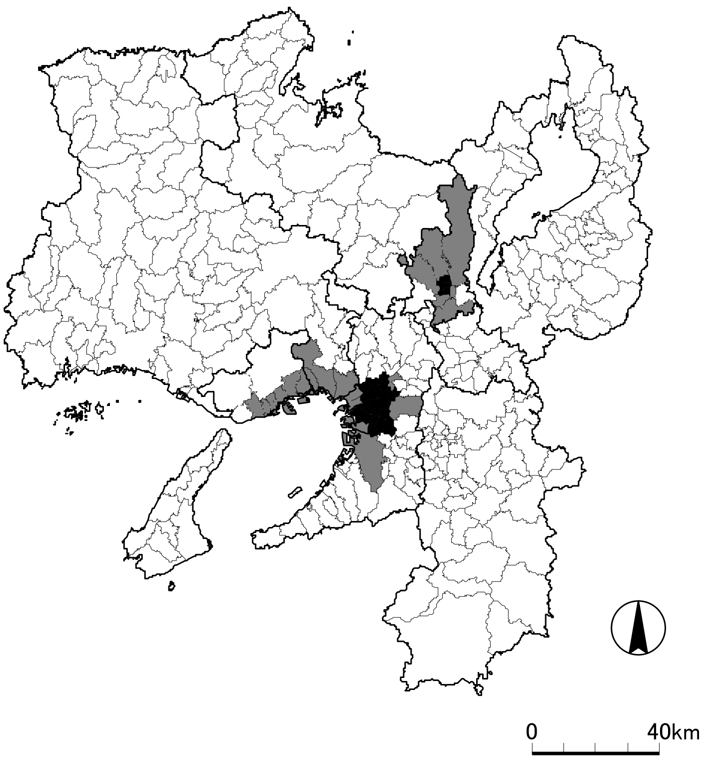

Figure 1 Map of the area restricted by Act concerning the Industry Restriction in Kinki

Note: Dark areas are fully restricted; pale areas are partially restricted municipalities. Classification of municipalities was done in 2001. Kinki is Shiga, Kyoto, Osaka, Hyogo, and Wakayama prefectures, but we exclude Wakayama prefecture from the map. The fully restricted area is Kamigyou-ku, Nakagyo-ku, and Shimogyo-ku of Kyoto city, Miyakojima-ku, Fukushima-ku, Nishi-ku, Minato-ku, Taisyo-ku, Tennouji-ku, Naniwa-ku, Higashi-yodogawa-ku, Higashinari-ku, Ikuno-ku, Asahi-ku, Jyoutou-ku, Abeno-ku, Sumiyoshi-ku, Higashi-sumiyoshi-ku, Nishinari-ku, Yodogawa-ku, Tsurumi-ku, Hirano-ku, Kita-ku, and Chuoku of Osaka city. Partially restricted areas are Kita-ku, Sakyo-ku, Higashiyama-ku, Minami-ku, Ukyo-ku, and Fushimi-ku of Kyoto city, Konohana-ku, Nishiyodogawa-ku, and Suminoe-ku of Osaka city,

[9] Approval in Metro was only 27 for factories and 9 for universities.

Higashinada-ku, Nada-ku, Hyogo-ku, Nagata-ku, Suma-ku, and Chuo-ku of Kobe city, Sakai, Moriguchi, Higashiosaka, Amagasaki, Nishinomiya, and Ashiya cities.

4 Causal inference and place-based policy

For program evaluation, we call the "treatment group" that group which takes treatment of the policy or program and designate the "control group" as that group which does not take treatment of a policy or program.

In many empirics in economics, a simple comparison of the outcomes of the treatment and control groups does not lead to accurate evaluation of a causal effect. Some covariates affect the outcomes of both groups. If we can observe both outcome data of treated for treatment group and outcome data of untreated for treatment group after the execution of policy or program, then a simple comparison of both outcomes corresponds to a causal effect. Nevertheless, this comparison is not possible in many cases. Consequently, we make a counterfactuals, which corresponds to the outcome data of untreated for the treatment group after the execution of policy or program. Then we compare the real outcome data for the treated group and counterfactual after the period of policy execution. This comparison is a so-called average treatment effect on the treated (ATT).

Flourishing studies of policy or program evaluation can be found in the fields of education and labor because a plausible counterfactuals is obtainable with random assignment. Compared with the fields of education and labor, the field of urban and regional economics presents some difficulty in conducting causal inference because of rare random assignment. In accordance with related literature, we designate "place-based policy" as related to policies or programs implemented for urban or regional unit.

Place-based policies are designated mainly for deprived areas and are aimed to revitalize these disadvantaged local economic activities such as growth of population, residents, employment, and small enterprises' activity. Therefore, for place-based policy, a policy or program is far from a random assignment, in which the treated area is correlated with a policy or program. In other words, the determination process of policy or program is strongly dependent on the local economic situation. Accordingly, it is difficult to find a useful controlled regional units. Also, it is difficult to appropriately evaluate causality in place-based policies.

DID combined with propensity score matching is a useful ways of evaluation of place-based policy. Nevertheless, using standard DID for identifying the causal effects of these programs might lead to some bias. Unbiased estimation using DID requires the assumption of a common trend before the treatment, although the estimated value under a place-based policy tends to be affected by unobserved economic variations, which leads to a biased estimation of DID.

To be more specific, spatial dependence is strongly suspected in urban or regional outcomes. Under the spatial dependence, unobserved heterogeneity exists. However, unobserved heterogeneity comprises many economic or social factors that vary across regions and time. Moreover, because these factors evolve in complicated ways, the standard DID cannot capture such an unobservable phenomenon.

As a solution to this difficulty, Bai (2009) proposes a more elaborate mode of using an interactive effect model or linear factor models for panel data that describe the complicated unobservable. Applying Bai's model for DID (Kim and Oka, 2014; Gobillon and Magnac, 2016) is useful for our empirics. Actually, a pivotal part of Bai's estimator relies on a factor model, factor and factor loadings capture the complicated unobservable of the urban or regional economies. It is particularly interesting that using Monte Carlo simulation, Kim and Oka (2014) and Gobillon and Magnac (2016) show that standard DID leads to biased estimation compared with the interactive effect model when interactive effects or factors are included in DGP.

We use Bai's (2009) method combined with PSM (Gobillon and Magnac, 2016; Givord et al., 2018) for our empirics.

5 Setup for causal inference

Here we describe the setup for causal inference used for this paper. Following Gobillon and Magnac (2016), the average effect of the treatment on the treated (ATT) is discerned as

$$ATT = [y_{it}(1) - y_{it}(0) | D_i = 1], \quad t \geq T_D, \qquad (1)$$

where $i = 1, 2, \cdots, N$ is an index of cross-sectional units, $t = 1, 2, \cdots, T$ represents the time index of observations, $D_i \in \{0, 1\}$ is a dummy variable for treatment, and $y_{it}(d)$ is the outcome for the $d = 1$ treatment group and the $d = 0$ control group. Treatment is executed on date $T_D < T$.

Cross-sectional units $i = 1, 2, \cdots, N_1$ are assigned to the treatment group; the other units $i = N_1 + 1, N_1 + 2, \cdots, N$ are assigned to the control group. ATT is also written as

$$ATT = \mathrm{E}[y_{it}(1)|D_i = 1] - \mathrm{E}[y_{it}(0)|D_i = 1], \quad t \geq T_D. \qquad (2)$$

The first term of the RHS of the equation is observed after the period of treatment, although the second term is not observable after the period of treatment. The second term is indeed "counterfactual."

Under the equal trend, we can write standard DID setting as

$$E\left[y_{it}(0) - y_{i,T_{D-1}}(0)\middle|D_i = 1\right] = E\left[y_{it}(0) - y_{i,T_{D-1}}(0)\middle|D_i = 0\right]. \ \ t \geq T_D. \qquad (3)$$

Then, the counterfactual is rewritten as

$$\mathrm{E}[y_{it}(0)|D_i = 1] = E\left[y_{it}(0) - y_{i,T_{D-1}}(0)\middle|D_i = 0\right] + E\left[y_{i,T_{D-1}}(0)\middle|D_i = 1\right]. \\ t \geq T_D. \qquad (4)$$

When there is no treatment, we can specify the outcome in the following equation as

$$y_{it}(0) = x'_{it}\beta + \lambda_i^* + \delta_t + \varepsilon_{it}, \qquad (5)$$

where x_{it} is $1 \times K$ covariates, λ_i^* denotes a fixed effect of cross-sectional unit, δ_t stands for a time fixed effect, and ε_{it} is an idiosyncratic term.

Now we introduce the interactive fixed effect term as

$$y_{it}(0) = x'_{it}\beta + f_t'\lambda_i + \varepsilon_{it}, \qquad (6)$$

where λ_i is $L \times 1$ factor loadings, f_t is $L \times 1$ factors, and ε_{it} is the idiosyncratic term. Restriction of the linear formation $f_t'\lambda_i = \lambda_i^* + \delta_t$ leads to a two-way model as given by equation (5). Consequently, the term $f_t'\lambda_i$ is a general expression to cope with complicated unobservable.

In the case of treatment, the corresponding specification becomes

$$y_{it}(1) = \alpha_{it} + x'_{it}\beta + f'_t\lambda_i + \varepsilon_{it}, \qquad (7)$$

where α_{it} is a treatment effect or causal effect. The whole observable outcome is

$$y_{it} = y_{it}(0)(1 - I_t D_i) + y_{it}(1) I_t D_i, \qquad (8)$$

where I_t is time indicator of treatment and D_i is an individual indicator of treatment.

Using (3.6) and (3.7), the above expression can be rewritten as

$$y_{it} = \alpha_{it} I_t D_i + x'_{it}\beta + f'_t\lambda_i + \varepsilon_{it}. \qquad (9)$$

We can reformulate the equation as

$$y_{it} = \alpha_t I_t D_i + x'_{it}\beta + f'_t\lambda_i + \varepsilon_{it} + (\alpha_{it} - \alpha_t) I_t D_i. \qquad (10)$$

Conditioned on "Assumption 3" in Gobillon and Magnac (2016, p.540),

$$\forall t \geq T_D, \quad \alpha_t = \alpha,$$

the estimable equation becomes,

$$y_{it} = \alpha I_t D_i + x'_{it}\beta + f'_t\lambda_i + \varepsilon_{it}. \qquad (11)$$

We consider multiple L factors for f_t in this model.

Writing the model in vector as

$$\boldsymbol{y}_i = \alpha \boldsymbol{I}'\boldsymbol{D}_i + \boldsymbol{X}_i\beta + \boldsymbol{F}'\lambda_i + \boldsymbol{\varepsilon}_i, \qquad (12)$$

where $\boldsymbol{y}_i = \begin{bmatrix} y_{i1} \\ y_{i2} \\ \vdots \\ y_{iT} \end{bmatrix}, \boldsymbol{I}' = \begin{bmatrix} I'_1 \\ I'_2 \\ \vdots \\ I'_T \end{bmatrix}, \boldsymbol{D}_i = \begin{bmatrix} D_{i1} \\ D_{i2} \\ \vdots \\ D_{iT} \end{bmatrix}, \boldsymbol{X}_i = \begin{bmatrix} X_{i1} \\ X_{i2} \\ \vdots \\ X_{iT} \end{bmatrix}, \boldsymbol{F}' = \begin{bmatrix} F'_1 \\ F'_2 \\ \vdots \\ F'_T \end{bmatrix}, \boldsymbol{\varepsilon}_i = \begin{bmatrix} \varepsilon_{i1} \\ \varepsilon_{i2} \\ \vdots \\ \varepsilon_{iT} \end{bmatrix}.$

Factor $\boldsymbol{F}$ has a dimension L. We can rewrite the model using matrix form as

$$\boldsymbol{y} = \alpha \boldsymbol{I}'\boldsymbol{D} + \boldsymbol{F}\boldsymbol{\Lambda}' + \boldsymbol{\varepsilon}, \qquad (13)$$

where $\boldsymbol{y} = (\boldsymbol{y}_1, \boldsymbol{y}_2, \cdots, \boldsymbol{y}_N)$, $\boldsymbol{\Lambda} = (\lambda_1, \lambda_2, \cdots, \lambda_N)'$, $and\ \boldsymbol{\varepsilon} = (\boldsymbol{\varepsilon}_1, \boldsymbol{\varepsilon}_2, \cdots, \boldsymbol{\varepsilon}_N)$. Because of $\boldsymbol{F\Lambda}' = \boldsymbol{F A A}^{-1}\boldsymbol{\Lambda}$, where $\boldsymbol{AA}^{-1}$ is an $L \times L$ matrix, the possible solution for this form is $L \times L$. Identification is possible with the L^2 restriction shown below.

Normalization, as

$$\frac{\boldsymbol{F}'\boldsymbol{F}}{\boldsymbol{T}} = \boldsymbol{I}, \quad (14)$$

leads to restriction of $L(L+1)/2$. Another $L(L-1)/2$ is from

$$\boldsymbol{\Lambda}'\boldsymbol{\Lambda} = diagonal. \quad (15)$$

Total restriction will be $\frac{L(L+1)+L(L-1)}{2} = L^2$. These steps are commonly taken for identification of the factor model.

6 Empirical strategy and data

6.1 Strategy for matching

In our empirical implementation, central Kinki (the restricted area by AIR): the central part of Osaka and Kyoto and the bay area of Hyogo (Fig. 1) are set as treatment group. As we mentioned earlier, it is difficult to find a control group or to make a counterfactual in place-based policy. Nevertheless, we follow Gobillon and Magnac (2016) and Givord et al. (2018): PSM is used to find control groups (municipalities). We use the nearest neighbor one-to-one PSM.

For unbiased causal inference, first of all, we omit the AIR in Metro for candidate for controls because these areas are also affected by the AIR. Secondly, to avoid possible interaction because of the AIR, we exclude the surrounding area of the AIR. In place-based policy, some policy which acts on some city possibly strongly affects nearer cities. If a nearer city is selected for controls, it might lead to a biased inference. Thirdly, we exclude partially restricted municipalities by AIR for preventing mixed up causal inference. We also exclude 2011 because a strong earthquake (The Great East Japan Earthquake) occurred at that time, disturbing the economic activity.

Targeted areas of the AIR are the same as the “Urbanized Area” designated by the “Kinki Region Development Act” and the “National Capital Region Development Act.” These two laws also define “Suburban Consolidation Zone,” where surrounding areas of “Urbanized Area.” Therefore, we exclude the “Suburban Consolidation Zone.” This exclusion is in line with the study by Accetturo and Blasio (2012), which set a control area as a different region from the treated areas so that estimation might be less exposed to a spillover of policy implementation.

Because AIR targeted large population areas, we choose municipalities with a large population as a candidate for control group under PSM method. Regarding a candidate for a control group, municipalities are chosen from currently (as of 2018) designated "Government-ordinance-designated Cities," "Core Cities," and "Special Cities," because these municipalities are designated by government mainly according to population criteria. The population criterion for "Government-ordinance-designated Cities" is 500 thousand, "Core Cities" is 300 thousand, and "Special Cities" is 200 thousand. [10,11,12]

For comparison, we also apply causal inference for central Metro.[13]

6.2 Data description

Data are extracted from "*Census of Manufacture*" (by Ministry of Economy, Trade and Industry) for the dependent variable (the number of the enterprises in the manufacturing sector) and for the control variable (the number of the enterprises in the transportation and machinery equipment sector). In addition, we extract nominal GDP data from "*Annual Report on Prefectural Accounts*" (by Cabinet Office) as a control variable.[14]

We select industries assumed to be more affected by AIR's restrictions. Figure 2 shows area per establishment within the Osaka Prefecture in 2002, the year of the law's repeal. The area per establishment of "Petroleum and coal products" and "Iron and Steel" registers relatively large, meaning their relocation to other locales would not be easy. Furthermore, both industries are primarily located in coastal regions which lie outside the orbit of the AIR's regulations. With these aspects in mind, we omit these industries in our analysis.

We additionally take into account the relative share of each industry in Osaka city and Tokyo's 23 wards, specifically selecting, for analysis, the industries that possess a large share. From Figure 3 and 4, we select 5 industries; "Fabricated metal products," "General machinery," "Apparel and other finished products," "Plastic products," and "Electrical machinery, equipment and supplies." We omit "Publishing, printing and allied products" from the analysis due to reforms regarding industry classification.[15] AIR itself

[10] Names of municipalities are in the appendix.
[11] We exclude Naha city because Naha is distant from the other municipalities. Moreover, they seem to follow different economic trends from those of the other municipalities.
[12] Because the system of special cities was abolished on 2015, requirements of population criteria for the core cities were relaxed to 200 thousand.
[13] Data for central Metro is constructed in the same way as that of central Kinki.
[14] The reason we only use the number of enterprises for outcome variable is that the data for the other variables, for instance, shipment value, in "*Census of Manufacture*" for the municipals where only one or two enterprises located are to be concealed. This concealment leads to difficulties in adjustment for municipal mergers, which we conduct in making the panel dataset.
[15] From 2002 onward, publishing is no longer classified within the orbit of manufacturing.

exempts certain particulars within industries — namely, boxed lunches, whose affiliation with the food industry meant we also drop “Food” as a category for analysis.

In consideration of recent reform to industry classification practice, we sum up our analytical selection of industries as such: “Textile mill products,” “Apparel and other finished products,” “Textile mill products,” “Ceramics, stone and clay products,” “Plastic products,” “Fabricated metal products,” “General machinery,” “Electrical machinery, equipment and supplies,” “Precision instruments and machinery,” “Ordinance and accessories,” and “Miscellaneous manufacturing products.”[16]

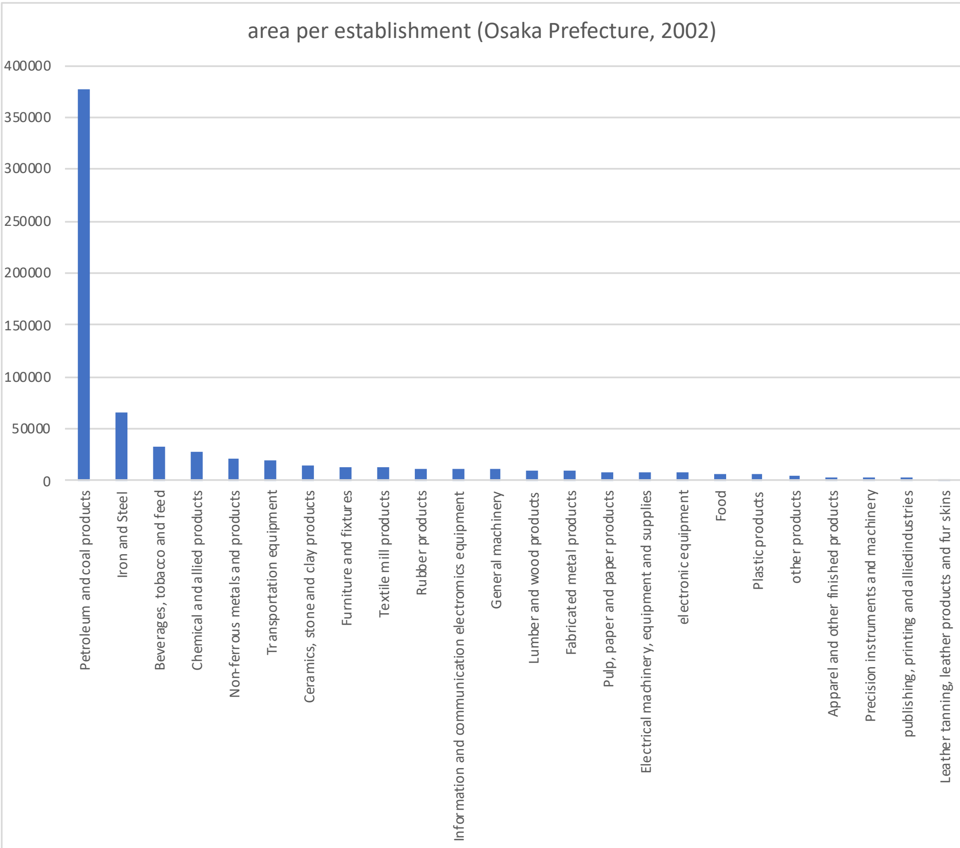

Figure 2 Area per establishment within the Osaka Prefecture in 2002

[16] These classifications are commonplace as of 2001.

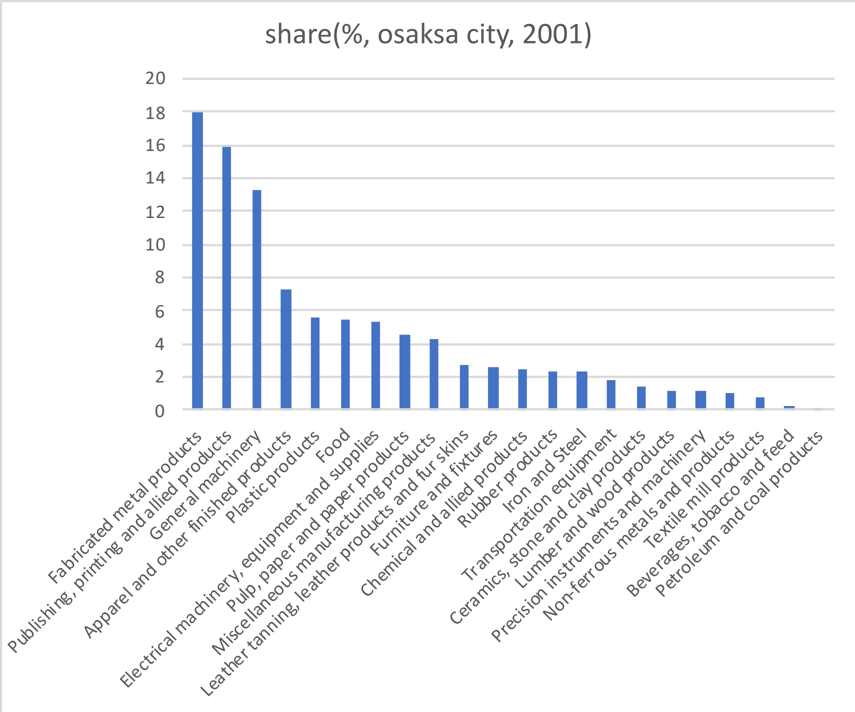

Figure 3 Share of manufacturing industries within Osaka city in 2001

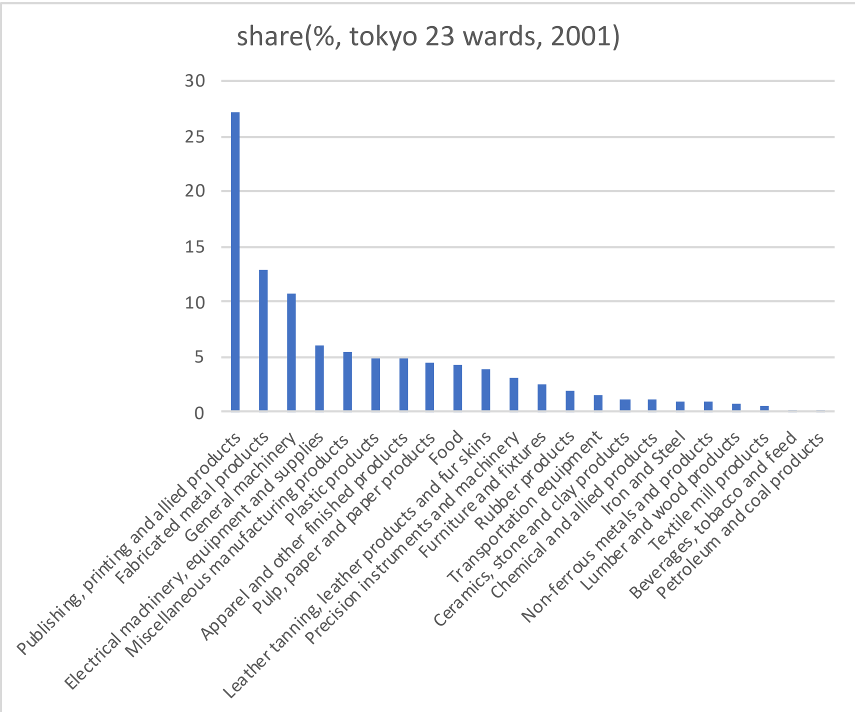

Figure 4 Share of manufacturing industries within Tokyo's 23 wards in 2001

The data are those of 1996–2016. We set the starting period to 1996 because, in 1995, the area was affected by a huge earthquake, the Great Hanshin-Awaji Earthquake, so that a marked decrease of the number of manufacturing enterprises was apparent in Hyogo prefecture, in which the area restricted by AIR was included at that time.[17,18] The other area of AIR in central Kinki (Osaka and Kyoto) might also have been affected by this earthquake to a greater or lesser extent.

Data are annual. We take growth rate for each variable so that the total period T is 16 and the treatment year T_D is 7 because the law was repealed on July 2002. We regard 2003 as a treatment year. We exclude data from the period 2002 to 2005 given the maximal timeframe of three years for a new plant's planning and construction, which assumes the impact of AIR's repeal to be weak in the three years after its enactment.

Causal inference in this paper is unique. As demonstrated in Figure 5, apart from the "common trend before the treatment," we set the "common trend after the treatment," verifying the pre-treatment differences between the treatment and control groups. If the AIR indeed had effect on the treatment group, the activity of the treatment group's manufacturing industries would show greater suppression than those of the control group's during the period of restriction.

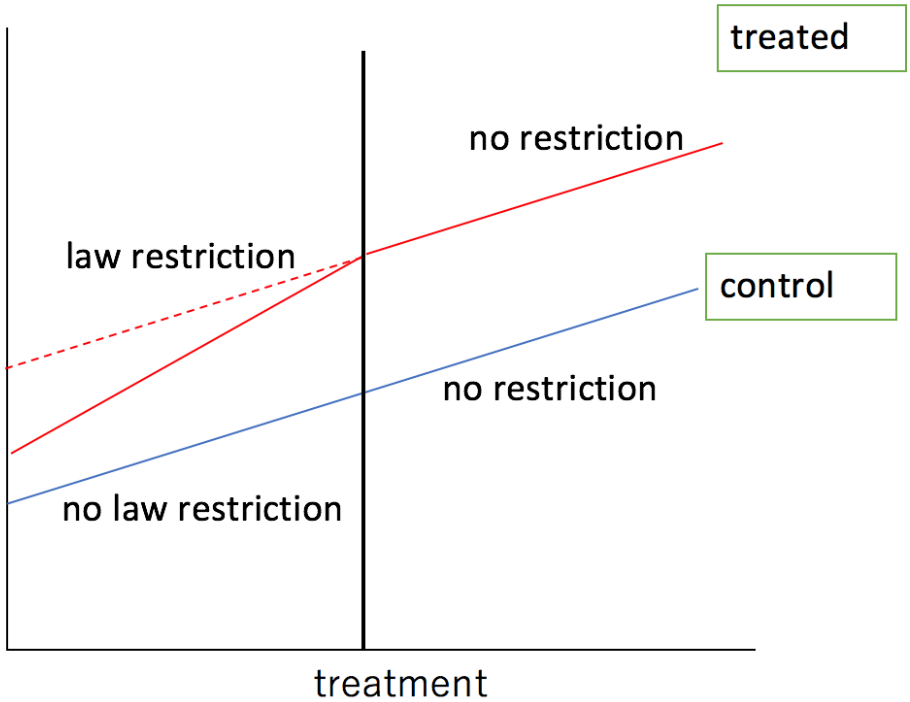

Figure 5 Conceptual diagram of the DID in this paper

We use a nominal GDP growth rate to control for economic trends and structural

[17] The earthquake mainly affected Suma, Nagata, Hyogo, Chuo, Nada, and Higashinada wards and Ashiya and Nishinomiya cities. These municipalities are all in the restricted area.
[18] However, Hyogo prefecture is already excluded because all of the restricted municipalities in Hyogo were partially restricted.

changes. Available GDP data are only those for the prefectural level. Therefore, we apply these data for the municipalities' corresponding prefectures. Further used for control includes the growth rate of the municipality's number of enterprises in the transportation and machinery equipment sector. In the 2000s, the automotive industry shows a great increase in the Japanese manufacturing industry.

6.4 Two methods

We also conduct standard DID. Two methods depend on PSM. For both methods, data-differentiated and we use two additional variables: cross-sectional fixed effects μ_i and time fixed effects δ_t. As such, specification for Bai's method with DID is expressed as

$$\Delta y_{it} = \alpha I_t D_i + \Delta x'_{it}\beta + f'_t\lambda_i + \mu_i + \delta_t + \varepsilon_{it}. \quad (16),$$

The specification for the standard DID is

$$\Delta y_{it} = \alpha I_t D_i + \Delta x'_{it}\beta + \mu_i + \delta_t + \varepsilon_{it}. \quad (17).$$

If the coefficient α is negative and significant, then we conclude that the repeal of the AIR take effect.

7 Empirical results and discussion

7.1 Propensity score matching

For central Kinki, we have 23 municipalities for the candidate treatment group and 107 municipalities for the candidate control group. For central Metro, 29 municipalities are taken for the candidate treatment group, and 107 municipalities are taken for the candidate control group.

Data used for the PSM are the share of the number of employees in the service sector plus the finance sector among all sectors in municipalities (from "*2016 Economic Census for Business Activity*" by Statistics Bureau, Ministry of Internal Affairs and Communications (MIC)) and the growth rate of the number of employees in the service sector plus the finance sector during 2006-2016 (from "*2006 Establishment and Enterprise*" and "*2016 Economic Census for Business Activity*" by Statistics Bureau, MIC). The ratio of daytime population to nighttime population, as well as the unemployment rate (both statistics culled from the "*2015 Population Census*" by

Statistics Bureau, MIC), are also included in the analysis. In addition, we use both the quadratic term and cross term of those covariates.

We present our PSM results in Figure 6 and 7. These figures are meant to show common support, so the matching is acceptable here.[19]

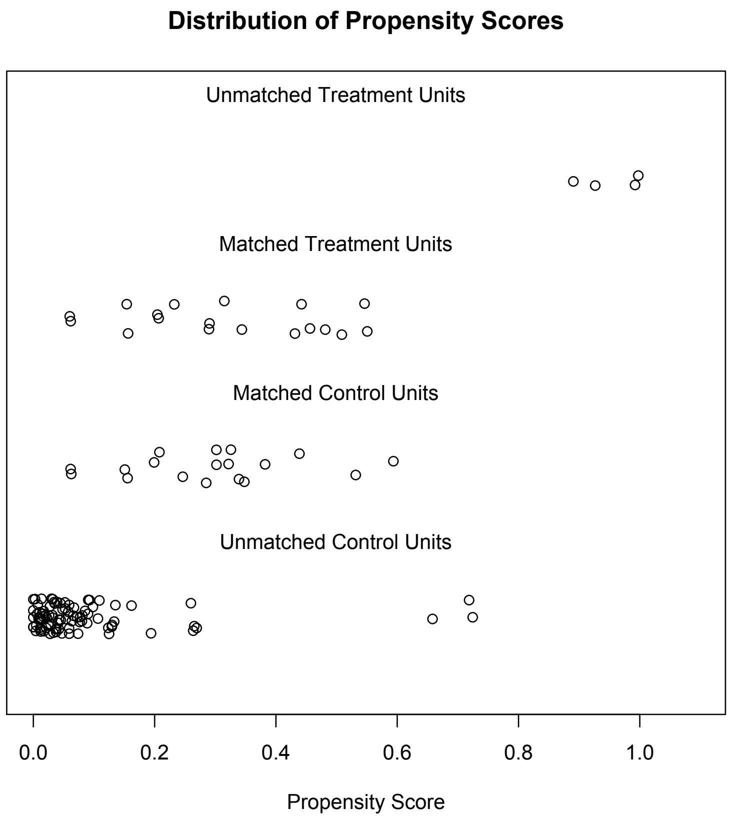

Figure 6 Results of propensity score matching for central Kinki using one-to-one nearest neighbor matching

Note: One-to-one nearest neighbor matching is conducted. Data used for the PSM are the share of the number of employees in the service sector plus the finance sector among all sectors in the examined municipalities (from "*2016 Economic Census for Business Activity*" by Statistics Bureau, MIC) and the growth rate of the number of employees in the service sector plus the finance sector during 2006–2016 in the examined municipalities (from "*2006 Establishment and Enterprise*" and "*2016 Economic Census for Business Activity*" by Statistics Bureau, MIC). The ratio of daytime population to nighttime population, as well as the unemployment rate (both from "*2015 Population Census*" by Statistics Bureau, MIC), are also included in the analysis. We additionally use both the quadratic term and cross term of those covariates. We use "MatchIt" package in R.

[19] Absolute value of standardized mean difference of all covariates are less than 0.1 after undergoing matching.

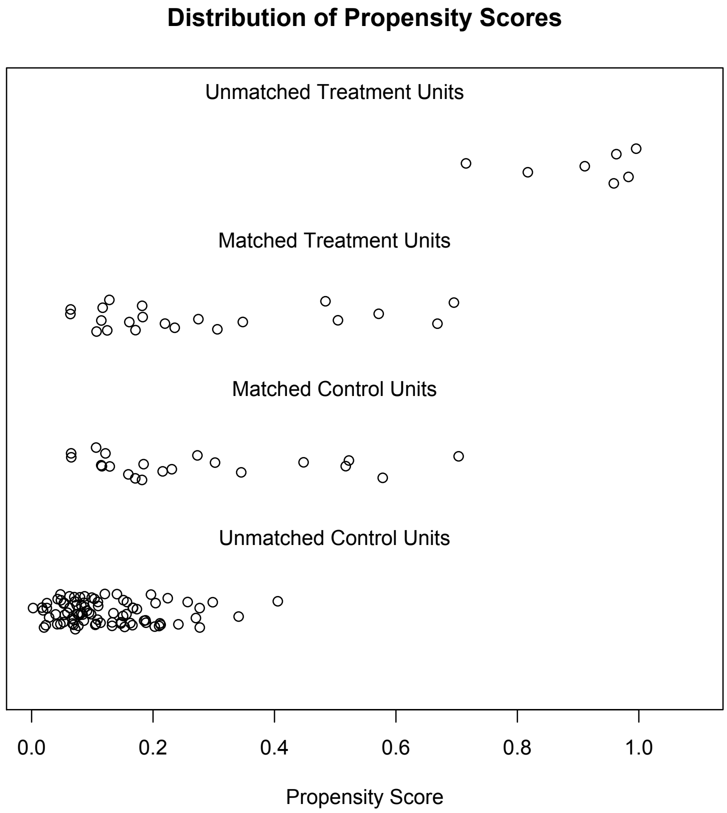

Figure 7 Results of propensity score matching for central Metro using one-to-one nearest neighbor matching

Note: One-to-one nearest neighbor matching is conducted. Data used for the PSM are the share of the number of employees in the service sector plus the finance sector among all sectors in the examined municipalities (from "*2016 Economic Census for Business Activity*" by Statistics Bureau, MIC) and the growth rate of the number of employees in the service sector plus the finance sector during 2006–2016 in the examined municipalities (from "*2006 Establishment and Enterprise*" and "*2016 Economic Census for Business Activity*" by Statistics Bureau, MIC). Ratio of daytime population to nighttime population and Unemployment rate (both from *2015 Population Census* by Statistics Bureau, MIC) are also used. We also use quadratic term and cross term of those covariates. We use "MatchIt" package in R.

Changes in central Kinki's average number of enterprises are expressed in Figure 8; here, the treatment group shows a rapid decrease relative to the control group prior to AIR's repeal, after which the gap became closer. Figure 9, which exhibits the average number of enterprises for central Metro, shows a similar trend. However the average number of the enterprises of treatment group fell below the control group after 2009.

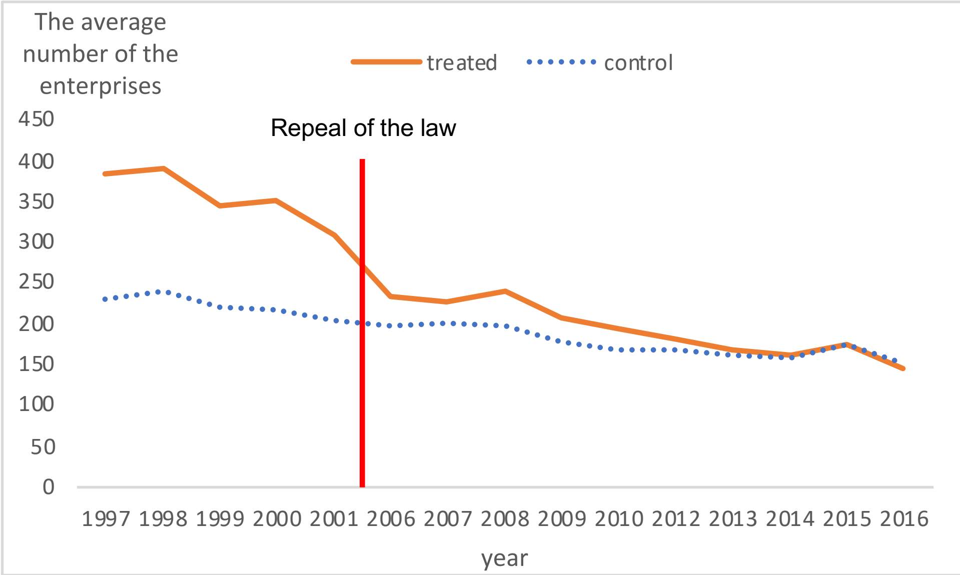

Figure 8 Change in average number of treatment and control group enterprises for central Kinki

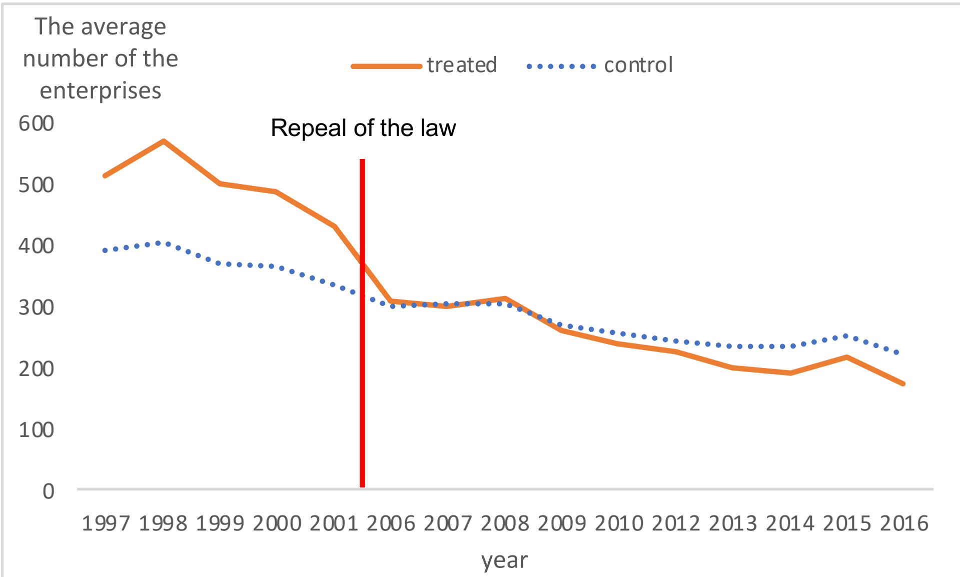

Figure 9 Change in average number of treatment and control group enterprises for central Metro

7.2 Results of causal inference

If the outcome in treated municipalities becomes significant and negative before the treatment compared with counterfactual, then we could infer that the deregulation of the AIR take effect in restricted area. Then we might conclude that there exists a causal effect (or treatment effect). We judge this causality to ascertain the estimated value of α in equations (16)–(17).

Results of causal inference of the repeal of AIR in central Kinki and central Metro using DID constructed on Bai's method with PSM are shown in Tables 1 and 2.[20] Following Givord et al. (2018), we set the numbers of factors to 1–5. Accordingly, for the number of factors 2 to 5, the estimated values of α are significant and negative in Kinki. Before the repeal of the AIR, central Kinki's number of manufacturing enterprises decreased by 3-5% relative to the period after. Contrastingly, all results registered as not significant for the Metro.

These results indicate that the restricted area in Kinki shows depreciated trends in manufacturing activity compared with the unrestricted area (designated as control) after the repeal of AIR. Therefore, deregulation of the AIR take effect in Kinki. From Figure 8, we recognize a closing gap between treated and control groups after the AIR's repeal, reflecting lessening depression to Kinki's manufacturing activity. However, the lack of effects in the Metro indicate no causality between the repeal of AIR and manufacturing activity. Therefore in Metro, activity of manufacturing has seen no change either before or after the AIR's repeal.

With or without control variables, the results are robust for the number of factor 2-5. The nominal GDP in Kinki's estimation is significant and negative for factor 3. The number of the enterprises in the transportation and machinery equipment sector is significant and positive for all number of factors in model c and significant and positive for factors 1, 3, and 4 in model d.

For the results of standard DID with PSM — displayed in Tables 3 and 4 — we cannot detect causal effects for all specifications both in central Kinki and central Metro. Although factors are not discernable, factors control unobservable spatial dependences. To wit, the results are refined by our use of Bai's DID in place of standard DID, which support the results of Monte Carlo simulation found by Kim and Oka (2014) and Gobillon and Magnac (2016).

[20] Iterations are conducted for 100 times for our estimation.

Table 1 Results of causal inference of repeal of Act concerning the Industry Restriction in central Kinki using Bai's method with propensity score matching

		the number of factors				
		1	2	3	4	5
a	**Treatment effect**	**-0.020**	**-0.033 ****	**-0.035 ****	**-0.052 *****	**-0.048 *****
		(0.013)	**(0.015)**	**(0.014)**	**(0.013)**	**(0.013)**
	Nominal GDP					
	The number of the enterprises in the transportation and machinery equipment sector					
b	**Treatment effect**	**-0.020**	**-0.033 ****	**-0.036 *****	**-0.051 *****	**-0.048 *****
		(0.013)	**(0.015)**	**(0.013)**	**(0.013)**	**(0.013)**
	Nominal GDP	0.135	-0.176	-0.394 **	0.127	-0.214
		(0.182)	(0.177)	(0.161)	(0.161)	(0.162)
	The number of the enterprises in the transportation and machinery equipment sector					
c	**Treatment effect**	**-0.021**	**-0.035 ****	**-0.036 *****	**-0.052 *****	**-0.051 *****
		(0.013)	**(0.015)**	**(0.013)**	**(0.012)**	**(0.013)**
	Nominal GDP					
	The number of the enterprises in the transportation and machinery equipment sector	0.036 ***	0.038 ***	0.054 ***	0.039 ***	0.024 ***
		(0.010)	(0.010)	(0.009)	(0.008)	(0.008)
d	**Treatment effect**	**-0.020**	**-0.035 ****	**-0.037 *****	**-0.052 *****	**-0.051 *****
		(0.013)	**(0.015)**	**(0.013)**	**(0.013)**	**(0.013)**
	Nominal GDP	0.129	-0.149	-0.320 **	0.022	-0.201
		(0.179)	(0.175)	(0.157)	(0.158)	(0.159)
	The number of the enterprises in the transportation and machinery equipment sector	0.036 ***	0.038	0.052 ***	0.039 ***	0.024
		(0.010)	(0.010)	(0.009)	(0.008)	(0.008)

Note: Standard errors are in parentheses. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent levels, respectively. Total number of periods is 16, number of periods before treatment is 6. The total number of observations for cross-sectional units is 36 (18 treated, 18 control). The treatment group is selected with propensity score matching from the central part of Osaka and Kyoto. The control group is selected with propensity score matching from candidate municipalities. The outcome variable is the number of the enterprises. The data source is the "*Census of Manufacture* (*Kogyo Toukei*)" for 1996–2016 (by Ministry of Economy, Trade and Industry).

Table 2 Results of the causal inference of repeal of Act concerning the Industry Restriction in central Metro using Bai's method with propensity score matching

		the number of factors				
		1	2	3	4	5
a	**Treatment effect**	**-0.018**	**-0.027**	**-0.022**	**-0.019**	**-0.018**
		(0.019)	**(0.020)**	**(0.020)**	**(0.018)**	**(0.016)**
	Nominal GDP					
	The number of the enterprises in the transportation and machinery equipment sector					
b	**Treatment effect**	**-0.018**	**-0.028**	**-0.023**	**-0.020**	**-0.018**
		(0.019)	**(0.020)**	**(0.020)**	**(0.018)**	**(0.016)**
	Nominal GDP	0.025	-0.103	0.295	0.321 *	0.045
		(0.182)	(0.182)	(0.182)	(0.164)	(0.160)
	The number of the enterprises in the transportation and machinery equipment sector					
c	**Treatment effect**	**-0.017**	**-0.027**	**-0.022**	**-0.019**	**-0.017**
		(0.019)	**(0.020)**	**(0.020)**	**(0.018)**	**(0.016)**
	Nominal GDP					
	The number of the enterprises in the transportation and machinery equipment sector	0.010	0.003	0.002	0.009	0.005
		(0.009)	(0.008)	(0.007)	(0.007)	(0.006)
d	**Treatment effect**	**-0.017**	**-0.028**	**-0.023**	**-0.019**	**-0.017**
		(0.019)	**(0.020)**	**(0.020)**	**(0.018)**	**(0.016)**
	Nominal GDP	0.017	-0.113	0.294	0.300 *	0.033
		(0.182)	(0.183)	(0.182)	(0.164)	(0.161)
	The number of the enterprises in the transportation and machinery equipment sector	0.010	0.004	0.000	0.008	0.005
		(0.009)	(0.008)	(0.007)	(0.007)	(0.006)

Note: Standard errors are in parentheses. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent levels, respectively. Total number of periods is 16, number of periods before treatment is 6. Total number of observations for cross-sectional units is 42 (21 treated, 21 control). The treatment group is selected with propensity score matching from central part of Tokyo and Kanagawa. The control group is selected with propensity score matching from candidate municipalities. The outcome variable is the number of the enterprises. The data source is the "*Census of Manufacture* (*Kogyo Toukei*)" for 1996–2016 (by Ministry of Economy, Trade and Industry).

Table 3 Results of the causal inference of repeal of Act concerning the Industry Restriction in central Kinki using standard DID with propensity score matching

	a	b	c	d
Treatment effect	**-0.020**	**-0.020**	**-0.021**	**-0.020**
	(0.015)	**(0.015)**	**(0.015)**	**(0.015)**
Nominal GDP		0.128		0.116
		(0.193)		(0.191)
The number of the enterprises in the transportation and machinery equipment sector			0.047 ***	0.047 ***
			(0.012)	(0.012)
Intersept	0.000	0.000	0.000	0.000
	(0.003)	(0.003)	(0.003)	(0.003)

Note: Standard errors are in parentheses. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent levels, respectively. Total number of periods is 16, number of periods before treatment is 6. The total number of observations for cross-sectional units is 36 (18 treated, 18 control). The treatment group is selected with propensity score matching from the central part of Osaka and Kyoto. The control group is selected with propensity score matching from candidate municipalities. The outcome variable is the number of the enterprises. The data source is the "*Census of Manufacture* (*Kogyo Toukei*)" for 1996–2016 (by Ministry of Economy, Trade and Industry).

Table 4 Results of the causal inference of repeal of Act concerning the Industry Restriction in central Metro using standard DID with propensity score matching

	a	b	c	d
Treatment effect	**-0.021**	**-0.019**	**-0.020**	**-0.018**
	(0.017)	**(0.017)**	**(0.017)**	**(0.017)**
Nominal GDP		-0.616 ***		-0.631 ***
		(0.181)		(0.181)
The number of the enterprises in the transportation and machinery equipment sector			0.019 *	0.021 **
			(0.010)	(0.010)
Intersept	0.000	0.000	0.000	0.000
	(0.003)	(0.003)	(0.003)	(0.003)

Note: Standard errors are in parentheses. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent levels, respectively. Total number of periods is 16, number of periods before treatment is 6. The total number of observations for cross-sectional units is 42 (21 treated, 21 control). The treatment group is selected with propensity score matching from the central part of Tokyo and Kanagawa. The control group is selected with propensity score matching from candidate municipalities. The outcome variable is the number of the enterprises. The data source is the "*Census of Manufacture* (*Kogyo Toukei*)" for 1996–2016 (by Ministry of Economy, Trade and Industry).

8 Conclusion

Serious doubt persists regarding the obstruction of the growth of larger cities, and the effect of deregulation is expected especially for central Kinki, because of the Act concerning the Industry Restriction (AIR). Our results, which utilized Bai's model, support this view: deregulation of the AIR indeed had effect in central Kinki.

Our prediction showed that the AIR was suspected to be restrictive and the effect of deregulation of AIR was expected, especially in central Kinki. This prediction is because, the AIR restricted the activity of manufacturing and the economy of the central area of the Kinki region was more highly dependent on manufacturing compared with central area of the Metropolitan area.

Appendix

List of Government-ordinance-designated Cities, Core Cities, and Special Cities.

1) Names of Government-ordinance-designated Cities:

Sapporo, Sendai, Yokohama, Kawasaki, Saitama, Chiba, Sagamihara, Niigata, Nagoya, Hamamatsu, Shizuoka, Osaka, Kobe, Kyoto, Sakai, Hiroshima, Okayama, Fukuoka, Kitakyushu, and Kumamoto.

Names of Core Cities:

Asahikawa, Hakodate, Iwaki, Koriyama, Akita, Morioka, Kashiwa, Yokosuka, Takasaki, Kawagoe, Maebashi, Koshigaya, Kanazawa, Toyama, Toyota, Gifu, Okazaki, Nagano, Toyohashi, Himeji, Higashiosaka, Nishinomiya, Amagasaki, Hirakata, Toyonaka, Wakayama, Nara, Takatsuki, Otsu, Akashi, Yao, Kurashiki, Fukuyama, Shimonoseki, Kure, Matsue, Tottori, Matsuyama, Takamatsu, Kochi, Kagoshima, Oita, Nagasaki, Miyazaki, Kurume, Sasebo, and Naha.

We exclude Naha city because Naha is distant from the other municipalities and they follow a different economic trend.

2) Names of Special Cities:

Yamagata, Tokorozawa, Mito, Hiratsuka, Soka, Kasukabe, Chigasaki, Yamato, Atsugi, Tsukuba, Ohta, Isezaki, Kumagaya, Odawara, Kofu, Nagaoka, Fukui, Joetsu, Ichinomiya, Yokkaichi, Kasugai, Fuji, Matsumoto, Numazu, Suita, Ibaraki, Kakogawa, Neyagawa, Takarazuka, Kishiwada, and Saga.

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