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IWATA, Shinichiro
Kanagawa University

KONDO, Keisuke
RIETI

The Research Institute of Economy, Trade and Industry
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The spillover effects of compact city policy on incumbent retailers: Evidence from Toyama City*

Shinichiro Iwata
Kanagawa University

Keisuke Kondo†
RIETI

Abstract

The compact city policy of Toyama City, Japan, aims to encourage density in both the city center and suburban hubs linked by public transport systems. The policy framework relates to the place-based policy, which targets geographic underperforming zones. Several town developments projected by this policy, including the development of housing, public and commercial facilities, and public transport systems, are conducted to increase the attractiveness of the target zones. Retail revitalization is then expected as a spillover effect through increasing market size. Using a difference-in-difference matching estimation with establishment-level panel data, this paper evaluates the policy impact on incumbent retailers located in the target zones, corresponding to the treatment group. The empirical results demonstrate that while the policy effects are not observed in the short run, the policy has a positive impact on both inputs and outputs for incumbent retailers in the long run. The existing policy framework, however, does not generate positive spillover effects on incumbent retailer productivity.

JEL classification: L81, R11, R58
Keywords: Place-based policies; Program evaluation; Compact city; Urban sprawl; Retail productivity

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† Corresponding author.

1 Introduction

Devoted proponents of compact cities have increased dramatically among policymakers in recent decades. Motorization, in conjunction with the development of a network of radial roads, generates the spatial dispersion of population within a city (Glaeser and Kahn, 2004). Such low density is less efficient when served by public transportation, leading to further automobile-dependent cities. These cities also favor suburban shopping malls, thereby giving rise to the hollowing out of shopping streets located in the city center or in nearby public transport stations/stops. To address this, compact city policies encourage high-density, mixed-use, and transport-oriented development (TOD) in target areas with public and private investment supported through subsidies, which can make the areas more attractive to potential consumers. Additional local footfall can increase the density of shoppers in the target zones and, accordingly, help raise the business performance of incumbent retailers likely to suffer from external shopping malls. To shed light on this issue, this paper uses a quasi-experimental design in Japan to estimate the effect of compact city policies on the performance of incumbent retailers, measured by annual sales, sales floor space, and the number of employees.

Toyama City, the capital of Toyama Prefecture in Japan, provides an important context in which to gauge the impacts of compact city policies. As is common in most medium-sized regional cities, Toyama experienced automobile-dependent dispersed urbanization flowing from six passenger vehicles for every ten inhabitants in the city in 2005.[1] As one consequence, the population density of Toyama's most densely inhabited district was the lowest of any Japanese prefecture capital with just 40.3 inhabitants per hectare. The share of retail sales in the central district of Toyama was 35.8% in 1997, but this decreased to 18.7% by 2007, possibly because large-scale commercial facilities newly entering the market are located in the suburbs.[2] These statistics well capture the notoriously sprawling features of Toyama. In response, Toyama has promoted compact city strategies, which attempt to convert its spatial structure to greater

[1]Calculated by the authors from the 2008 Toyama Shi Tokeisho. https://www.city.toyama.toyama.jp/kikakukanribu/johotokeika/tokei/tokeisho/tokeishoh20.html (accessed on July 7, 2021).

[2]Figures for residential density and retail sales from the Second Round of the Toyama Basic Plan for City Center Revitalization. Toyama City, April 2012. https://www.city.toyama.toyama.jp/data/open/cnt/3/2332/1/dai2kichukatukeikaku.pdf (accessed July 7, 2021).

residential concentrations in the city center as well as in areas along the public transport axes. The latter spatial target zones are unique in Japan. This is because many train and tram tracks have remained in the city, whereas they have been abandoned in many other local cities. As a result, Toyama received the country's first authorization for its Basic Plan for City Center Revitalization from the central government on February 8, 2007, and was selected by the OECD (2012) as a notable case study of compact city policies.[3]

This paper relates to a growing literature on urban economics that has conducted place-based policy evaluation (Neumark and Simpson, 2015). In this, policymakers designate a geographical area, and several programs are implemented intensively within this area, with the literature often considering tax incentives for individual firms located in specific underperforming districts known as Enterprise/Empowerment Zones (Busso et al., 2013; Givord et al., 2013; Wang, 2013). For their part, Toyama compact city policies do not directly provide tax or subsidy incentives to individual firms. Instead, they offer subsidy incentives for community development in the target zones. For example, the city government has promoted the development of housing, public and commercial facilities, and public transport systems to increase the attractiveness of the target areas. If households move to these target areas or acquire housing, they can then receive the subsidies. These projects also attract travelers from outside areas. The spatially targeted policies of Toyama City are, therefore, expected to have a positive spillover effect on incumbent retailers through increasing market size.

A critical problem in evaluating place-based programs is that the areas affected are not randomly selected in accordance with given criteria. To overcome this selection bias, Busso et al. (2013), Givord et al. (2013), and Wang (2013) selected areas that adopted programs later as applicants for the control group. They then used matching methods to select a reasonable counterfactual for any of the treated areas based on area level covariates.[4] However, the average treatment effect on the treated (ATT) can still suffer from systematic differences between the

[3]The others are Melbourne (Australia), Vancouver (Canada), Paris (France), and Portland (US). Among these, Toyama is closest in population size to Portland.

[4]We may consider that a regression discontinuity design is valid for drawing causal inferences because a geographic boundary can clearly split areas into the treated and the control. However, the impact of place-based programs is likely to involve leakage to areas with a common boundary (Givord et al., 2013; Hanson and Rohlin, 2013).

areas. For example, time-invariant unobservable factors such as the motivation of firms in the area may affect both treatment status and outcomes. Fortunately, a difference-in-differences (DID) estimator can correct for this selection bias on time-invariant unobservable heterogeneity (Heckman et al., 1997; Smith & Todd, 2005). For this reason, the aforementioned studies have integrated a matching method with a DID estimator to compare the conditional before–after outcomes of the earlier treated with those of the matched later treated.

Our quasi-experimental design follows Busso et al. (2013), Givord et al. (2013), and Wang (2013). However, compared with these studies, the present study involves far fewer treated areas because we focus on only one city, namely, Toyama City. To address this, we apply a matching method based on individual establishment-level characteristics rather than area-level statistics. That is, the individual establishments are considered as the unit of observation, and this enables us to ensure a large sample size for both the treatment and control groups. Our control group is selected from establishments located in cities where a Basic Plan for City Center Revitalization has been authorized about ten years after Toyama. The city center in these cities provides a rational counterfactual in that they, likewise, experienced suburban sprawl, but had not yet implemented compact city policies. We then estimate the difference in the average growth of outcomes between the treatment and the matched control groups to recognize the causal effect of compact city policy.

Compact city policies favor built public transit systems to break away from car dependence, and for this reason Toyama City designed unique spatially targeted zones along public transport routes. Like the above, we employ a DID matching estimator to compare the before–after outcomes between the existing retailers in target zones along the public transport lines in Toyama and the matched control group. One difference is that we select the control group from establishments located in cities where the Basic Plan is authorized at around the same time, but where target zones along the public transport axes were not designed. Thus, this paper also relates to the literature on TOD and its impact. Numerous empirical works have attempted to identify the economic impacts of TOD on surrounding neighborhoods. Nonetheless, the number of studies focusing on the impact on retail activities, which is a key component of mixed-use

TOD, remains limited, with Schuetz (2015) and Credit (2017) as exceptions.[5]

Our results suggest that compact city policy in the central zone does not produce clear positive spillover effects on sales or floor space, although there appears to be a delayed improvement in employment. Five and seven years after the policy was enacted, we do not find significant differences in the growth rates of retail sales, floor space, or employment compared with their matched counterfactuals. After nine years, the growth rates of retail sales and floor space remain statistically indistinguishable from those of the counterfactuals. In contrast, the growth rate of employment is 6.2 percentage points higher. Our findings are therefore somewhat different from the existing literature on place-based policies. For instance, Busso et al. (2013) demonstrated that the Urban Empowerment Zone program in the US had no significant impact on increasing employment among incumbent firms, while Givord et al. (2013) found that place-based tax exemptions in France were not effective in fostering either business creation or employment for already existing companies, potentially because of increased competition among new entrants in the target areas.

Moreover, we do not find any significant policy impact on incumbent retailers located along Toyama's public transport axes. Schuetz (2015) also showed that TOD has no significant impact on retail employment near rail transit stations, suggesting that consumers in automobile-dependent cities still prefer shopping by car.

Overall, these results lead us to conclude that the current framework of Toyama's compact city strategies produces positive spillover effects that are limited both in scope and in the range of outcomes considered. Specifically, these effects appear only for employment and only within the city center among incumbent retailers.

The rest of the paper is organized as follows. Section 2 briefly introduces the ideas behind the compact city policies of Toyama City, Japan. Section 3 discusses the empirical method, data, and results. Finally, Section 4 presents the conclusion.

[5] Considering preintervention trends, they selected control areas from the same metropolitan area where the treated areas are located. Unlike Schuetz (2015) and Credit (2017), our selected counterfactuals come from outside Toyama City.

2 Background

Before the 1990s, the development of large-scale retail stores in Japan was strictly coordinated by the central government to preserve local retail activity.[6] As a result, the Japanese retail sector was dominated by small and medium-sized retailers (Itoh, 2000). Even when cars became the dominant transport mode in regional cities, only medium-sized stores were developed along suburban highways. However, these restrictions were gradually relaxed after May 1990 in response to the Japan–US Structural Impediments Initiative.[7] Since then, developers have secured low-priced land on the edge of cities to construct large-scale commercial facilities with huge parking lots. One consequence is that retail activity in city centers has deteriorated substantially and the traditional shopping street has been ridiculed as a shuttered street because of highly-visible empty shops.[8]

To restrain further suburban sprawl, the Japanese central government enforced the following three acts relating to urban renewal in the 1990s and 2000s: the Act on the Measures by Large-Scale Retail Stores for Preservation of Living Environment (in effect from 2000), which regulates developments by considering the impact on the neighborhood environment such as noise and traffic congestion; the City Planning Act (in effect from 1968; revised in 2006) which allows local governments to prohibit the development of commercial facilities with a total floor space of 10,000 square meters or more in the suburbs; and the Act on Vitalization in City Center (in effect from 1998; revised in 2006 and 2014), which aims to reinvigorate the geographical core of cities where urban (public) facilities including commercial facilities are concentrated.

As part of its 2006 Amended Act on Vitalization in City Center, the central government newly introduced a "Selection and Concentration" objective. Within this, and to receive subsidies from the central government for this purpose, each local government must elaborate a Basic Plan for City Center Revitalization that includes the reinvigoration of its city center by

[6] See Sadun (2015) for the impact of entry barriers against large stores on independent retailers.

[7] Igami (2011) investigated the effects of this deregulation on existing competitors in the Tokyo supermarket industry.

[8] Daunfeldt et al. (2020) investigated the extent to which the entry of external shopping malls in small cities in Sweden affected the productivity of incumbent firms located in the city center. The empirical results suggested that the productivity of incumbent firms fell after the establishment of new external shopping malls, but that these impacts resulted from other negative time trends such as population aging and shrinking.

creating liveliness, promoting residence, enhancing economic vitality, and upgrading the public transportation system and submitting it for certification. As of June 29, 2021, the Cabinet Office had certified 257 Basic Plans for 151 of Japan's 1,741 municipalities.[9] As the name suggests, the Basic Plan for City Center Revitalization focuses on the spatially targeted area in the city core, instead of targeting the entire region. Therefore, nearly all local governments that have gained authorization for their Basic Plan have attempted to form a city with a monocentric urban structure, with the projects listed in the Basic Plan conducted in only the inner-core areas.

After the Toyama Basic Plan was first authorized on February 8, 2007, Toyama City government implemented various projects for establishing convenient public transportation, creating liveliness, and promoting residence in the central area, comprising 27 projects in the first round, and more than 60 projects in the second and third rounds.[10] Table 1 details the key projects listed in the Toyama Basic Plan during our study period between 2007 and 2016.

Fig. 1 displays the extent to which population and commercial facilities of 10,000 square meters or more (point object) in Toyama City (the thick line) suburbanized over the decade of our analysis. A dashed line indicates existing railway and tram lines in 2005. The spatially targeted zone of the city center is surrounded by the black frame (436 hectares), while those of the public transport axes are surrounded by the gray frame. The city center includes Toyama Station and the traditional shopping streets. As shown, much of the dark-colored mesh in the central area in 1995 is converted to light-colored mesh by 2005, whereas the opposite took place in the suburbs, suggesting widescale population dispersal between 1995 and 2005. According to the Second Round of the Toyama Basic Plan for City Center Revitalization, population in the central district decreased by 11.5 percent between 1995 and 2006. Turning to commercial facilities, one (Seibu Department Store; 13,516 square meters) of four department stores disappeared from the city center zone during this time, while a mega-shopping mall (Favore; 47,360 square meters) opened in the suburbs. In addition, several large-scale retail stores, including the largest mall in

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[9]See the webpage of the Vitalization in City Center, the Cabinet Office of Japan. https://www.chisou.go.jp/tiiki/chukatu/index.html (accessed June 29, 2021)

[10]See Kidokoro (2008), Takami and Hatoyama (2008), OECD (2012), and Arai (2019) for further details about compact city polices in Japan and Toyama City.

the region (Aeon mall; 54,200 square meters), were established in satellite cities.[11] The Second Round of the Toyama Basic Plan noted that the number of retailers in the central district fell by 36.0 percent between 1994 and 2007.

Unlike other local governments, Toyama City government adopted its compact city based on a polycentric urban formation. Besides the Toyama Basic Plan, Toyama planned networks of public transportation terminating in the city center, and incorporated residential areas along the public transport axes into the target zones. The Portram, which transformed an unprofitable railway connecting the city center and the suburbs into an attractive light rail transit in 2006, is considered as a successful case for compact cities in Japan. This supplementary project seems to be rational because it is unrealistic for a sprawling city to adopt a monocentric shape. Residential areas were designed within 500 meters for railway stations or tram stops and within 300 meters for bus stops (Fig. 1). The main projects were a subsidy scheme for building/owing/renting a house in these areas.

Retailers in the city center zone could also enjoy the benefits of the Hokuriku Shinkansen (high-speed bullet train), which launched on March 14, 2015. The Hokuriku Shinkansen increased the number of passengers at Toyama Station and sharply reduced passenger numbers at Toyama Airport, which is in the suburbs. Although the Hokuriku Shinkansen was a national project, the Toyama Basic Plan of course considered it. Indeed, the Portram connected with the Centram (a loop tram line in the city center) under the Hokuriku Shinkansen viaduct at Toyama Station in 2020 for greater passenger convenience. Note that our study includes the impact of the Hokuriku Shinkansen project.

It is important to note that compact city developments are not simple retail revitalization. Instead, they are town developments, which strive to reinvigorate the liveliness and the economic vitality of the community as a whole. According to OECD (2012), the characteristics of compact cities are dense and proximate development patterns, built-up areas linked by public transport systems, and accessibility to local services and jobs. The Toyama compact city strategies precisely aimed to form the spatial urban structure characterized by OECD (2012).[12]

[11] Both Favore and Aeon malls extended their floor space further in 2019.

[12] Given the circumstances of an aging and shrinking population in a typical local city, the Ministry of Land,

Policymakers maintain that Toyama's compact city strategies serve to attract residents to geographically designated areas. We, therefore, hypothesize that these policies also boosted the economic performance of firms in these areas, including incumbent retailers.

3 Empirical analysis

3.1 Empirical methodology

This paper estimates the causal influence of Toyama compact city planning on incumbent retailers located in the city center zone and along public transportation line zones, using the DID matching estimation developed by Heckman et al. (1997) and Smith & Todd (2005).

The target zone for the city center is illustrated in Fig. 1. The treatment group comprises incumbent retailers located in the target zone. We apply a two-step procedure to choose the appropriate control group and establish the appropriate counterfactual pair of the treatment group. The first stage relates to the geographical similarities between the two groups. To consider this, we use the time lag of policy implementation. The target zones that are authorized later suffer from sprawling and thus seem to be a reasonable counterfactual for what would happen to the earlier target zones in the absence of policy (Busso et al., 2013; Givord et al., 2013; Wang, 2013). Fig. 2 depicts our twenty selected cities where a Basic Plan was authorized from 2015 onwards, i.e., 8–10 years after Toyama. We remove incumbent retailers in Sakai (not shown), which is a government-designated city with a large population, from the control group. Each local government designates the geographical area of the central city where the Basic Plan is applied. We select incumbent retailers located in the target zone of these cities as the potential set for the control group. The second stage relates to the firm similarities. We select the counterfactual pair from the potential set of the control group, using the propensity score matching algorithm based on establishment-level attributes. Carefully controlling for the initial conditions of the treatment and control groups using this two-step procedure follows the assumption of pretreatment parallel trends.

Infrastructure, Transport and Tourism has advanced a "Compact and Network" policy since 2014 to maintain sustainable urban management. These spatial developments aim at residential concentration in the city center and suburban hubs, with public transportation networks connecting them. We can, therefore, also regard the Toyama compact city model as a leading example of a "Compact and Network" policy.

Denote t as the treated year, $t+s$ as s years after the treatment, and $t-1$ as one year before the treatment. The ATT of the DID matching estimator measures the difference in the average growth of the outcomes between the treated and untreated such as:

$$ATT = E(Y^1_{i,t+s} - Y^1_{i,t-1} | T_{i,t} = 1, \boldsymbol{X}_{i,t-1}) - E(Y^0_{i,t+s} - Y^0_{i,t-1} | T_{i,t} = 1, \boldsymbol{X}_{i,t-1}),$$

where $Y^1_{i,\tau}$ and $Y^0_{i,\tau}$ are the naturally logged outcomes of an incumbent retailer i under treatment and nontreatment in year τ, respectively, $T_{i,t}$ is a dummy variable indicating an incumbent retailer, i is a treated retailer, and $\boldsymbol{X}_{i,t-1}$ represents the characteristics of the incumbent retailer i in the pretreatment year. We can observe the average growth of the outcomes of the treated (the first term on the right-hand side), while we require the control group to estimate the counterfactual average growth (the second term on the right-hand side). We, therefore, apply the matching estimation to identify the counterfactual average growth from the control group using the observational covariates (Rubin, 1977).

The following ATT of the DID matching estimator then captures the magnitude of the difference in average growth of the outcomes between the treatment and control groups such as:

$$ATT = \frac{1}{N_1} \sum_{i \in \mathcal{I}_1} \left[(Y^1_{i,t+s} - Y^1_{i,t-1}) - \sum_{j \in \mathcal{I}_0} W_{ij} (Y^0_{j,t+s} - Y^0_{j,t-1}) \right],$$

where $\mathcal{I}_1$ is the set of indices corresponding to treated incumbent retailers in Toyama, N_1 is the number of treated incumbent retailers in Toyama, j is the untreated incumbent retailers, $\mathcal{I}_0$ is the set of indices corresponding to untreated incumbent retailers outside Toyama, and W_{ij} are the weights ($0 \leq W_{ij} \leq 1$), which depend on the closeness of the propensity scores between i and j. In this paper, one-to-one propensity score matching (1-PSM) is used as the benchmark. In this case, $W_{ij} = 1$ for all matched counterfactuals. As a robustness check, we also apply one-to-two propensity score matching (2-PSM). In this case, $W_{ij} = 0.5$.

The propensity score is defined as:

$$e(\boldsymbol{X}_{i,t-1}) = \Pr(T_{i,t} = 1 | \boldsymbol{X}_{i,t-1}).$$

The target zones for the public transport lines are the districts with easy accessibility to public transport in Fig. 1. Like above, the treatment group comprises incumbent retailers located in the target zones. The potential control groups are in cities where the Basic Plan was authorized around the same time but the public transport axes were not designed. To repeat, each local government designates the geographical areas of the central city where the Basic Plan is applied. However, there were no cities that designated target zones along the public transport axes even ten years after the approval of their Basic Plan. We, therefore, select incumbent retailers located outside the targeted central zone as a candidate counterfactual. This selection approach must violate the assumption of pretreatment parallel trends because the zones are just the suburbs of these cities, which are less likely to have the same features in the target zones for the public transport lines in Toyama. To address this concern, we limit the sample to cities that are spatially close to Toyama City. Fig. 3 plots the seven selected cities in Hokuriku region (Niigata, Toyama, Ishikawa, and Fukui Prefectures) where the Basic Plan was authorized by 2008. We select cities whose Basic Plans were authorized by 2008 and thus exclude Niigata (a government-designated city), Tsuruga (authorized in 2009), and Tokamachi (authorized in 2013). The target zones for the city center in each city are colored deep sky-blue. Incumbent retailers located outside these target zones in the seven cities provide the potential set for the control group. We then select the counterfactual pair of the treated incumbent retailers from the potential set, using propensity score matching based on establishment-level attributes. We also incorporate the neighboring market conditions of each establishment into the covariates to further address the assumption of pretreatment parallel trends, as discussed in detail in the next subsection.

3.2 Data

The data are from the 2002, 2004, 2007, and 2014 Census of Commerce conducted by Ministry of Economy, Trade and Industry (METI), which is linked to the 2012 and 2016 Economic Census for Business Activity conducted by Ministry of Internal Affairs and Communications (MIC) and METI. The Census of Commerce covers establishments in the wholesale and retail sectors, comprising about 1,600,000, 1,500,000, and 1,400,000 establishments in 2004, 2007, and 2014, respectively. In this paper, we only focus on establishments in the retail sector.

Note that the individual establishments are treated as the unit of observation. The incumbent establishments include establishment codes from the previous census, and this enables us to construct establishment-level panel data for incumbent retailers. We convert the location of each establishment from the block (Cho-Cho-Aza) level into combinations of longitude and latitude using geocoding. This enables us to recognize the corresponding mesh block for each establishment's location. Moreover, we construct a unique 50 meter meshed shapefile for Toyama City and add information on the target zones to the corresponding mesh (Fig. 1). We also make a shapefile for the control group, which includes information on the geographical areas of the city center based on the block level (see, e.g., the deep sky-blue colored polygon in Fig 3). Then we can identify whether the existing establishments are located in the target zones or not.

The data covers the periods before and after the Toyama compact city policies: the pretreatment period is prior to 2007 and the posttreatment period is from 2007 onward. We, therefore, can calculate the 2007–2012, 2007–2014, and 2007–2016 changes in the outcome variables. The outcomes are annual sales, which are deflated 2015 prices using the consumer price index (2015 = 100), sales floor space, and the number of employees. We take the natural logarithmic transformation for the outcome variables. We regard sales as a production output and floor space and employees as production inputs.

The matching is based on establishment-level covariates during the pretreatment period between 2002 and 2007. Specifically, we use annual sales of goods, sales floor space, and the number of employees from the 2002, 2004, and 2007 Census of Commerce, along with the shares of female, full-time workers, and opening hours from the 2004 and 2007 Census. We also use a parking lot dummy, the number of parking vehicles, the share of E-commerce, a dummy variable indicating the share of over-the-counter franchisees, a dummy variable reflecting large retail stores from the 2007 Census of Commerce.[13]

In the analysis of the areas along the public transport lines, we obtain the neighboring market conditions for local employment and residential population around each individual es-

[13] Our data processing is as follows. First, we exclude establishments for which we cannot obtain location information at the block level. Second, we exclude the top and bottom one percent of observations for each measure of productivity growth as these are possible extreme outliers. Third, we restrict the surviving establishments to those where all necessary information is available to conduct the matching and to calculate the growth rates.

tablishment. A one-kilometer mesh population is obtained from the 2000, 2005, 2010, 2015, and 2020 Population Census (MIC), while one-kilometer mesh employment is obtained for 2001 and 2006 from the Establishment and Enterprise Census (MIC), the 2009 and 2014 Economic Census for Business Frame (MIC and METI), and the 2012 and 2016 Economic Census for Business Activity (MIC and METI), respectively. We employ linear interpolation to estimate the values for missing years. We define a two-kilometer radius around the centroid of each mesh block where the incumbent retailer i is located as the neighboring market of the incumbent retailer i. Addresses are geocoded to latitude and longitude coordinates to obtain the corresponding mesh code of each establishment. Fig. 4 depicts the case of the market neighboring Toyama City Hall as an example, with total employment and residential population within the mesh colored light mint green serving as neighboring market variables.

3.3 Empirical results and discussion

Table 2 presents the empirical results of the DID PSM, estimations in the target zone for the city center.[14] Panels A and B in column 1, which apply the DID 1-PSM, suggest that compact city policies do not have any significant treatment effects on either sales growth or floor space growth throughout the nine-year study period. The ATT that estimates for retail employment growth in Panel C are also not significant over the five- and seven-year intervals. We, however, finally identify a positive and significant impact on the employment growth of incumbent retailers located in the city center after nine years of the policies in operation. Specifically, the treated incumbent retailers experienced a 6.2 percentage point increase in employment growth, indicating that they received spillover effects from compact city policies. Note that the Hokuriku Shinkansen, which we know has brought consumers to the target zone for the city center from outside the city, seems to have complemented the impact of compact city polices on certain aspects of employment.

With the results from Panels A, B, and C in column 2, all of which apply the DID 2-PSM

[14]Tables A.1-A.3 in the Appendix present the balancing test results based on the one-to-one propensity score matching (1-PSM) algorithm. Although the matches are selected based on the estimated propensity scores, the results in the tables suggest that the gaps in some variables become larger after matching. In addition, the tables show that the variance ratios of some variables in the matched samples deviate from one.

estimator, we obtain qualitatively similar findings to those from the DID 1-PSM estimator. These findings are robust, as the only positive result in column 1 emerges for retail employment growth over the nine-year interval.

Table 3 presents the empirical results in the target zones along the public transport lines.[15] This demonstrates that none of the outcomes for incumbent retailers differ from those of the matched counterfactuals.

Overall, the results in Tables 2 and 3 suggest that the Toyama compact city policies do generate retail revitalization only in terms of employment and only in the target zones in the city center. However, according to the Final Follow-up Report on the Second Round of Toyama Basic Plan for City Center Revitalization, the compact city policies of Toyama City positively affected the numbers of tram passengers and net migration to the city center because these variables reversed their downward trends during this time.[16] In evidence, ridership of the city tram was approximately 13,900 per day in 2016, which is 900 passengers higher than the targeted value, while net migration was approximately 700 people during the period from 2011 to 2016, which is 300 people higher. Ridership of the suburban tram and net migration in the transportation corridors also increased (Arai, 2019).

It is also possible that the policies tended to attract new retailers to the target zones, thereby intensifying competition and lowering the performance of incumbent retailers. However, new entrants can also enhance the performance of nearby incumbent retailers by bringing more customers to the area.[17]

As such, there should be positive externalities on the demand side as better visibility with the new tram, the net increase in inhabitants, and the entry of new retailers benefit incumbent retailers in the target zones. Why then is the performance of surviving retailers unchanged, except for employment in the city center? The key mechanism underlying these findings is likely tax distortions favoring incumbent retailers that act as exit barriers (Nishimura and Tachibana,

[15]Tables A.4–A.6 in the Appendix present matching results of balancing tests based on the 1-PSM algorithm.

[16]The Final Follow-up Report on the Second Round of the Toyama Basic Plan for City Center Revitalization. Toyama City, May, 2017. https://www.city.toyama.toyama.jp/data/open/cnt/3/2332/1/toyama_saisyuFU_2017.06.pdf (accessed July 7, 2021).

[17]The average productivity of surviving retailers in these areas can also increase when intensified competition expels less productive retailers (Håkansson et al., 2019).

1996; Yamazaki, 2021). For example, incumbent retailers owning retail premises in the target areas, often mom-and-pop stores, tend to continue operating even though their business performance is low because Japanese inheritance taxes give preferential treatment to real estate assets.[18] Surviving unattractive shops also seem to offset the positive shopping externalities. This implies that any newly created consumers are less likely to exert spillover benefits on shopping streets in the target zones. Indeed, the Final Follow-up Report on the Second Round of the Toyama Basic Plan for City Center Revitalization indicated that foot traffic in the city center remained flat and at a low level. Local footfall was only about 23,000 pedestrians on a Sunday in 2016, which is much lower than the targeted value of 32,000 pedestrians.[19]

4 Conclusion

The compact city policies of Toyama City aim at enhancing residential concentration in the central city center and multiple areas in suburbs, and the public transport system connecting them. Town developments that are projected by Toyama compact city programs are not simple retail revitalization. However, visibility on the new tram, the net increase in inhabitants, and the entry of new retailers are likely to increase shopper traffic in the target zones, and we expect these to indirectly affect the performance of incumbent retailers plagued with urban sprawl.

This paper contributes to the literature on urban economics examining place-based policy evaluation by focusing on the spillover effects of town development on individual-level firm performance. This contrasts with the existing literature, which has focused on place-based policies that directly benefit firms in target zones, such as tax exemptions or subsidies. Namely, we empirically measured the potential spillover effects of Toyama compact city policies on the growth in performance of incumbent retailers located in the targeted zones using DID matching estimations and establishment-level panel data. Geocoding techniques allowed us to identify establishments treated by the compact city policies with matching primarily conducted using

[18] The tax base of financial assets is evaluated at their market value, whereas the tax base of real estate assets is evaluated at about 70 percent of market value. Therefore, households have an incentive to hold real estate assets for inheritance purposes.

[19] The Final Follow-up Report also pointed out that empty shops remained at a high level in the central shopping streets.

establishment-level characteristics. The results suggest that the compact city policies exert no spillover effects on either inputs (retail sales) or outputs (sales floor space and the number of employees) for incumbent retailers in the short term. The policies still have no positive impact in the long run, except on employment in the target zone of the city center. Overall, these results lead us to conclude that the current framework of Toyama's compact city strategies produces positive spillover effects that are limited both in scope and in the range of outcomes considered. Although our chosen empirical model cannot provide the precise mechanism underpinning this, we reason that it is potentially because low-performing retailers cling to the targeted areas for survival because Japanese inheritance taxes provide more favorable treatment to real estate assets (Nishimura and Tachibana, 1996; Yamazaki, 2021).

Two ancillary notes could serve to improve our understanding of the impacts of compact city policies on enhancing economic vitality. First, not only retailers but also service providers and hospitality businesses can enjoy the benefits of positive externalities arising from the demand side (Credit, 2018). The DID matching estimator we employ can also be applied to the productivity growth of these sectors. Unfortunately, there is no suitable long-run data available for Japan. Second, local government policymakers are often interested in the extent to which their own policies have an aggregate impact on performance in the target zones. In such a situation, the sample size of the treatment group is of course reduced to one (i.e., only Toyama City in our case). Accordingly, standard matching estimations will not work. Instead, a synthetic control method could be applied for an aggregate-level evaluation if sufficient pre and postintervention information is available (Abadie et al., 2010; Abadie, 2021). We defer these items to future research.

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Declaration of generative AI in the writing process

During the preparation of this work, the authors used ChatGPT in order to improve readability. After using this service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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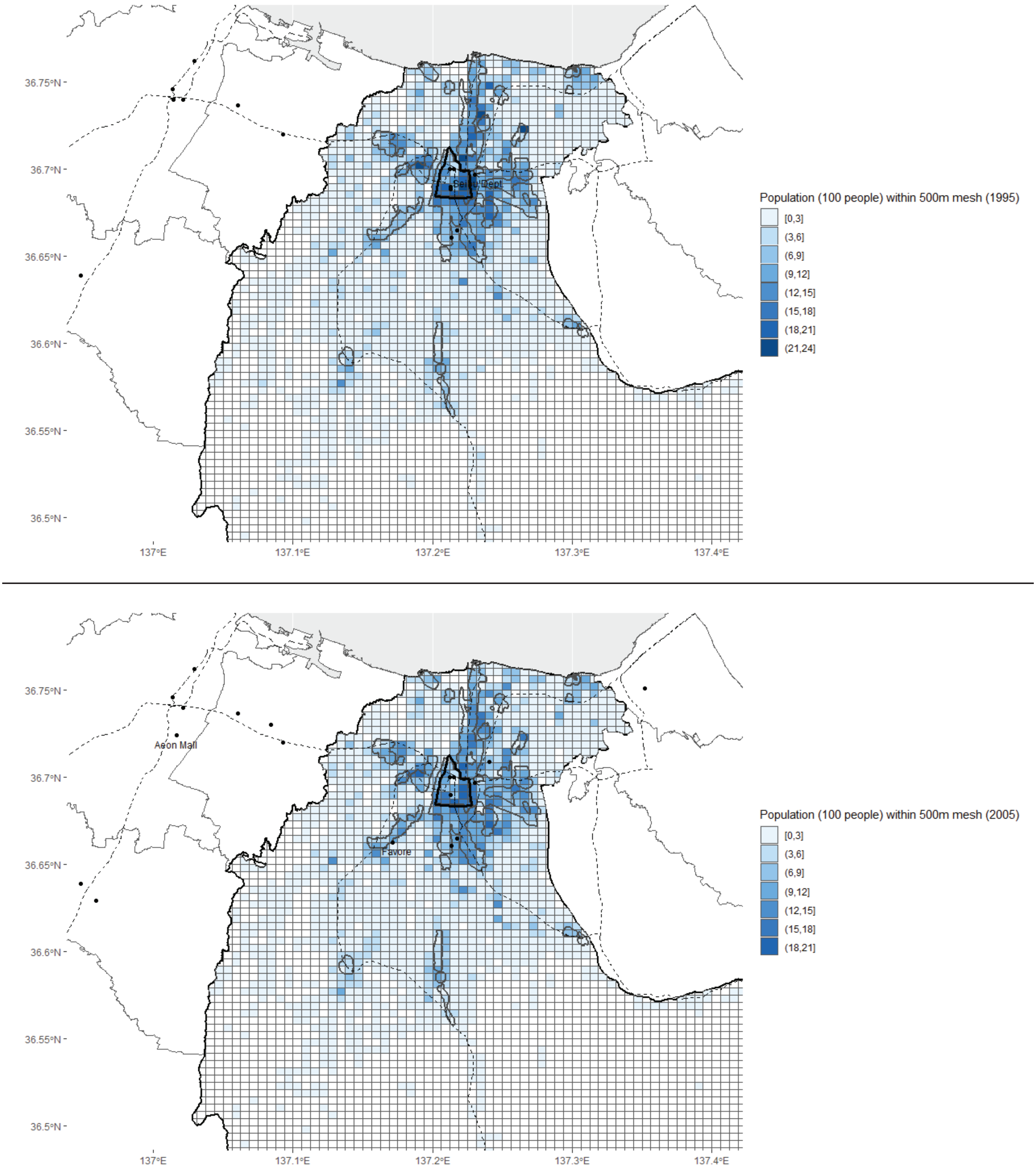

Figure 1 Population density and location of large commercial facilities between 1995 and 2005

Sources: Information on population and Shapefiles with 500m mesh provided by Ministry of Internal Affairs and Communications (https://www.stat.go.jp/data/gis). Shapefiles of administrative district and railway/tram lines provided by the National Land Information Division, National Spatial Planning and Regional Policy Bureau, Ministry of Land, Infrastructure, Transport and Tourism (https://nlftp.mlit.go.jp/ksj/). Location information on commercial facilities of 10,000 square meters or more (point objects) provided by Zenkoku Ogata Koriten Soran, Toyo Keizai. Information on spatially targeted zones along public transport routes provided by Toyama City (https://www2.wagmap.jp/toyama/Portal).

Notes: Created by the authors using R ver. 3.6.3. The spatially targeted zone of the city center is surrounded by the black frame, while those of the public transport axes are surrounded by the gray frame.

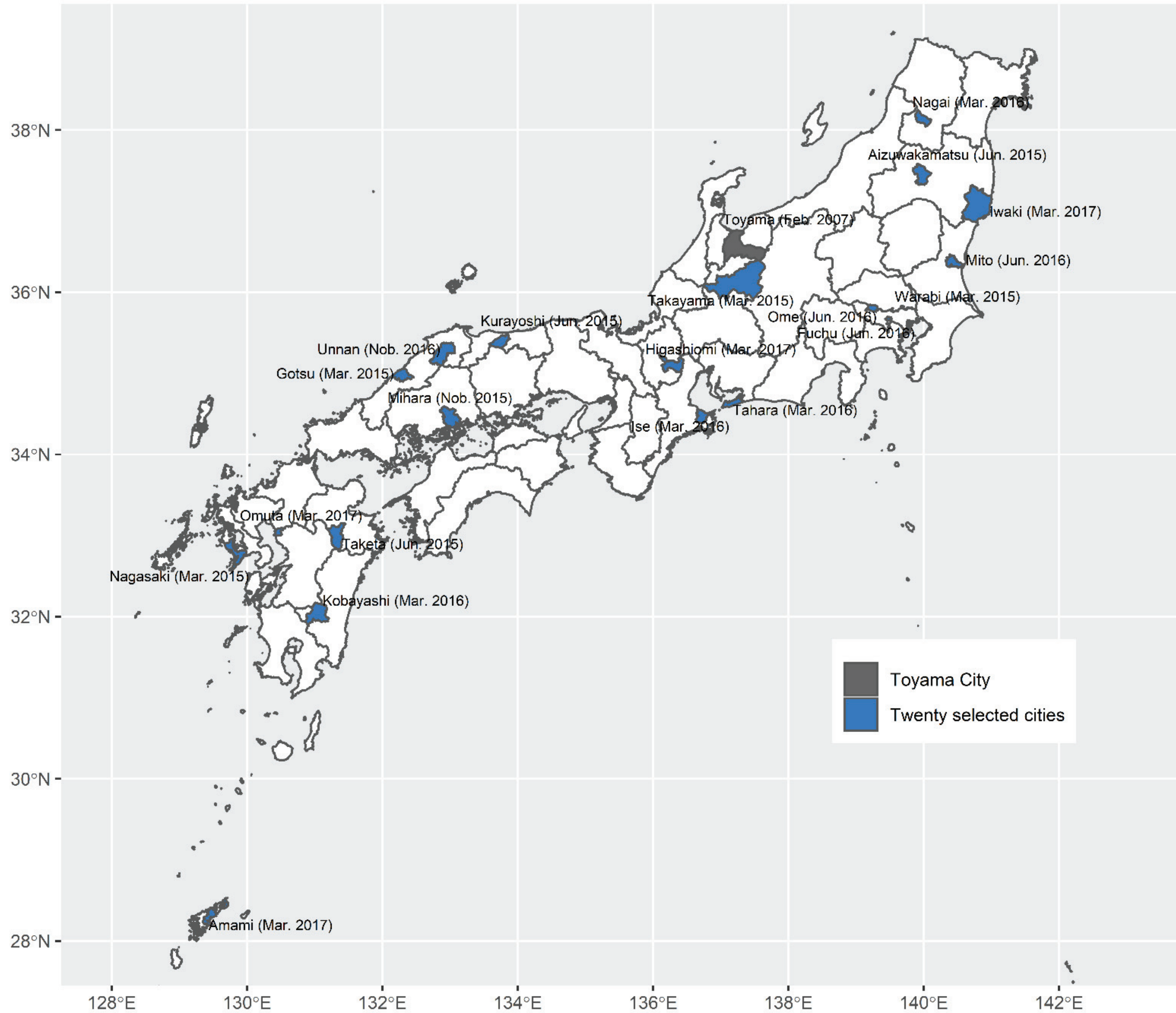

Figure 2 Twenty selected cities where a Basic Plan was authorized 8–10 years after Toyama City

Source: Shapefiles of administrative district provided by the National Land Information Division, National Spatial Planning and Regional Policy Bureau, Ministry of Land, Infrastructure, Transport and Tourism (https://nlftp.mlit.go.jp/ksj/). List of authorized Basic Plans available from the Cabinet Office (https://www.chisou.go.jp/tiiki/chukatu/).

Note: Created by the authors using R ver. 3.6.3.

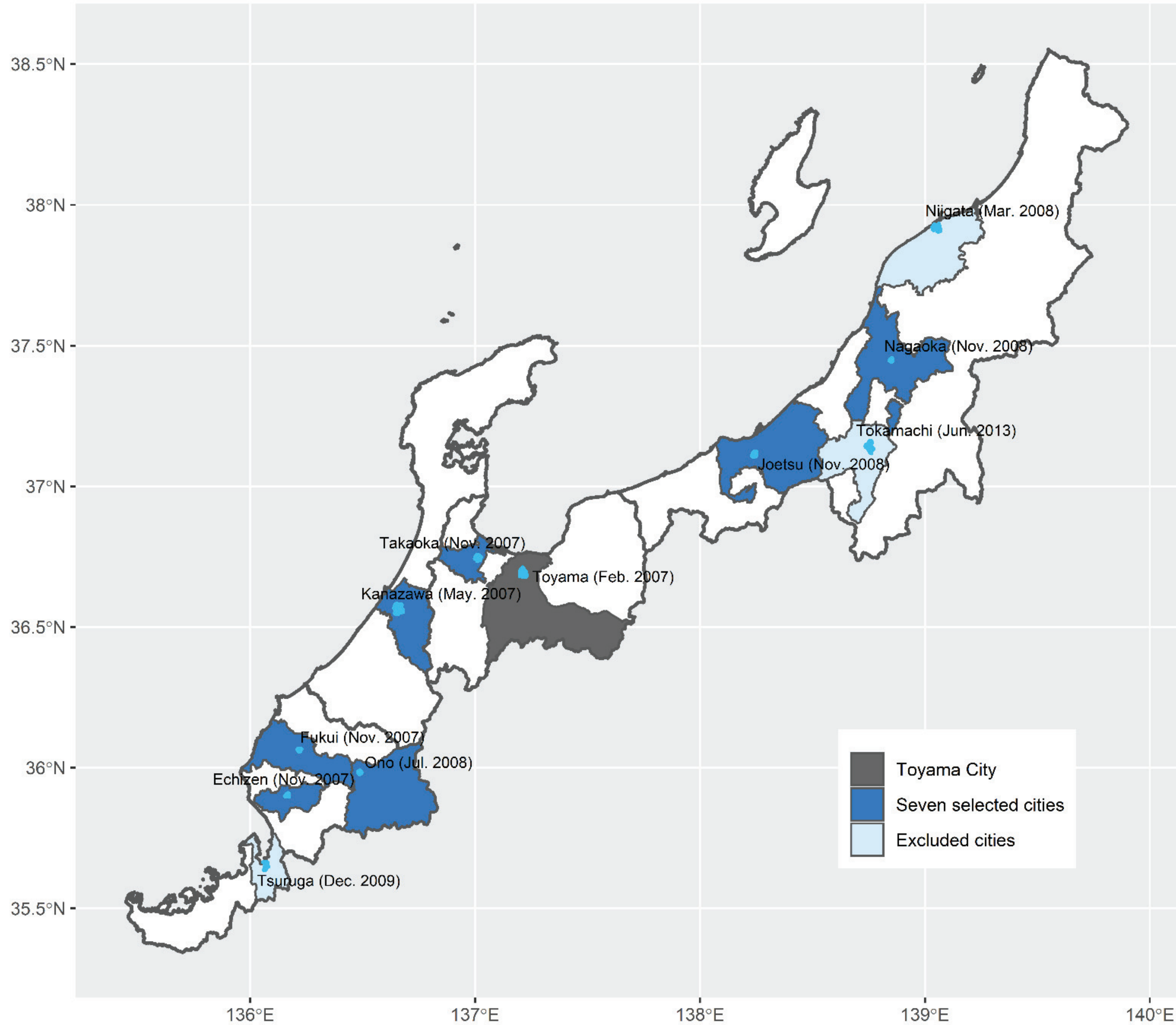

Figure 3 Seven selected cities in Hokuriku region where a Basic Plan was authorized by 2008

Source: Shapefiles of administrative district provided by the National Land Information Division, National Spatial Planning and Regional Policy Bureau, Ministry of Land, Infrastructure, Transport and Tourism (https://nlftp.mlit.go.jp/ksj/). List of authorized Basic Plans available from the Cabinet Office (https://www.chisou.go.jp/tiiki/chukatu/).

Notes: Created by the authors using R ver. 3.6.3. The deep sky-blue colored areas indicate the spatially targeted zone in each city.

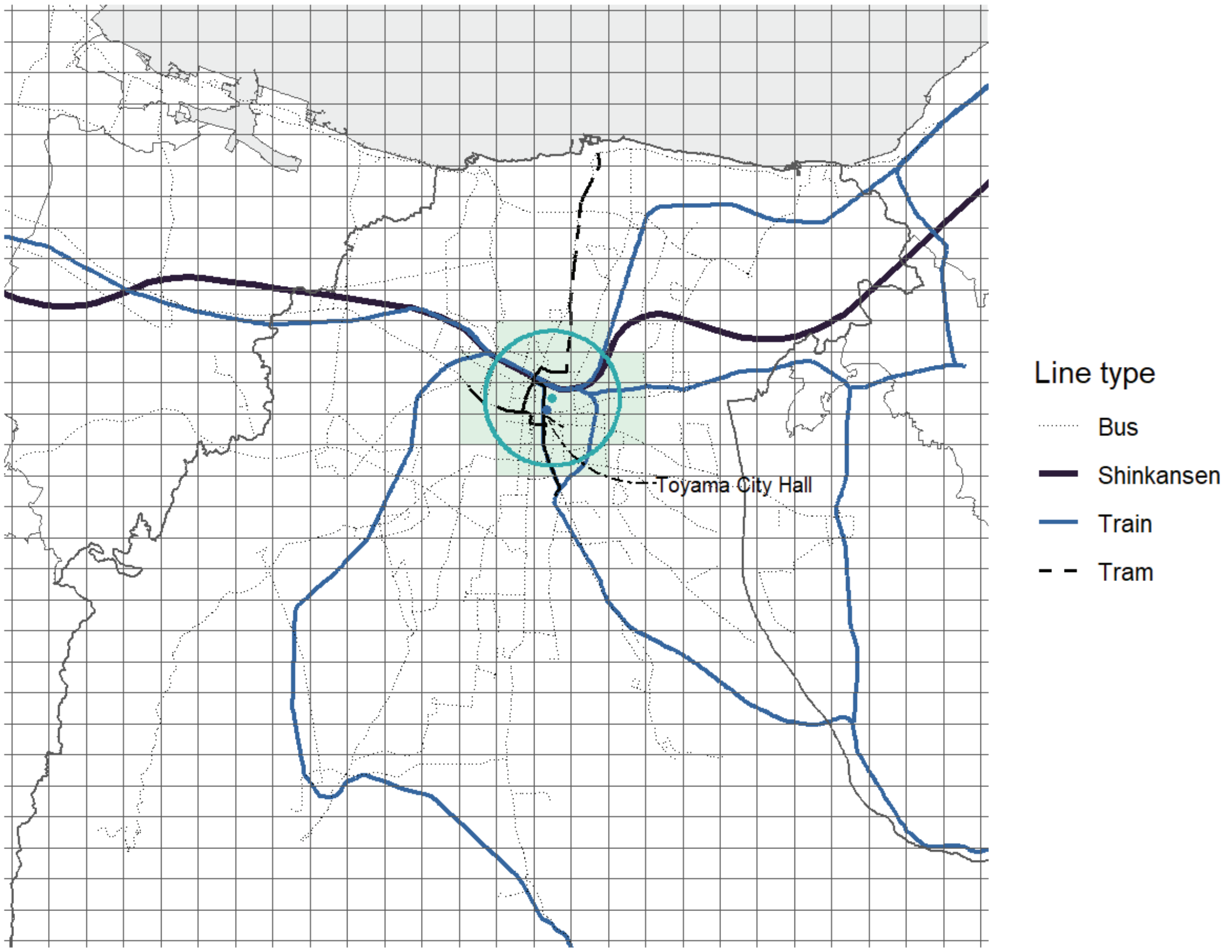

Figure 4 Example of a neighboring market

Sources: Shapefile of 1km mesh provided by the Ministry of Internal Affairs and Communications (https://www.stat.go.jp/data/mesh).
Shapefiles of administrative district and railway/tram lines provided by the National Land Information Division, National Spatial Planning and Regional Policy Bureau, Ministry of Land, Infrastructure, Transport and Tourism (https://nlftp.mlit.go.jp/ksj/).

Note: Created by the authors using R ver. 3.6.3.

Table 1: Key projects included in the Toyama Basic Plan for City Center Revitalization

Objective	Project
The first round (Feb. 2007–Mar. 2012)	
Upgrading the public transportation system [Ridership of the city tram]	Loop-line service for the city tram (Centram) Circular community bus service Public transport pass for senior citizens
Creating liveliness [Pedestrian flows]	Redevelopment of the retail core Development of facilities (movie theater, food hall, multipurpose open space with a large grass roof)
Promoting residence [Residential population]	Promotion of constructing apartment buildings Financial support for house building and rent
The second round (Apr. 2012–Mar. 2017)	
Upgrading public transportation, cycling, and walking [Ridership of the city tram]	Railway grade crossing around Toyama station North (Portram) south (Centram) connection of trams at Toyama Station Construction of a north-south free passage at Toyama Station Land readjustment around Toyama Station New tram station opening Public transport pass for senior citizens Built environments on bicycle use
Creating liveliness [Pedestrian flows]	Mixed-use redevelopment projects (retail, movie theater, and hotel) Development of cultural exchange facilities (glass art museum and library)
Providing a high quality of life [Social increase in residential population]	Mixed-use redevelopment projects (retail and residence) Renovation of local exchange center Operation of childcare support facility

Sources: The Toyama Basic Plan for City Center Revitalization, Toyama City, February 2007. https://www.city.toyama.toyama.jp/data/open/cnt/3/2332/1/all.pdf (accessed July 7, 2021); The Second Round of Toyama Basic Plan for City Center Revitalization, Toyama City, April, 2012. https://www.city.toyama.toyama.jp/data/open/cnt/3/2332/1/dai2kichukatukeikaku.pdf (accessed July 7, 2021).

Note: Performance indicators in square brackets.

Table 2: Average treatment effect on the treated (ATT) of the Toyama compact city policies (the city center zone)

	DID 1-PSM	DID 2-PSM	Treatment	Control
Panel A: Growth rate of annual sales				
2007–2012	0.009	0.004	370	2,973
	(0.038)	(0.033)		
2007–2014	0.035	0.056	294	2,550
	(0.051)	(0.044)		
2007–2016	0.037	0.047	298	2,519
	(0.063)	(0.055)		
Panel B: Growth rate of sales floor space				
2007–2012	–0.032	0.001	362	2,855
	(0.040)	(0.036)		
2007–2014	0.049	0.045	286	2,478
	(0.046)	(0.040)		
2007–2016	–0.018	0.035	107	1,198
	(0.066)	(0.056)		
Panel C: Growth rate of employees				
2007–2012	–0.012	–0.007	518	3,914
	(0.024)	(0.021)		
2007–2014	0.005	0.025	365	2,906
	(0.032)	(0.026)		
2007–2016	0.062**	0.049**	321	2,610
	(0.029)	(0.024)		

Notes: Standard errors following Abadie and Imbens (2006, 2016) in parentheses. ** denotes significance at the 5%. Estimation results were obtained by `teffect psmatch` in Stata ver. 15.1.

Table 3: Average treatment effect on the treated (ATT) of the Toyama compact city policies (public transportation line zones)

	DID 1-PSM	DID 2-PSM	Treatment	Control
Panel A: Growth rate of annual sales				
2007–2012	0.013	0.015	600	6,728
	(0.029)	(0.026)		
2007–2014	0.041	0.049	486	5,684
	(0.039)	(0.032)		
2007–2016	−0.015	0.021	506	5,653
	(0.039)	(0.034)		
Panel B: Growth rate of sales floor space				
2007–2012	0.024	0.040	578	6,394
	(0.033)	(0.029)		
2007–2014	0.030	0.042	468	5,466
	(0.038)	(0.033)		
2007–2016	−0.048	−0.051	205	2,044
	(0.048)	(0.042)		
Panel C: Growth rate of employees				
2007–2012	−0.003	0.023	764	8,611
	(0.018)	(0.016)		
2007–2014	0.002	0.000	578	6,494
	(0.023)	(0.020)		
2007–2016	−0.030	−0.024	532	5,853
	(0.024)	(0.021)		

Notes: Standard errors following Abadie and Imbens (2006, 2016) in parentheses. Estimation results were obtained by `teffect psmatch` in Stata ver. 15.1.

Appendix

Table A.1 Balancing tests based on 1-PSM algorithm for annual sales (the city center zone)

	2007–2012		2007–2014		2007–2016	
Variable	Raw	Matched	Raw	Matched	Raw	Matched
Panel A: Standardized differences						
Annual sales (2002)	0.064	0.032	-0.002	-0.036	-0.026	-0.015
Annual sales (2004)	0.049	0.013	-0.020	-0.103	-0.058	-0.014
Annual sales (2007)	0.065	0.027	0.005	-0.101	-0.049	-0.009
Employees (2002)	-0.019	0.037	-0.066	-0.061	-0.125	0.024
Employees (2004)	-0.015	0.016	-0.055	-0.055	-0.123	0.009
Employees (2007)	-0.018	0.052	-0.069	-0.057	-0.127	-0.002
Sales floor space (2002)	-0.005	0.040	-0.083	0.001	-0.079	-0.046
Sales floor space (2004)	0.041	0.055	-0.040	-0.002	-0.032	-0.035
Sales floor space (2007)	0.016	0.080	-0.060	-0.010	-0.064	-0.029
Share of female workers (2004)	0.044	0.041	0.087	-0.088	0.035	0.011
Share of female workers (2007)	0.107	0.047	0.172	-0.125	0.107	0.048
Share of full-time workers (2004)	0.100	0.025	0.030	0.027	-0.038	0.027
Share of full-time workers (2007)	0.156	-0.014	0.103	0.006	0.018	0.043
Opening hours (2004)	-0.060	-0.008	0.002	0.004	0.015	-0.016
Opening hours (2007)	-0.050	-0.038	0.012	0.015	0.016	0.005
Parking lot dummy (2007)	-0.015	0.077	0.019	-0.049	0.023	0.041
Parking vehicles (2007)	-0.056	-0.044	-0.093	0.028	-0.114	-0.072
Share of E-commerce (2007)	-0.088	-0.042	-0.095	-0.060	-0.090	0.002
Share of over-the-counter (2007)	-0.337	0.022	-0.366	-0.015	-0.373	-0.001
Franchisee dummy (2007)	-0.014	-0.033	0.016	-0.019	0.045	-0.071
Large-scale retail stores dummy (2007)	0.155	0.016	0.201	-0.009	0.153	-0.019
Panel B: Variance ratio						
Annual sales (2002)	1.019	1.108	0.988	0.938	0.904	1.246
Annual sales (2004)	1.048	1.157	0.889	0.991	0.887	1.142
Annual sales (2007)	0.957	1.116	0.857	1.008	0.874	1.021
Employees (2002)	0.902	1.110	0.837	0.788	0.802	1.069
Employees (2004)	0.897	1.138	0.835	0.775	0.802	1.081
Employees (2007)	0.907	1.122	0.809	0.799	0.815	1.097
Sales floor space (2002)	0.795	0.920	0.792	0.780	0.807	0.953
Sales floor space (2004)	0.830	0.863	0.841	0.914	0.834	0.956
Sales floor space (2007)	0.769	0.904	0.816	0.794	0.772	0.864
Share of female workers (2004)	1.152	1.202	1.085	1.118	1.112	1.017
Share of female workers (2007)	1.014	0.978	0.927	0.998	0.981	0.901
Share of full-time workers (2004)	1.164	1.142	1.162	1.131	1.101	1.047
Share of full-time workers (2007)	1.094	0.984	1.095	0.963	1.034	1.026
Opening hours (2004)	1.230	1.401	1.285	1.252	1.459	1.328
Opening hours (2007)	1.199	1.396	1.293	1.280	1.335	1.075
Parking lot dummy (2007)	1.009	0.972	0.994	1.026	0.993	0.983
Parking vehicles (2007)	0.735	1.027	0.664	0.902	0.640	0.790
Share of E-commerce (2007)	0.072	0.312	0.056	0.405	0.080	1.030
Share of over-the-counter (2007)	1.849	0.877	1.924	0.953	1.880	0.922
Franchisee dummy (2007)	0.920	0.823	1.100	0.903	1.306	0.702
Large-scale retail stores dummy (2007)	1.472	1.034	1.564	0.984	1.442	0.963

Note: Natural logarithmic transformation for annual sales, employees, and sales floor space.

Table A.2 Balancing tests based on 1-PSM algorithm for sales floor space (the city center zone)

Variable	2007–2012 Raw	2007–2012 Matched	2007–2014 Raw	2007–2014 Matched	2007–2016 Raw	2007–2016 Matched
Panel A: Standardized differences						
Annual sales (2002)	0.046	0.030	-0.002	0.044	0.007	-0.012
Annual sales (2004)	0.036	0.053	-0.017	0.058	0.017	-0.032
Annual sales (2007)	0.052	0.041	0.007	0.046	0.074	-0.059
Employees (2002)	-0.037	0.057	-0.058	0.099	-0.127	0.069
Employees (2004)	-0.020	0.103	-0.048	0.063	-0.105	-0.004
Employees (2007)	-0.027	0.122	-0.057	0.056	-0.091	0.051
Sales floor space (2002)	-0.014	0.085	-0.083	0.107	-0.030	0.095
Sales floor space (2004)	0.036	0.069	-0.044	0.063	0.052	0.130
Sales floor space (2007)	-0.003	0.077	-0.051	0.109	-0.080	0.129
Share of female workers (2004)	0.066	0.070	0.086	0.050	0.280	-0.026
Share of female workers (2007)	0.110	0.038	0.152	0.100	0.213	0.005
Share of full-time workers (2004)	0.098	-0.044	0.041	0.023	0.160	-0.022
Share of full-time workers (2007)	0.153	-0.011	0.112	0.059	0.249	-0.006
Opening hours (2004)	-0.073	0.027	0.011	-0.022	-0.232	-0.084
Opening hours (2007)	-0.061	0.036	0.018	-0.013	-0.349	-0.132
Parking lot dummy (2007)	-0.024	0.051	0.004	0.064	0.130	-0.120
Parking vehicles (2007)	-0.053	-0.029	-0.089	-0.036	-0.185	0.169
Share of E-commerce (2007)	-0.087	-0.017	-0.094	-0.065	-0.167	0.107
Share of over-the-counter (2007)	-0.320	-0.012	-0.377	0.076	-0.390	0.088
Franchisee dummy (2007)	-0.009	0.058	0.014	-0.056	-0.101	0.000
Large-scale retail stores dummy (2007)	0.159	0.024	0.198	0.119	0.313	0.126
Panel B: Variance ratio						
Annual sales (2002)	1.044	1.389	1.007	1.301	1.082	1.201
Annual sales (2004)	1.066	1.131	0.901	1.023	0.613	0.755
Annual sales (2007)	0.966	1.167	0.869	1.115	0.694	0.973
Employees (2002)	0.882	1.032	0.840	0.894	0.750	1.139
Employees (2004)	0.875	1.128	0.838	0.883	0.652	0.850
Employees (2007)	0.895	1.148	0.817	0.806	0.742	1.009
Sales floor space (2002)	0.772	0.941	0.793	0.815	0.836	1.168
Sales floor space (2004)	0.796	0.888	0.826	0.830	0.934	1.349
Sales floor space (2007)	0.727	0.919	0.799	0.785	0.810	1.089
Share of female workers (2004)	1.137	1.050	1.075	0.991	0.986	1.116
Share of female workers (2007)	1.026	0.994	0.962	0.865	1.178	1.141
Share of full-time workers (2004)	1.160	1.080	1.184	1.156	1.172	1.110
Share of full-time workers (2007)	1.114	0.986	1.106	0.991	1.025	0.872
Opening hours (2004)	1.234	1.717	1.303	1.368	0.770	1.034
Opening hours (2007)	1.230	1.524	1.329	1.312	0.256	0.951
Parking lot dummy (2007)	1.014	0.981	1.001	0.974	0.944	1.099
Parking vehicles (2007)	0.732	0.955	0.652	0.880	0.612	1.342
Share of E-commerce (2007)	0.072	0.365	0.057	0.230	0.005	25.000
Share of over-the-counter (2007)	1.862	0.972	2.064	0.905	2.170	0.843
Franchisee dummy (2007)	0.950	1.487	1.084	0.758	0.547	1.000
Large-scale retail stores dummy (2007)	1.488	1.054	1.550	1.269	1.514	1.140

Note: Natural logarithmic transformation for annual sales, employees, and sales floor space.

Table A.3 Balancing tests based on 1-PSM algorithm for employees (the city center zone)

	2007–2012		2007–2014		2007–2016	
Variable	Raw	Matched	Raw	Matched	Raw	Matched
Panel A: Standardized differences						
Annual sales (2002)	0.035	-0.048	-0.015	0.018	-0.027	0.031
Annual sales (2004)	0.019	-0.057	-0.047	-0.005	-0.073	0.005
Annual sales (2007)	0.040	-0.026	-0.033	-0.004	-0.061	0.024
Employees (2002)	-0.071	-0.024	-0.105	0.072	-0.131	0.038
Employees (2004)	-0.048	-0.034	-0.096	0.063	-0.122	0.001
Employees (2007)	-0.077	-0.015	-0.128	0.021	-0.162	0.001
Sales floor space (2002)	-0.024	-0.048	-0.085	0.076	-0.067	0.090
Sales floor space (2004)	0.005	-0.031	-0.047	0.086	-0.026	0.086
Sales floor space (2007)	-0.016	-0.032	-0.075	0.112	-0.060	0.103
Share of female workers (2004)	0.072	0.018	0.064	0.068	0.051	0.078
Share of female workers (2007)	0.145	0.037	0.115	0.048	0.095	0.066
Share of full-time workers (2004)	0.070	-0.088	0.004	0.026	-0.027	0.070
Share of full-time workers (2007)	0.118	-0.019	0.034	0.067	0.004	-0.003
Opening hours (2004)	-0.027	-0.138	-0.032	-0.031	-0.011	0.002
Opening hours (2007)	-0.025	-0.128	-0.024	-0.053	-0.011	0.003
Parking lot dummy (2007)	0.029	-0.008	0.027	0.079	0.022	0.013
Parking vehicles (2007)	-0.114	0.001	-0.115	-0.068	-0.122	0.005
Share of E-commerce (2007)	-0.090	-0.034	-0.097	-0.030	-0.089	0.031
Share of over-the-counter (2007)	-0.306	-0.030	-0.355	0.076	-0.374	0.031
Franchisee dummy (2007)	0.042	-0.100	0.016	-0.045	0.045	-0.050
Large-scale retail stores dummy (2007)	0.186	-0.041	0.162	0.078	0.149	0.027
Panel B: Variance ratio						
Annual sales (2002)	0.919	1.268	0.958	1.322	0.926	1.143
Annual sales (2004)	0.940	1.203	0.895	1.066	0.936	1.116
Annual sales (2007)	0.856	1.080	0.870	1.142	0.900	1.012
Employees (2002)	0.854	1.098	0.811	1.062	0.788	0.918
Employees (2004)	0.843	1.061	0.829	1.056	0.809	1.001
Employees (2007)	0.813	0.996	0.812	1.041	0.789	0.964
Sales floor space (2002)	0.758	0.841	0.776	1.014	0.783	0.973
Sales floor space (2004)	0.800	0.857	0.818	1.041	0.834	1.050
Sales floor space (2007)	0.742	0.868	0.792	0.945	0.790	1.042
Share of female workers (2004)	1.131	1.158	1.095	1.020	1.132	1.120
Share of female workers (2007)	1.004	0.976	0.994	0.975	1.031	1.014
Share of full-time workers (2004)	1.141	1.025	1.104	1.073	1.105	1.177
Share of full-time workers (2007)	1.147	0.965	1.060	1.047	1.034	1.019
Opening hours (2004)	1.276	1.425	1.171	1.118	1.427	1.422
Opening hours (2007)	1.184	1.240	1.168	1.065	1.321	1.330
Parking lot dummy (2007)	0.984	1.005	0.989	0.966	0.993	0.994
Parking vehicles (2007)	0.625	0.974	0.621	0.859	0.606	1.016
Share of E-commerce (2007)	0.032	0.430	0.050	0.572	0.077	1.535
Share of over-the-counter (2007)	1.851	1.063	1.852	0.862	1.901	0.894
Franchisee dummy (2007)	1.252	0.648	1.094	0.792	1.305	0.777
Large-scale retail stores dummy (2007)	1.496	0.933	1.444	1.175	1.432	1.058

Note: Natural logarithmic transformation for annual sales, employees, and sales floor space.

Table A.4 Balancing tests based on 1-PSM algorithm for annual sales (public transportation line zones)

	2007–2012		2007–2014		2007–2016	
Variable	Raw	Matched	Raw	Matched	Raw	Matched
Panel A: Standardized Differences						
Annual sales (2002)	0.129	-0.039	0.131	-0.020	0.127	0.050
Annual sales (2004)	0.115	-0.028	0.113	-0.044	0.110	0.012
Annual sales (2007)	0.150	-0.075	0.150	-0.052	0.153	-0.011
Employees (2002)	0.129	0.056	0.141	-0.009	0.148	-0.010
Employees (2004)	0.147	0.044	0.140	-0.043	0.149	0.017
Employees (2007)	0.174	0.031	0.187	-0.046	0.187	0.001
Sales floor space (2002)	0.170	-0.039	0.184	-0.035	0.205	0.036
Sales floor space (2004)	0.179	-0.028	0.201	-0.038	0.212	0.011
Sales floor space (2007)	0.223	-0.017	0.249	-0.026	0.254	0.053
Share of female workers (2004)	0.138	-0.004	0.167	-0.042	0.161	-0.001
Share of female workers (2007)	0.137	0.030	0.172	0.030	0.160	-0.037
Share of full-time workers (2004)	-0.049	-0.047	-0.086	-0.034	-0.096	0.041
Share of full-time workers (2007)	-0.055	-0.030	-0.036	-0.038	-0.044	0.062
Opening hours (2004)	-0.008	0.078	0.014	-0.019	0.002	-0.023
Opening hours (2007)	-0.011	0.070	0.017	0.048	0.009	-0.018
Parking lot dummy (2007)	0.086	0.020	0.060	-0.054	0.041	-0.004
Parking vehicles (2007)	0.079	0.008	0.103	0.028	0.121	0.036
Share of E-commerce (2007)	-0.095	0.100	-0.060	-0.010	-0.060	0.015
Share of over-the-counter (2007)	0.155	0.026	0.125	-0.088	0.135	0.004
Franchisee dummy (2007)	0.039	0.135	0.052	-0.009	0.049	-0.053
Large-scale retail stores dummy (2007)	0.304	0.042	0.319	0.022	0.297	0.000
Neighboring total employment (2007)	0.177	-0.012	0.207	-0.023	0.188	-0.009
Neighboring residential population (2007)	0.178	-0.017	0.208	-0.016	0.181	-0.017
Panel B: Variance Ratio						
Annual sales (2002)	1.187	1.040	1.191	0.884	1.204	1.009
Annual sales (2004)	1.202	1.000	1.213	0.890	1.225	1.012
Annual sales (2007)	1.236	1.127	1.244	0.954	1.241	1.116
Employees (2002)	1.272	0.854	1.320	0.843	1.295	0.929
Employees (2004)	1.301	0.858	1.381	0.867	1.341	0.928
Employees (2007)	1.319	0.872	1.379	0.825	1.375	0.965
Sales floor space (2002)	1.267	0.892	1.302	0.859	1.247	0.971
Sales floor space (2004)	1.248	0.874	1.332	0.871	1.266	0.964
Sales floor space (2007)	1.201	0.831	1.237	0.826	1.200	0.910
Share of female workers (2004)	1.024	1.066	1.014	1.030	1.029	0.969
Share of female workers (2007)	1.017	1.086	0.977	1.015	1.015	1.044
Share of full-time workers (2004)	0.934	0.899	0.947	1.028	0.936	1.060
Share of full-time workers (2007)	0.911	1.000	0.946	1.055	0.930	1.080
Opening hours (2004)	1.067	1.500	1.182	1.009	1.116	0.953
Opening hours (2007)	1.051	1.388	1.168	1.157	1.112	0.972
Parking lot dummy (2007)	1.032	1.006	1.026	0.985	1.020	0.998
Parking vehicles (2007)	1.395	0.929	1.379	0.824	1.375	0.943
Share of E-commerce (2007)	0.015	21.360	0.248	1.375	0.258	2.262
Share of over-the-counter (2007)	0.836	1.014	0.911	1.357	0.883	1.148
Franchisee dummy (2007)	1.192	2.018	1.259	0.964	1.254	0.810
Large-scale retail stores dummy (2007)	2.198	1.083	2.185	1.039	2.105	1.000
Neighboring total employment (2007)	0.550	0.785	0.537	0.713	0.565	0.772
Neighboring residential population (2007)	0.318	0.467	0.303	0.389	0.316	0.440

Note: Natural logarithmic transformation for annual sales, employees, and sales floor space.

Table A.5 Balancing tests based on 1-PSM algorithm for sales floor space (public transportation line zones)

	2007–2012		2007–2014		2007–2016	
Variable	Raw	Matched	Raw	Matched	Raw	Matched
Panel A: Standardized Differences						
Annual sales (2002)	0.139	0.110	0.125	0.018	0.323	0.028
Annual sales (2004)	0.122	0.138	0.101	0.056	0.270	-0.014
Annual sales (2007)	0.149	0.103	0.143	0.014	0.317	-0.032
Employees (2002)	0.135	0.098	0.135	0.060	0.253	-0.010
Employees (2004)	0.160	0.077	0.140	0.049	0.276	-0.013
Employees (2007)	0.179	0.058	0.187	0.064	0.329	0.027
Sales floor space (2002)	0.179	0.070	0.174	0.046	0.312	-0.035
Sales floor space (2004)	0.192	0.094	0.192	0.038	0.336	-0.017
Sales floor space (2007)	0.232	0.084	0.245	0.025	0.343	-0.023
Share of female workers (2004)	0.151	-0.035	0.177	0.013	0.161	0.046
Share of female workers (2007)	0.143	-0.048	0.174	0.014	0.191	0.052
Share of full-time workers (2004)	-0.030	0.026	-0.094	-0.078	-0.148	0.056
Share of full-time workers (2007)	-0.033	0.033	-0.051	0.003	-0.182	0.042
Opening hours (2004)	-0.034	0.040	0.015	0.079	0.024	-0.038
Opening hours (2007)	-0.037	0.026	0.010	0.064	0.062	-0.117
Parking lot dummy (2007)	0.088	-0.017	0.077	0.009	0.062	-0.049
Parking vehicles (2007)	0.089	0.063	0.098	0.049	0.154	0.032
Share of E-commerce (2007)	-0.091	0.056	-0.052	-0.017	-0.095	0.006
Share of over-the-counter (2007)	0.141	-0.009	0.142	-0.009	0.185	0.106
Franchisee dummy (2007)	0.024	0.044	0.051	0.010	0.010	-0.040
Large-scale retail stores dummy (2007)	0.309	0.053	0.335	-0.006	0.496	-0.050
Neighboring total employment (2007)	0.189	-0.021	0.210	-0.002	0.140	-0.020
Neighboring residential population (2007)	0.187	-0.025	0.210	0.001	0.133	-0.023
Panel B: Variance ratio						
Annual sales (2002)	1.205	0.941	1.193	1.021	0.837	0.708
Annual sales (2004)	1.228	0.893	1.226	0.839	1.052	0.771
Annual sales (2007)	1.265	1.026	1.251	1.027	1.106	0.941
Employees (2002)	1.296	0.914	1.321	0.950	1.158	0.685
Employees (2004)	1.319	0.902	1.369	0.960	1.182	0.649
Employees (2007)	1.343	0.932	1.379	1.015	1.194	0.691
Sales floor space (2002)	1.299	0.897	1.291	0.971	1.067	0.771
Sales floor space (2004)	1.276	0.888	1.297	0.967	1.078	0.772
Sales floor space (2007)	1.223	0.834	1.221	0.970	1.064	0.802
Share of female workers (2004)	1.013	1.020	1.007	0.972	0.907	0.953
Share of female workers (2007)	1.012	1.045	0.968	0.946	0.856	0.882
Share of full-time workers (2004)	0.954	0.971	0.933	0.867	0.955	1.067
Share of full-time workers (2007)	0.930	1.028	0.933	0.929	0.860	0.987
Opening hours (2004)	1.031	1.630	1.198	1.350	0.874	0.929
Opening hours (2007)	1.018	1.366	1.167	1.249	0.877	0.620
Parking lot dummy (2007)	1.032	0.996	1.032	1.003	1.033	0.983
Parking vehicles (2007)	1.426	0.999	1.402	1.003	1.378	0.839
Share of E-commerce (2007)	0.016	3.637	0.303	0.645	0.260	1.472
Share of over-the-counter (2007)	0.859	1.040	0.881	1.057	0.716	0.794
Franchisee dummy (2007)	1.115	1.227	1.251	1.041	1.042	0.866
Large-scale retail stores dummy (2007)	2.232	1.107	2.242	0.991	1.669	0.980
Neighboring total employment (2007)	0.540	0.762	0.535	0.811	0.619	0.898
Neighboring residential population (2007)	0.315	0.468	0.304	0.428	0.302	0.428

Note: Natural logarithmic transformation for annual sales, employees, and sales floor space.

Table A.6 Balancing tests based on 1-PSM algorithm for employees (public transportation line zones)

Variable	2007–2012 Raw	2007–2012 Matched	2007–2014 Raw	2007–2014 Matched	2007–2016 Raw	2007–2016 Matched
Panel A: Standardized Differences						
Annual sales (2002)	0.132	0.062	0.135	-0.038	0.135	0.001
Annual sales (2004)	0.130	0.037	0.116	-0.057	0.114	-0.038
Annual sales (2007)	0.146	0.031	0.148	-0.035	0.150	-0.021
Employees (2002)	0.150	0.012	0.140	-0.042	0.154	-0.016
Employees (2004)	0.160	0.015	0.143	-0.026	0.155	-0.028
Employees (2007)	0.173	0.020	0.184	-0.020	0.190	-0.028
Sales floor space (2002)	0.165	0.033	0.181	-0.048	0.205	-0.017
Sales floor space (2004)	0.177	0.011	0.192	-0.046	0.208	0.005
Sales floor space (2007)	0.204	0.025	0.232	-0.042	0.248	-0.026
Share of female workers (2004)	0.098	-0.039	0.151	0.042	0.171	-0.037
Share of female workers (2007)	0.104	0.003	0.152	0.065	0.163	0.016
Share of full-time workers (2004)	-0.042	0.056	-0.073	-0.012	-0.079	-0.046
Share of full-time workers (2007)	-0.045	0.049	-0.028	-0.017	-0.038	-0.039
Opening hours (2004)	0.048	-0.044	0.016	0.032	0.022	-0.043
Opening hours (2007)	0.042	-0.032	0.019	-0.042	0.037	-0.072
Parking lot dummy (2007)	0.035	0.042	0.077	0.028	0.058	0.050
Parking vehicles (2007)	0.099	-0.039	0.080	-0.036	0.112	-0.055
Share of E-commerce (2007)	-0.064	-0.024	-0.060	0.013	-0.056	0.084
Share of over-the-counter (2007)	0.126	0.007	0.117	0.008	0.135	0.010
Franchisee dummy (2007)	0.069	-0.042	0.044	-0.016	0.068	0.008
Large-scale retail stores dummy (2007)	0.252	0.025	0.316	-0.054	0.311	-0.010
Neighboring total employment (2007)	0.158	0.034	0.200	0.009	0.175	0.026
Neighboring residential population (2007)	0.150	0.038	0.184	-0.003	0.170	0.026
Panel B: Variance ratio						
Annual sales (2002)	1.125	0.820	1.168	0.920	1.190	0.845
Annual sales (2004)	1.111	0.854	1.182	0.905	1.216	0.875
Annual sales (2007)	1.165	0.932	1.211	0.952	1.235	0.908
Employees (2002)	1.214	0.863	1.287	0.794	1.309	0.791
Employees (2004)	1.246	0.858	1.320	0.788	1.338	0.870
Employees (2007)	1.286	0.910	1.335	0.815	1.369	0.847
Sales floor space (2002)	1.186	0.865	1.259	0.782	1.255	0.811
Sales floor space (2004)	1.177	0.892	1.273	0.759	1.277	0.847
Sales floor space (2007)	1.147	0.870	1.210	0.768	1.214	0.849
Share of female workers (2004)	1.019	1.019	1.027	1.029	1.025	1.049
Share of female workers (2007)	1.001	0.994	1.003	1.031	1.008	0.974
Share of full-time workers (2004)	0.957	1.040	0.979	1.018	0.978	1.001
Share of full-time workers (2007)	0.898	1.007	0.945	0.971	0.949	0.970
Opening hours (2004)	1.240	0.920	1.134	1.240	1.231	0.920
Opening hours (2007)	1.243	0.888	1.141	1.044	1.243	0.831
Parking lot dummy (2007)	1.011	1.012	1.030	1.009	1.026	1.020
Parking vehicles (2007)	1.327	0.863	1.335	0.807	1.373	0.827
Share of E-commerce (2007)	0.206	0.675	0.250	2.128	0.273	63.634
Share of over-the-counter (2007)	0.870	1.031	0.910	1.038	0.884	1.045
Franchisee dummy (2007)	1.315	0.867	1.219	0.937	1.351	1.035
Large-scale retail stores dummy (2007)	1.818	1.047	2.177	0.916	2.161	0.983
Neighboring total employment (2007)	0.534	0.703	0.562	0.813	0.574	0.706
Neighboring residential population (2007)	0.305	0.409	0.316	0.456	0.324	0.403

Note: Natural logarithmic transformation for annual sales, employees, and sales floor space.