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Urban Redevelopment Program and Demand Externality*

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Abstract

Demand externality generated by the agglomeration of commercial activities is a potential source of city formation. We study the impact of a large-scale urban redevelopment program involving the construction of a shopping complex at the center of Tokyo. The redevelopment program increased the land price and commercial building use in its neighborhood. It also increased the total sales of neighborhood firms but not their profits. We argue that the redevelopment program generated substantial demand externality but the benefit fell on the landlord.

Keywords: Demand Externality, Shopping Externality, Urban Redevelopment Program

JEL Classification: R12, R14, R52

1 Introduction

Shops selling niche bland and restaurants serving cuisines of specific regions accentuate urban life, and savvy urban residents benefit from the variety of goods available. Reflecting

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this view, urban economists point to the variety of goods available to urban residents and consumers' love of variety as sources of urban agglomeration (Glaeser et al., 2001; Diamond, 2016), as well as the cause of urban gentrification (Baum-Snow and Hartley, 2020; Couture and Handbury, 2020). Given this preference, opening a new business in an urban agglomeration potentially generates a positive externality to its neighboring stores. If the goods offered by the entrant are differentiated from the goods provided by the incumbents, the opening enhances the variety of goods available in the area and makes it more attractive through chain-travel (Stahl, 1982; Brueckner, 1993; Teller and Reutterer, 2008; Clapp et al., 2019; Koster et al., 2019; Miyauchi et al., 2022; Leonardi and Moretti, 2023). Estimating the size of this positive demand externality in an urban center is crucial to understanding the sources of urban agglomeration.

Despite its importance, the estimation of demand externality is challenging due to the endogenous location choice of shops. High-sales shops are sorted to busy shopping streets, because only they can afford the high rent. Then, the spatial correlation of sales among shops on such streets does not necessarily imply the demand externality, representing the general difficulty in separating the externality from sorting in urban economics (Combes et al., 2012). Existing studies in the literature on shopping externality have overcome the problem through various methods. Using cross-section data of US shopping malls, Gould et al. (2005) show that the presence of anchor stores in a mall increases the sales of non-anchor stores. They overcome the identification issue by testing the Coase theorem prediction; they demonstrate that the anchor store receives a substantial rent discount from the mall developer, because it internalizes the shopping externality. Leonardi and Moretti (2023) document that the repeal of a location regulation on restaurants in Milan caused the concentration of restaurants in a specific district, suggesting the importance of demand externality in the restaurant industry. Using panel data of retail stores in the Netherlands, Koster et al. (2019) report a substantial shopping externality. They address the sorting issue by using the location of the commercial landmarks a century ago as the instrumental variable, under the maintained assumption that the past location of commercial landmarks is uncorrelated with the current unobserved characteristics of the neighborhood. Nakajima and Teshima (2017) use a random allocation of fish wholesalers' plots by lottery in the Tsukiji fish market in Tokyo and find a significant shopping externality. In another study, Miyauchi et al. (2022) estimate a structural model that incorporates the agent's travel itinerary decision, allowing for a trip chain, demonstrating the presence of a shopping externality.

Unlike previous studies on shopping externality, we use the redevelopment program in the central shopping district of Tokyo as a plausibly exogenous event to implement a difference in differences (DiD) estimation. In the DiD framework, we examine changes in the land price, building use, and sales and profits of stores in the immediate neighborhood compared with changes in the control group in the immediate surrounding neighborhood. Previous studies estimate production or housing externality in the DiD framework. For instance, to examine the production externality, Greenstone et al. (2010) estimate the effect of manufacturing plant opening. To explore the housing externality, Rossi-Hansberg et al. (2010) estimate the impact of gentrification of an urban housing unit, Autor et al. (2014) estimate the effect of the replacement of residents induced by the repeal of rent control, and Koster and van Ommeren (2019) and Bradlow et al. (2023) estimate the impact of public housing development.[1] Following this strand of literature, we assess the shopping externality generated by a large-scale redevelopment program in central Tokyo.

The specific event we focus on is redeveloping a shopping district in Tokyo, Omotesando, in 2006 initiated by the opening of Omotesando Hills that replaced 76 years old apartment units. Omotesando is a high-end shopping street featuring a top-brand shop that extends about 1100m in central Tokyo. Apartment units built in 1927 had occupied about one-third of one side of the street. Most apartment units were vacant and abandoned, although residents occupied some units, and some were used as shops. The apartment units were demolished in 2003, and the new commercial and residential compound, namely Omotesando Hills, was rebuilt and opened in 2006 at the initiative of a private land developer. This program significantly expanded the rebuilt facility's floor area, thus accommodating new shops. This redevelopment program allegedly revitalized its neighborhood by attracting more people to the area.

To implement the DiD strategy, we define the area within the radius of 1.5 km from Omotesando Hills as the treatment group and the area between the radius of 1.5 km and 2.0 km as the control group. We first document how the redevelopment program affected the neighborhood land price to report a substantial price increase. We then attribute the price hike to the increase in the land demand for commercial use by examining the changes

[1] Greenstone et al. (2010) examine the effect of manufacturing plant opening and find that an opening of a large plant increases the total factor productivity (TFP) of incumbent firms in the neighborhood. Rossi-Hansberg et al. (2010) examine the impact of the urban revitalization program in Richmond, Virginia and find that the land value increases by 10-15% in the nearest neighborhood and its effects dissipate to half at 300 m (=1000 feet). Autor et al. (2014) examine the impact of eliminating rent control in Boston, Massachusetts. They find that eliminating rent control increased the rent of formerly controlled units and caused residents to turn over, suggesting that wealthier residents replaced the previous residents. This change in residents increased the rent of uncontrolled units by 20% in the radius of 300 m (=0.2 miles) from the decontrolled units. Bradlow et al. (2023) examine the effect of public housing projects on the building of housing units in its neighborhood using a South African data set. They find a positive externality of up to 500 meters.

in building use, sales and profit of neighborhood firms.

We find the redevelopment program substantially increased the neighborhood land price. The official land price analysis shows that the Omotesando Hills opening in 2006 increased the appraised land price by 31.3% in its closest neighborhood between 2005 and 2008. This externality diminishes almost linearly with the distance and completely dissipates at about 1.44 km from the Omotesando Hills. Within the treated area, the average treatment effect between the pre- (1998-2005) and post-treatment periods (2006-2018) was 0.086 log points, meaning that the annual average treatment effect was 0.96%

To shed light on the mechanism behind the sharp land-price hike around the opening of Omotesando Hills, we analyze the change in land use in its neighborhood. If the opening generates the demand spillover to its neighborhood, it would cause a shift in the building use from residential purpose to commercial purpose, although Omotesando is a densely populated area, and the building supply is presumably inelastic. We analyze the change in land use based on the geographically detailed land-use survey that takes place every three years by the Bureau of Urban Development of the Tokyo Metropolitan government. The descriptive analysis shows that the total share of commercial areas (i.e., commercial facilities plus composite facilities of residential and commercial use) within a 1.5 km radius of Omotesando Hills increased from 20.3% to 23.8% from 2001 to 2016.

The increase in the land price and the commercial building use in the Omotesando Hills neighborhood at the time of its opening is consistent with the demand spillover from the Omotesando Hills. To investigate the possibility, we examine whether the opening of Omotesando Hills increased sales in neighborhood stores. We generate aggregate sales and profit by 250m mesh using firm-level accounting information compiled by a credit-rating company, TOKYO SHOKO RESEARCH, LTD. (TSR). Focusing on sales and profits of single-establishment firms, we find that the mesh-level total sales in the treatment area grew faster than those in the control area. The mesh-level total sales increased by 0.911 log points, on average, within the treated area from the pre- (1998-2005) to post-treatment (2006-2018) periods, meaning the annual average treatment effect is 9.0%. Regardless of this substantial sales growth, we find no impact on the mesh-level aggregate profits.

We develop a market equilibrium model that enables us to comprehensively understand the impacts of the urban redevelopment program on land price, building use, and firm performance. The model demonstrates that the externality created by the redevelopment program induced a demand increase for commercial use. Combined with the inelastic land supply, the demand increase for the land resulted in the soaring land price in the neighborhood.[2] Furthermore, the theory predicts that the land price is determined by the marginal firm whose benefit from the externality is at the minimum in the treatment area. Thus, the firm with an extra benefit from the externality than the marginal firm earns the quasi-rent. Conversely, when the treatment effects from the externality are homogeneous across firms, the benefit of the externality falls entirely on landlords, because all firms located in the treatment area are marginal firms. The absence of profit growth among control firms is consistent with the case of homogeneous firms.

This study contributes to the literature on estimating demand externality in three ways. First, we employ the DiD strategy to credibly estimate the size of the externality of a redevelopment program in the active center of a city. Second, we explicitly examine the change in land use to infer the shift in the land demand for commercial use. Third, our examination of firm performance provides direct evidence for a shopping externality and an increase in the demand for land for commercial use. The analysis of firms' profits further sheds light on the incidence of the shopping externality.

2 Redevelopment of Omotesando in Tokyo

This subsection describes the location and the redevelopment program to set the ground for the identification strategy and interpretation of the results. The redevelopment program took place in the shopping center of Tokyo, namely Omotesando.[3] The vicinity of Omotesando has been a leading fashion district in Japan since the 1970s.

The redevelopment program we focus on included demolishing old apartment units and constructing a modern shopping and residential complex at Omotesando. Apartment units built in 1927 occupied the street's north side, extending about 300m.[4] The area was originally

[2]The findings echo those of previous studies that point to the importance of limited land supply in urban development. Saiz (2010) points out the role of land supply as a determinant of urban growth in a general context, and Hsieh and Moretti (2019) demonstrate that the growing demand for urban land and the limited supply of it resulted in soaring land prices in U.S. urban areas.

[3]Omotesando means the front approach to the Meiji shrine. It extends about 1100 meters from the shrine's front gate at the west end to Aoyama Street at the east end, lined with zelkova trees. The road is 36 meters wide with six car lanes and wide pedestrian paths on both sides of the street, and it is slightly sloped up toward the east.

[4]The apartment units were called Dojunkai Aoyama apartments; Dojunkai was a non-profit organization that provided high-quality housing units to promote recovery from the damage caused by the Great Kanto Earthquake in 1923. Initially, rooms were rented out to upper-middle-class people, such as military officials, government officials, and university professors. In 1950, the apartment units were sold to tenants, but the Tokyo metropolitan government continued to hold the land ownership.

on the outskirts of Tokyo but gradually developed into a fashionable commercial area in the post-war period because of its proximity to the residential area for the middle-class military officials of the US Air Force. As the area developed into a central commercial district, some of the apartment rooms started to be used as commercial facilities.

As the apartment units depreciated, the idea of a redevelopment program emerged.[5] The Tokyo metropolitan government sold its owned land to the unit owners association in 1998. Afterward, the redevelopment preparation association was established in 2001 under the initiative of a private land developer, Mori Building Co., Ltd, and started the planning. The apartment units were demolished in 2003, and the new commercial and residential compound called Omotesando Hills was rebuilt and launched on February 11, 2006.

The launch of Omtesando Hills substantially changed the land use on the site. Just before the demolition of the apartment units, as of 2002, there were 10 buildings with 138 apartment units, each with an area of 32-44 square meters. Among them, only about 20 units were inhabited just before demolishment, and boutiques and stores occupied an additional 15 units. Thus, more than 100 units were vacant. The newly built Omotesando Hills has six floors above and six floors below the ground with a floor area of $34,061m^2$. It houses about 100 shops and restaurants, 38 housing units, and 196 parking spots. In the end, the redevelopment program expanded the floor area by about seven times, increased the shops by about seven times, and doubled the number of active residential units.[6] [7])

[5]As early as 1968, discussions about the redevelopment plan started between the association of unit owners and the Tokyo Metropolitan Government. While both parties reached a basic agreement in 1988, they could not agree on the prices, as the land price of Tokyo was extremely high around that time, reflecting the land price bubble in the late 1980s. The Hanshin-Awaji earthquake in 1995 raised concerns about the seismic capacity of the 69-year-old buildings, and negotiations resumed.

[6]Omotesado Hills was intentionally designed to generate a spillover effect to its neighborhood. The architect of the facility, Tadao Ando, later recalled that he intended the building to be continuous to Omotesando Street by limiting the height of the building to the height of the Zelkova tree and placing the sloped corridor inside the building to express the continuation of the slope from the front street to the inside corridor. This design principle presumably had an impact on generating positive externality on the land value of neighboring properties.

[7]Information on the Omotesando redevelopment program is based on the following sources: (1) *Nihon Keizai Shinbun* articles dated June 30, 1984; February 14, 1988; July 29, 1989; May 3, 1994; September 30, 1995; and November 17, 1999; (2) *Nikkei Sangyo Shinbun* articles dated July 6, 1988; December 7, 1999; and January 20, 2006; (3) a *Nikkei MJ* article dated February 28, 2006; (4) *Asahi Shinbun* articles dated February 26, 2000, and February 18, 2002; and (5) the Development History section of the Omotesando Hills official website (`https://www.omotesandohills.com/en/information/about/development.html`.

3 Impact on Land Price

3.1 Land Price Data

We first examine the effect of the opening of Omotesando Hills on the land prices of its neighborhood. As data for land price, we use the Land Appraisal for Fixed Asset Tax provided by the Research Center for Property Assessment System. These data contain land appraisals for the evaluation point representing the price per one square meter of standard land facing the road. The evaluation points are dense; Each 250m-mesh includes 28.9 road IDs, on average, and each road ID includes 4.8 observation points, on average, for the treatment and control areas. Local municipalities are in charge of conducting appraisals, and they reappraise the values every three years based on the national appraisal standards with the help of certified real-estate appraisers.[8] The value has been intended to show 70% of the market value. We use the data published in 2003, 2006, 2009, 2012, 2015, and 2018. Since the prices reflect the values of January 1st of the previous year, the data we use reflect the values of 2002, 2005, 2008, 2011, 2014, and 2017. To avoid confusion, we hereafter use the year of evaluation instead of the year of publication to indicate the year.[9]

We construct unbalanced panel data to control the unobserved heterogeneity of each road. The challenge in constructing road identifiers is that the appraisal location changes slightly within a road across survey years. To overcome the difficulty, we generate permanent road IDs with a hierarchical cluster analysis, namely, the unweighted pair group method with arithmetic mean (UPGMA). The data construction process is as follows. First, we calculate the longitude and latitude for the geographic centroid of each road. We use this centroid point (hereafter, point) as the observation unit. Second, we pool all the points across years and cluster the points using the Unweighted Pair Group Method with the Arithmetic mean (UPGMA) method.[10] Different road IDs are attached to a road across the years when a road

[8] The Tokyo Metropolitan Government conducts appraisals of the land of Tokyo's 23 wards.

[9] Appraisal values may involve appraisal biases; thus, using transaction prices is arguably a better choice to estimate hedonic equations. In Japan, the Land General Information System maintained by the Ministry of Land Infrastructure and Transportation publishes real-estate transaction prices. Since these data are based on non-mandatory questionnaire surveys of real-estate buyers, the sample size is smaller than *land appraisal for fixed asset tax.* Also, this system conceals the detailed address of each piece of real estate. For these two reasons, conducting our analysis is difficult with transaction prices. Since our analysis always includes location-fixed effects, the appraisal bias does not affect our analysis as long as the appraisal bias is constant over time.

[10] It is difficult to cluster all the points at once due to the large number of points. Therefore, we perform clustering points for each 1km mesh by the following method. We first merge the nearest points regarding the shortest distance on an ellipsoid to form a cluster. We then define the distance between clusters as the average of all possible combinations of points in the distinct clusters. Based on this distance, we merge the

is divided or combined. The total number of points in the 2km radius of the Omotesando Hills is 27,328 over the sample period between 2002 and 2017.[11] Each point belongs to a unique road ID. The number of road IDs is 5,736. Table 1 shows the summary statistics of land prices and other variables used as control variables, which are explained below.

3.2 Graphical Examination of Price Change

We now overview the impact of the opening of Omotesando Hills on neighborhood land prices. Panels in Figure 1 are the heat maps of price change around the event. The latitude and longitude for each road ID are calculated as the average of the coordinates of points that share the same ID. The color of the dots reflects the log difference of the prices between every two adjacent years of each road ID. We calculate the mean land price for each road ID and then calculate the log difference of this mean value for each road ID.[12] A red (blue) color indicates positive (negative) growth, and a darker color means a larger absolute value.[13]

We first graphically examine if the common trend assumption holds by examining if the land price trend in the neighborhood of Omotesando Hills differed from the places distant from the location before the opening of Omotesando Hills in 2006. As shown in Panel (a) of Figure 1, the growth rates between 2002 and 2005 (i.e., the growth rates in the pre-treatment period) are slightly higher in the neighborhood of Omotesando Hills. This implies that the treatment and control groups do not share similar trends and, thus, arguably violate the common trend assumption. To handle this, we condition the point-specific growth rate of land prices between 2002 and 2005 in the regression analysis as an explanatory variable to explain the land price growth after 2008 to recover the causal impact of the opening of Omotesando Hills on neighborhood land prices.

Panel (b) of Figure 1 shows the growth rates from 2005 to 2008 (i.e., the growth rates from the pre-treatment to post-treatment periods). All the points exhibit positive growth, but the growth was more substantial around Omotesando Hills. This suggests that the positive externality effect dampens as the distance from Omotesando Hills increases.

Panels (c) - (e) of Figure 1 show the growth rates in the post-treatment period. All the

closest clusters and continue the merging process until all the distances between clusters are 5 meters or more. This is to set the height of the hierarchical cluster tree to 5 meters.

[11] Among these 27,328 points, 24 points directly face Omotesando Hills.

[12] Some road IDs do not have an observation in specific years. Thus, the heat maps include only the road ID points that have observations in both adjacent years.

[13] To draw the heat map, we winsorize the outliers of road IDs whose log difference in land prices is more than one by replacing them with one. For example, we winsorize the observations from 29 road IDs in Panel (b) of Figure 1 out of 3,562 road IDs.

points have negative growth from 2008 to 2011, reflecting the effect of the global financial crisis that occurred in 2008. The growth rates from 2011 to 2014 and the ones from 2014 and 2017 are nearly zero at most points. Notably, the growth rates do not vary depending on the distance from Omotesando Hills in the post-treatment period. This indicates that this event did not increase land prices after 2008.

In sum, the graphical presentation illustrates that (1) the common trend assumption may be violated, (2) the positive externality effect on land prices gradually fades as it gets far away from Omotesando Hills, and (3) the opening of Omotesando Hills has one-shot effects but does not change the long-term growth rates of neighborhood land prices. These graphical results suggest the presence of the externality generated from the opening of Omotesando Hills. In the following subsection, we estimate the externality effects quantitatively using regression, controlling for road-fixed effects.

3.3 Empirical Model

This section introduces the regression model to quantify the impact of the Omotesando Hills's opening on the neighborhood's land prices. We model the impact decay by distance from Omotesando Hills. Each point is classified by the distance into the treatment and control groups. The points in the treatment group are close enough to be affected by the externality generated by the opening of Omotesando Hills. In contrast, the points in the control group are far enough away not to be affected. The definition of the treatment group requires the choice of the distance up to which the externality reaches. Similarly, the definition of the control group involves the choice of a maximum distance. We assume that the externality potentially reaches up to $1.5km$ and the maximum distance to be included in the control group is $2.0km$. Given d_i be a distance of a point i from Omotesando Hills, we treat a point i with $d_i \leq 1.5km$ as the treatment group and a point i with $1.5 \leq d_i \leq 2km$ as the control group. The area included in the treatment group is $2.25\pi km^2$, and in the control group it is $1.75\pi km^2$. The total number of points in the $2.0km$ radius of Omotesando Hills is 27,328, and about 53.8% of them belong to the treatment group.

We estimate the following hedonic price model:

$$\ln p_{it} = \sum_{t \neq 2005} \sum_{A} \beta_{tA} \times g_A(d_i) + f_{r(i)} + f_t + \epsilon_{it}, \tag{1}$$

where $\ln p_{it}$ is a natural-log price of point i in time t, the function $g_A(d_i)$ is the indicator function that takes the value one if the d_i falls in the fifty-meter intervals: $A =$

$\{[0, 50), [50, 100), .., [1450, 1500]\}$. The parameter β_{tA} captures the price change in each interval in each survey year relative to 2005, which is the survey timing immediately before the opening of Omotesando Hills in February 2006. This fully satiated specification does not impose an assumption on the decay of the treatment effects concerning the distance from the event's epicenter. We assume the error term, ϵ_{it}, satisfies the conditional independence $E[\epsilon_{it}|d_i, f_{r(i)}, f_t] = 0$ and may be correlated within a cluster defined by the road ID.

The model incorporates the year fixed effect f_t and the road fixed effects $f_{r(i)}$. We had wished to include the local fixed effect f_i, but we could not, because some land prices are measured at different points depending on the survey year. We instead incorporate the fixed effects of the facing road, $f_{r(i)}$, where $r(i)$ indicates the road ID, and each point i must face one road. $f_{r(i)}$ then captures the fixed effect of the facing road. The road-fixed effects virtually capture the location-fixed effects, because the mean of the average distance of location i within a road unit r is 0.36m, the 90th percentile is 0.96m, and the maximum is 2.87m.

3.4 Regression results

Consistent with the findings from the maps, we find a substantial increase in land price in the neighborhood of Omotesando Hills at the time of its opening. To report the estimated impacts, Panels (a)-(f) of Figure 2 show the point estimates of the externality effect β_{tA} for each survey year in Equation (1). The error bars in these panels represent the 95% confidence intervals, calculated on the standard error robust against road-ID level clustering.

Panel (a) of Figure 2 shows the price change in 2002 relative to 2005.[14] Since Omotesando Hills opened in 2006, both years belong to the pre-treatment period. Thus, this estimation examines whether the parallel trend assumption holds between the control and treatment groups. The estimates are significantly negative up to 1,200m (except 1,000-1,050m) with a significance level of 1%, and the absolute values of the estimates linearly decline, implying that the areas closer to Omotesando Hills in the treatment group have slightly positive price growth from 2002 to 2005 compared to the control areas. The most significant price increase occurs in the 200-250m intervals, with a 14.9% increase. Consistent with the heat map finding, the absence of the pre-trend is rejected. This can be due to either the anticipation effect or self-selection of the location. We cannot completely exclude the possibility that Omotesando Hills had been constructed within the growing area. Thus, we address potential issues arising from violating the parallel trend assumption later in the analysis.

Panel (b) of Figure 2 shows the price change from 2005 to 2008, right before and after

[14] The points facing Omotesando Hills are included in the observations.

the opening. The effects are positive and statistically significant at 0-1,200m and 1,350-1,400m. The sizes of the estimated externality decrease with the distance, and the estimated relationship is remarkably linear. The most significant price increase occurs in the radius of 50m, with a 49.1% increase.

Panels (c), (d), and (e) of Figures 2 show the price changes in 2011, 2014, and 2017 relative to 2005, respectively. In each panel, the externality effects are downward-sloping, similar to the estimates reported in Panel (b). These results indicate that the event's positive impact on land prices persist after 2008. Moreover, the impact stays constant, suggesting the absence of an effect on the long-term growth of land prices.

Similarly, Panel (f) of Figure 2 reports the price change in the post-treatment period relative to the pre-treatment period. Both panels confirm that the opening of Omotesando Hills significantly increases the land price in local neighborhoods, and its effect declines with the distance from Omotesando Hills. According to Panel (f), the most significant price increase occurs in the 0-50m intervals, with a 54.1% increase. Again, the estimates are significant up to 1,200m (except 1,000-1,050m).

Overall, the analysis of land price change by the distance from Omotesando Hills exhibits the long-lasting impact of the opening of Omotesando Hills on land price, and the estimated impacts linearly decline with distance. We note, however, the presence of the pre-trend between 2002 and 2005 as a caveat.

3.5 Handling the Pre-Trend

As shown in Panel (a) of Figure 2, the areas closer to Omotesando Hills experienced higher price growth than the control area even before the opening of Omotesando Hills in 2006. Whether we should control for this pre-trend is controversial, because the pre-trend may pick up the anticipation effect, which is the land price increase in the expectation of a land price increase after the opening of Omotesando Hills. If the pre-trend is due to the anticipation effect, controlling for the pre-trend results in an over control, because the pre-trend is due to the causal impact of the opening of Omotesando Hills. If, however, Omotesando Hills happens to be located in a growing area, the presence of the pre-trend raises a concern that the impact of the opening of Omotesando Hills is overestimated. Taking a conservative stance, we estimate the impact conditional on the pre-trend depending on points by adding the year fixed effects f_t times log difference of land prices in 2005 between those in 2002 to the equations (1). Specifically, we estimate the following models:

$$\ln p_{it} = \sum_{t \neq 2002,2005} \sum_{A} \beta_{tA} \times g_A(d_i) + f_{r(i)} + f_t + \delta_t \ln(p_{r2005}/p_{r2002}) + \epsilon_{it}, \tag{2}$$

where p_{it} is the land price at point i in year t, $g_A(d_i)$ is a set of dummy variables, $f_{r(i)}$ is the road ID fixed effects, f_t is year fixed effects, and $\ln(p_{r2005}/p_{r2002})$ is the log difference of the average land prices in 2005 and 2002. Including the pre-existing linear trend of the dependent variable as an independent variable is a standard way of controlling for location-specific trends in the literature (Autor et al., 2024).

Panels (a) - (d) in Figure 3 show the estimation results based on Equation (2). Here, we do not estimate β_{2002A} because $g_A(d_i) \times 1(t = 2002)$ and $\ln(p_{r2005}/p_{r2002}) \times 1(t = 2002)$ are nearly collinear. Panel (a) shows the land price change between 2005 and 2008 and indicates that the opening of Omotesando Hills in 2006 increased the nearest neighbor's land price by about 0.4 log points. The positive effects decline with the distance remarkably linearly and are statistically significant at 0-1,200m and 1,400-1,450m. Panel (b) displays the land price change between 2005 and 2011. The estimated coefficients are similar to those in Panel (a), implying that the land price increase realized between 2005 and 2008 persisted until 2011. We find similar tendencies in Panels (c) and (d). These results suggest that the land price change in 2006 was persistent until 2017.

To further confirm the long-term impact of the opening of Omotesando Hills, we pooled all the observation points, namely 2002, 2005, 2008, 2011, 2014, and 2017, defining 2002 and 2005 as the pre-treatment period and 2008-2017 as the post-treatment period. We then estimate the following model:

$$\ln p_{it} = \sum_{A} \beta_A \times g_A(d_i) \times 1(t \geq 2006) + f_r + f_t + \delta_t \ln(p_{r2005}/p_{r2002}) + \epsilon_{it}. \tag{3}$$

The estimated β_A represents the land price increase after Omotesando Hills's opening compared with the previous period.

Panel (e) of Figure 3 shows the estimation results based on Equation (3). Compared to Panel (f) of Figure2, the estimated treatment effects get about 16.1% smaller by controlling for pre-trends. Again, however, these effects decline with distance from Omotesando Hills. The estimates are significant up to 1,000m and at the 1,100-1,150m interval, with a significance level of 0.01. The most significant price increase occurs in 0-50m intervals, with a 40.6% increase. Thus, qualitatively, controlling pre-trends does not change the conclusions. Given the substantial change in the estimated impacts by controlling for the pre-trend, however, to take a conservative stance, we treat the specification controlling for the pre-trend as the preferred estimate.

3.6 Linear Specification

The non-parametric estimation results in the previous subsection show that the treatment effects linearly decline concerning the distance from Omotesando Hills. Thus, to succinctly capture the remarkable linear relationship, we estimate the following model:

$$\begin{aligned}\ln p_{it} = &\sum_{t \neq 2002,2005} 1(d_{i,km} \leq 1.5km) \times (\gamma_{t0} + \gamma_{t1} d_{i,km}) \\ &+ f_{r(i)} + f_t + f_t \times \ln(p_{r2005}/p_{r2002}) + \epsilon_{it},\end{aligned} \tag{4}$$

where $d_{i,km}$ shows d_i in kilometers and $1(d_{i,km} \leq 1.5km)$ takes one if the point belongs to the treatment group. The other notations are the same as in previous equations. The parameter γ_{t0} captures the distance-invariant price change over the treatment group in each survey year relative to 2005, and the parameter γ_{t1} represents the distance-variant price change in each survey year relative to 2005. The γ_{t1} implies that the price change linearly declines with distance from Omotesando Hills.

Table 2 tabulates the OLS estimates of Equation (4). According to Column (1) in Table 2, γ_{t0} is significantly positive for every survey year t. Thus, the treatment effect persisted through the post-period. The estimate for 2008 is higher than that for subsequent years, however, indicating that the treatment effect was largest soon after the opening, and it then declined slightly in subsequent years. The estimates indicate that the land price increased around 0.22-0.31 log points in the treatment group compared to the control group. The estimated slope parameters γ_{t1} in the model (4) are all significantly negative. The values indicate that land prices drop by 0.19-0.22 log point every 1km away from Omotesando Hills. In every estimation, the treatment effect becomes equal to zero at about 1.2 - 1.4km away from Omotesando Hills.[15]

We conduct a robustness check of the basic estimation result. First, we examine how much the result depends on the control group's choice by changing the control group's outer limit from 2.0km to 2.5km. Column (2) of Table 2 changes the distance range of the control group from 1.5-2km to 1.5-2.5km. The expansion of the control group virtually does not alter the sizes of the estimated coefficients. This result reassures that our basic result does

[15] We calculate this value by dividing γ_{t0} (resp. γ_0) by the absolute value of γ_{t1} (resp. γ_1) for each survey year. We conduct two joint hypothesis tests. The first null hypothesis is that γ_{t0} is equal for all years, and the second null hypothesis γ_{t1} is equal for all years. Both are rejected at the 1% significance level.

not depend on the choice of the control group. There is also a concern that the Stable Unit Treatment Value Assumption (SUTVA) may be violated. Specifically, the event could affect the control group nearest to the treatment group. This could reduce the accuracy of our estimates concerning the magnitude of the event's impact. To address this issue, we update the control group in Column (3) to be at a distance of 2.0-2.5 km, compared to the 1.5-2.5 km range used in Column (2). This adjustment excludes areas 1.5-2.0 km away, which are those closest to the treatment group, from the control group. Despite this adjustment, the size of the estimated coefficients remains unchanged. Therefore, a significant violation of the SUTVA is less of a concern.

Finally, we examine how much the opening of new stations and subway lines affects the estimation results. In particular, a new subway line called *Fukutoshin* line started to operate in June 2008 and serves the *Omotesando* station close to Omotesando Hills. This event does not directly affect the estimated impact on the 2008 land price, as the 2008 land price (as of January 1st) is data before the station's opening. The anticipation effect of the station opening, however, may have driven the result. To address this plausible concern, we include the distance to the nearest station as an additional control variable. The road ID fixed effects do not absorb this variable, because opening new stations generates time variation. The estimated effects reported in Column (5) show that the inclusion of this variable has little impact on the estimated intercept and slope coefficients, as demonstrated by the similar results of Column (5) to those of Column (1). Overall, we confirm the robustness of our baseline results.

Our model heretofore allows year-specific parameters to capture the effect of the opening of Omotesando Hills on land prices, and the estimated effects depend on the years since the opening of Omotesando Hills to a certain degree. We now attempt to capture the average effect by pooling multiple years after the opening of Omotesando Hills. To attain this goal, we estimate the following parsimonious linear specification model that imposes identical parameter assumptions:

$$\begin{aligned}\ln p_{it} =& \gamma_0 \times 1(d_{i,km} \leq 1.5km) \times 1(t \geq 2006) \\ &+ \gamma_1 \times d_{i,km} \times 1(d_{i,km} \leq 1.5km) \times 1(t \geq 2006) \\ &+ f_r + f_t + f_t \times \ln(p_{r2005}/p_{r2002}) + \epsilon_{it},\end{aligned} \tag{5}$$

where after-treatment dummy $1(t \geq 2006)$ takes one if the year of the observation is after the event. The other notations are the same as in previous equations. The parameter γ_0

captures distance-independent price changes in the post-treatment period relative to the pre-treatment period in the treatment group compared with the changes in the control group. The parameter γ_1 captures the distance-dependent price change in the post-period relative to the pre-period compared to the control group's changes. The negative γ_1 implies that the price change linearly declines with the distance from Omotesando Hills. Note that the linear terms $1(d_{i,km} \leq 1.5km)$ and $1(t \geq 2006)$ are absorbed in location and year-fixed effects.

Table 3 tabulates the OLS estimates of the model (5). Column (1) shows that γ_0 is significantly positive at 0.26, implying that the treatment group experienced a 0.26 log point increase in land prices compared to the control group in the post-period relative to the pre-period. The estimated γ_{t1} is -0.19, indicating that land prices dropped by 0.19 log point every 1km from Omotesando Hills. The estimates of γ_0 and γ_{t1} imply that the effect of Omotesando Hills dissipates at 1.32km. The average treatment effect within this 1.32km radius was about 0.086 log point from the pre- (2002, 2005, where the midpoint is 2003.5) to post-treatment period (2008, 2011, 2014, 2017, where the midpoint is 2012.5).[16] Thus the annual average treatment effect is about 0.96% (= $\exp(0.086)^{1/9} - 1$).[17]

Columns (2) - (4) of Table 3 report the estimation results of the various robustness checks. The specification model for each column is the same, with the same number of columns as in Table 2. Again, we confirm the robustness of our baseline results, that is, Column (1).

3.7 Placebo: The cases for residential and office building redevelopment programs

Thus far, we argued that the increase in land prices around Omotesando Hills was due to the shopping externality. Demolishing age-old buildings and reconstructing new buildings, however, may generate the externality without the shopping externality. A straightforward way to test if the shopping externality is the mechanism behind the observation would be to examine changes in sales in neighborhood stores. We will implement this analysis in Section 5. Before proceeding to this direct analysis, we implement an indirect test by examining

[16]This (area-weighted) average treatment effect within the treated area is calculated as $\frac{\int_0^{|\hat{\gamma}_0/\hat{\gamma}_1|}(\hat{\gamma}_0+\hat{\gamma}_1 x)\times 2\pi x dx}{|\hat{\gamma}_0/\hat{\gamma}_1|^2\pi}$ where $\hat{\gamma}_0$ and $\hat{\gamma}_1$ represent the point estimates of γ_0 and γ_1 from Equation (5). $|\hat{\gamma}_0/\hat{\gamma}_1|$ shows the distance at which the event's effect dissipates. $(\hat{\gamma}_0 + \hat{\gamma}_1 x)$ shows the rate of change in land price at a distance of $x$km from Omotesando Hills. $2\pi x$ shows the circumference (i.e., area) at a distance of $x$km from Omotesando Hills. $|\hat{\gamma}_0/\hat{\gamma}_1|^2\pi$ shows the total area of the treated area.

[17]Let V_1 and V_T denote the values of the outcome variables in period one and period T, respectively. If the estimated effect of the event, $\hat{\delta}$, is expressed in log points, we have $\exp(\hat{\delta}) = V_T/V_1$. If we define x as the annual growth rate of the outcome variable, we have $V_1 \times (1+x)^{T-1} = V_T$. Rearranging this equation yields $x = (V_T/V_1)^{\frac{1}{T-1}} - 1$. From the equivalence $\exp(\hat{\delta}) = V_T/V_1$ follows that $x = \exp(\hat{\delta})^{\frac{1}{T-1}} - 1$.

whether we observe a similar land price change in the case of redevelopment programs that do not entail the shopping externality, such as the redevelopment programs of an office complex or residential buildings. Here, we use Equation (5) as our specification model. The after-treatment dummy $1(t \geq \textit{event year})$ takes one when the year of observation t is the same as or later than the treatment year.

The first example we pick is the case of the redevelopment program of an office complex named Toranomon Hills. We adopted the opening of Toranomon Hills in 2014 as a comparison case because the same developer, Mori Building Co., implemented the project. Toranomon Hills is a complex of offices, residences, and hotels with limited commercial facilities in an office district. Thus, we do not expect the presence of a shopping externality, unlike Omotesando Hills. According to Column (1) of Table 4, the opening of Toranomon Hills decreases the land prices surrounding them by about 0.083 log points, and this negative effect gets smaller with the distance from the building. These results imply that constructing a new building does not raise land prices. The decrease in the neighborhood land price is not surprising, given that the construction of Toranomon Hills discretely increased the effective land supply and worsened access to sunlight.

The second example is the redevelopment of residential apartments. Omotesando Hills replaced Dojunkai Aoyama Apartments, a set of residential units. Dojunkai is an agent to promote the reconstruction after the 1923 Kanto Great Earthquake. It constructed various apartment units in the 1920s, and several apartments were demolished in the 2000s and 2010s to build new apartment units. We focus on five apartment buildings whose redevelopment plans were completed after 2005: Edogawa, Otsuka-Joshi, Uenoshita, Minowa, and Kiyosuna Apartments. We define the treatment year of each apartment building as the year when its reconstruction was completed: 2005, 2013, 2015, 2011, and 2005, respectively. Like the Dojunkai Aoyama Apartments before Omotesando Hills, these buildings were rebuilt due to their age, but unlike the Dojunkai Aoyama Apartments, they were converted into residential buildings. One exception is the Otsuka-Joshi apartment building, which was rebuilt as an office building. Columns (2) - (6) in Table 4 show the estimation results. The rebuilding of the Edogawa apartment building in Column (2) and the Otsuka-Joshi apartment building in Column (3) do not significantly affect land prices in the neighborhood. The rebuilding of the Uenoshita apartment building in Column (4), the Minowa apartment building in Column (5), and the Kiyosuna apartment building in Column (6) decreased land prices in the respective neighborhoods but by a smaller amount.

Examination of redevelopment plans not involving shopping facilities indicates that demolishing old buildings and constructing new buildings does not necessarily raise land prices.

These results suggest that the shopping externality is a plausible reason for the land price increase around Omotesando Hills after its opening.

4 Impact on Land Use

In the previous section, we find that the opening of Omotesando Hills substantially increased neighborhood land price. Behind this observation, we hypothesize that the opening of Omotesando Hills increased the land demand for commercial use in the neighborhoods. While the surrounding area is densely populated, substituting residential units for commercial units is possible to the extent that zoning regulations allow.[18] Thus we examine how building use changed after the opening of Omotesando Hills. Specifically, we estimate the effect on the share of the particular building use around the points in the land price data.

4.1 Land Use Data

To observe land use, we draw on the Survey of the Current Status of Building Use in 2001, 2006, 2011, and 2016 provided by the Bureau of Urban Development, Tokyo Metropolitan Government. These data record the current usage of all buildings in Tokyo based on an onsite survey by visual inspection of their exterior. Each building has one building use classification code. We focus on five principal classification codes: detached house unit, apartment unit, commercial facility unit, composite residential and commercial facility unit, and office unit.

Using these data, we construct the following five outcome variables for the building nearest to each geographic point, namely, the share of detached houses, the share of apartments, the share of commercial facilities, the share of composite facilities (of residential and commercial use), and the share of office facilities. These land use variables are constructed by focusing on the share of specific building use within the total floor area, because the total

[18] The Tokyo metropolitan government plans and implements zoning regulations for the central Tokyo area. Historically, the government revised its zoning regulations every eight years until 2004. Then, the government comprehensively revised the regulations in 2004. Since then, zoning regulations could be revised as needed according to the revision of the district plans by the government (https://www.toshiseibi.metro.tokyo.lg.jp/keikaku/shingikai/pdf/riyou01_06.pdf). In 2020, it was announced that zoning regulations in Tokyo would be reviewed comprehensively for the first time since 2004. During the analysis period, the zoning was revised in 2004, but there were almost no changes in zoning within a 2-km radius of Omotesando Hills (https://www.toshiseibi.metro.tokyo.lg.jp/kanko/area_ree/h16_gaiyou.pdf). There are several district plans within this 2km radius. For example, the district plan for the Omotesando District, which includes Omotesando Hills, was planned in 2002. According to this plan, in principle, the first floors of buildings facing Omotesando Street are not allowed for purposes other than commercial use, such as stores, restaurants, and exhibition halls.

floor area of buildings in the neighborhood changes over the years due to the demolition or construction of buildings. We employ the share as outcome variables to exclude the change in the overall building supply, because we aim to capture the supply for each use.[19] The data construction method is explained below using the share of detached houses as an example. (1) We match each building with its nearest road ID in the land price data. Thus, we identify the neighboring buildings for each road ID. The average distance between pairs of buildings and road IDs is about 27 meters. (2) We sum the area of all neighboring buildings for each road ID. (3) We sum the area of neighboring buildings used as detached houses for each road ID. (4) We divide the outcomes from (3) by the outcome from (2). We construct the other variables in the same way.

4.2 Empirical Model and Results

Using land use as the outcome variable instead of land price, we estimate similar models as Equations (3) and (5). Below, $share^j_{rt}$ denotes the share of building use j around road ID r at year t where j is the land use for each category: detached houses, apartments, commercial facilities, composite facilities of residential and commercial, and offices. We estimate the effect on each building use in each 50m interval with the following model:

$$share^j_{rt} = \sum_A \beta^j_{tA} \times g_A(d_r) \times 1(t \geq 2006) + f_r + f_t + \epsilon_{rtj}, \tag{6}$$

where, as before, $g_A(d_r)$ is a set of dummy variables corresponding to intervals for each 50m distance from Omotesando Hills. As before, β^j_{tA} captures the treatment effect size depending on the distance from the Omotesando Hills.

Figure 5 illustrates the estimated β^j_{tA} for each land use as the outcome variable. The figures demonstrate that the opening of Omotesando Hills reduced the share of apartments up to 1,250m and increased the share of commercial facility units up to 800m. The effects on the share of detached houses and combined residential and commercial facilities are statistically insignificant, with some exceptions. Further, we do not observe any significant changes in offices. In the end, this analysis reveals that the opening of Omotesando Hill replaced apartments with commercial facilities in its neighborhood. A caveat, however, is that the effects are not precisely estimated, because the functional form concerning the distance from Omotesando Hills is very flexible.

[19] In this analysis, we use only those road IDs for which all six years of data are available in the land price data. Omotesando Hills itself is excluded from the following calculation.

To overcome the limitation, we estimate a restrictive model to quantify the impact more precisely by substantially reducing the number of parameters. As a first-order approximation, we assume that the treatment effect decays linearly to the distance from the event's epicenter. Specifically, we estimate the following model:

$$\begin{aligned} share^j_{rt} =& \gamma^j_0 \times 1(d_{r,km} \leq 1.5km) \times 1(t \geq 2006) \\ &+ \gamma^j_1 \times d_{r,km} \times 1(d_{r,km} \leq 1.5km) \times 1(t \geq 2006) \\ &+ f_r + f_t + \epsilon^j_{rt}, \end{aligned} \tag{7}$$

where $d_{r,km}$ is the distance from the epicenter in kilometers to road ID r, γ^j_0 captures the treatment effect at the epicenter, and γ^j_1 captures the linear decay of the treatment effect concerning the distance from it.

Table 6 reports the estimation results with Equation (7). Each column corresponds to the regression results that use the share of different building use as the dependent variable. The reduction of the model parameters comes with a substantial improvement in estimate precision. As seen in Figure 5, there are significant decreases in the share of housing units and increases in the share of commercial units. Column (1) shows that the share of detached housing units decreases by 2.3 percentage points at the epicenter, and the impact dissipates to zero at about 1.1 kilometers from it. Column (2) shows that the share of apartments decreases by 11 percentage points at the epicenter, and the impact dissipates to zero at about 1.4 kilometers from it. The average treatment effect within the treated area is about 3.6 percentage points. The decrease in apartments is substantial, given that the share of apartments is 30.2% in the control group. Column (3) shows the share of commercial facilities increases by 8.4 percentage points at the epicenter and decays almost completely in 1.5 kilometers from it. Column (4) shows the share of composite units that combine residential and commercial facilities by 5.4 percentage points at the epicenter and decay almost completely 1.3 kilometers from it. As expected from the graphical presentation in Figure 5, Column (5) shows that the opening of Omotesando Hills does not affect the fraction of office units in its neighborhood. Overall, the opening of Omotesando Hills caused the substitution of residential land use for commercial land use in a discernible way. Omotesando Hills increased the share of "commercial facilities" and "composite facilities of residential and commercial use" by 2.8 percentage points and 1.8 percentage points, on average, within the treated area from the pre-treatment (2001 and 2006, where midpoint is 2003.5) to the post-treatment (2011 and 2016 where midpoint is 2013.5) periods, respectively. Thus, the annual growth rate in percentage points is about 0.28 percentage point (= 2.8/10) and 0.18 percentage point (= 1.8/10), respectively. The descriptive calculations show that the total share of commercial areas (i.e., commercial facilities plus composite facilities of residential and commercial use) within a 1.5 km radius of Omotesando Hills increased from 20.3% to 23.8% from 2001 to 2016, which is a 17% increase.

Analysis of the changes in land use in the neighborhood of Omotesando Hills reveals a substantial increase in the commercial use of land due to the substitution of land use within the limits of zoning regulations. The nearest neighborhood of Omotesando Hills is designated as a *Category I mid/high-rise oriented residential zone*. Contrary to its name, small shops with a floor area of up to 500 square meters are allowed in this zone. Thus, substituting residential units with small shop units has occurred within the zone to the extent the regulation allows. In contrast, the rigidity of office units shows that substituting them for shops did not occur regardless of the flexible zoning regulations, suggesting that those locations were already best used as office locations.

5 Impact on Firms' Performance

So far, we have found that the opening of Omotesando Hills increased land prices and commercial building use within the treatment group. The observed increases in land price and changes in building use imply that the demand for commercial land grew after the event. To directly examine the change in the derived demand for commercial land, we analyze the sales and profit growth of the firms in the neighborhood that potentially benefited from the externality of the opening of Omotesando Hills.

5.1 TSR Data

We use a firm database provided by TOKYO SHOKO RESEARCH, LTD. (TSR), which is one of the largest credit-rating companies in Japan and widely used for academic research (Bernard et al., 2019; Carvalho et al., 2021). This database contains each firm's sales and profits, along with its basic profile, such as industry, number of establishments, and headquarters-level address for each year from 1998 to 2018.

For the firms' performance analysis, as we did for the land price and land use analysis, we treat geographic units as the unit of analysis. More specifically, we treat 250-meter mesh (the square mesh with sides measuring 250 meters, covering a total area of 62,500 square meters) as the unit of analysis. We transform the firm-level data to geographic data by aggregating individual firm-level data by the 250-meter mesh, where each firm is allocated to the mesh based on its headquarters address. Since the address information in the database is that of the headquarters, sales may not necessarily occur at the reported address. Thus, we focus on single-establishment firms to ensure that customer sales happen at the reported address. We further restrict the sample to those firms not in bankruptcy and with sales and profit information in the current calendar year. Then, we calculate aggregate sales and profit for each 250-meter mesh. We begin our analysis from the aggregate figure of all industries and move to the subsample analysis focusing on the firms in industries that are likely to benefit from the externality generated by Omotesando Hills, namely 1. textiles and apparel retail and wholesale, 2. food and beverage retail, and 3. restaurants.[20] Table 7 shows the summary statistics of the outcome variables used in this section.

5.2 Firm dynamics

The opening of Omotesando Hills has allegedly revitalized the neighborhood's commercial activities. To examine if this is the case, as a first step, we examine the evolution of the number of firms for all industries. To capture the firm dynamics, we classify all single-establishment firms into three types: entering, exiting, or surviving. To define these three groups, we consider 1998-2005 as the pre-treatment period and 2006-2018 as the post-treatment period. Firms that existed only in the pre-treatment period are classified as exit firms, and firms that existed only in the post-treatment period are classified as entry firms. Firms that existed in both the pre- and post-treatment periods are classified as surviving firms. We count each mesh's entering, exiting, and surviving firms, respectively. We also calculate the number of existing firms in the pre-treatment period (hereafter referred to as the number of preexisting firms) as the sum of the number of exiting and surviving firms, meaning the number of unique firms between 1998 and 2005.

Panels (a) and (b) in Figure 6 show the number of entering and exiting firms, respectively. We observe a substantial number of entries in the area, which increases as the location approaches Omotesando Hills. The number of exits also increases as the mesh gets closer to the building, but the quantity is significantly smaller than the number of entries. Thus, these figures indicate that the density of single-establishment firms (presumably, shops) increased in the neighboring area.

[20]TSR allows respondents to report their industry in up to three categories according to the sales composition. We define a firm as belonging to a specific industry category if the firm reports the industry as one of the three industry codes.

The graphical analysis reveals that the opening of Omotesando Hills induced the entry of single-establishment firms. We further attempt to quantify the impacts of the new opening of Omotesando Hills on the numbers of entering and exiting firms in the neighborhood by estimating the following negative binomial regression model:

$$E(n_{lm}) = \exp[\alpha_l + \sum_A \beta_{lA} \times g_A(d_m) + \gamma \times N_{0m}], \tag{8}$$

where outcome variables n_{lm} are the number of firms with type $l \in \{entry, exit\}$ at 250m-mesh m. We employ the negative binomial regression model to accommodate that some 250m meshes have zero values in n_{lm}. The variable d_m is the distance of the centroid point of each mesh from Omotesando Hills. The function $g_A(d_m)$ is the indicator function taking one if the d_m falls in the 500m intervals: $A = \{[0, 500), [500, 1000), [1000, 1500)\}$. The wider bin width than that in the previous analysis is due to the smaller sample size than that in the previous analysis. The stock variable N_{0m} counts the number of unique firms between 1998 and 2005 within mesh m to capture the mechanical effect of the business density on the entry and exit. The parameter β_{lA} indicates the impact of distance category A on firm dynamics $l \in \{entry, exit\}$.

Panel (a) of Figure 7 reports the estimated coefficients β_{lA} with 95 percent confidence intervals. The estimates indicate that the effect on the number of exiting firms is significantly positive within the 0-500m intervals, where entry is about 52.1% $(= (\exp(\hat{\beta}_{entry,0-500}) - 1) \times 100 = (\exp(0.42) - 1) \times 100)$ larger than in the control group. At the same time, however, the number of entries is not substantially different from that of the control area. Thus, the opening of Omotesando Hills increased the number of exits but did not affect the number of entries in its neighborhood, making the area sparse in terms of the number of firms.

Panels (b) - (d) of Figure 7 present the regression outcomes by specific industries: (b) Textiles and apparel Retail and Wholesale, (c) Food and Beverage Retailing, and (d) Restaurants. The outcome variables, n_{lm}, and the control variables, N_{0m}, are calculated using firms belonging to each industry.

The analysis of the textile and apparel industry's retail and wholesale sectors, as shown in Panel (b), indicates that both entry and exit were more frequent in the nearby area within 500 meters. Between 500 and 2000 meters, however, we observed more entry than exit. These findings suggest that the opening of Omotesando led to the entry of single-establishment firms in the textile and apparel industry. Panel (c) confirms that the entry of single-establishment firms was more prominent in the nearby area between 500 and 2000 meters compared to the control area in the food and beverage retail industry analysis. In contrast, the analysis of the restaurant industry in Panel (d) indicates that the entry and exit rates in the vicinity were not statistically different from those in the control area (except for the exit rate in 0-500m).

The findings presented in Figure 7 suggest that the establishment of Omotesando Hills resulted in the exit of single-establishment firms of all industries from its immediate vicinity. This was probably due to the consequent increase in land prices and rent, but the entry of single-establishment firms in industries that presumably benefited from the externalities generated by Omotesando Hills became active. This indicates that the opening of Omotesando Hills transformed the industrial structure of the neighborhood by influencing the firm dynamics. In the process, only firms that could afford the high rent were able to stay in the area. To shed light on the underlying mechanism, we will further analyze the impact on firms' sales and profit.

5.3 Firm performance

We next examine the impacts of the opening of Omotesando Hills on the performance of neighboring firms. To address this, we estimate the effect on firms' sales and profit in the neighborhood.

We use total sales and profit per 250-meter mesh as the outcome variables. We calculate total sales and profit per mesh by taking the sum of firms' sales and profit for each year.[21] After calculating the area sum of sales and profit, we seek to take the natural logarithm of these variables. Taking the logarithm of these variables, however, would result in missing variables, because sales could be zero and profit could be negative. Therefore, before taking the natural logarithm, we first normalize the sum of the profits so that the minimum value is zero. After that, we use the inverse hyperbolic sine transformation introduced by Bellemare and Wichman (2020) to solve the problem of the log transformation of zero. Using these data, we estimate the following model:

$$\ln v_{mt} = \sum_{A} \beta_A \times g_A(d_m) \times 1(t \geq 2006) + f_m + f_t + \epsilon_{mt}, \tag{9}$$

where $\ln v_{mt}$ is a log value of total sales or profit of 250-m mesh m in time t, ϵ_{mt} is an error term. We assume the conditional independence $E[\epsilon_{mt}|f_m, f_t, d_m] = 0$ and clustering with mesh level. The other notations are the same as those in Equation 9.

Figures 8 and 9 report the estimated coefficients of interest β_A in Equation (9) and corresponding 95% confidence intervals for each of the selected industries. Panel (a) of Figure

[21] Before this calculation, we winsorize firms' sales and profit at level 1 and 99% to exclude outliers.

8 shows a striking increase in total sales of all industries. The treatment effect is positive and statistically significant, and its effect declines with the distance from Omotesando Hills. The largest impact is in the 0-500m intervals, where total sales increased by about 2.13 log points between the period before (between 1998 and 2005, the midpoint is 2001.5) and the period after (between 2006 and 2018, the midpoint is 2012). While this estimate might seem too large, this figure is the growth rate over a 10.5-year period. Thus the annual growth rate is about 22.5% ($= \exp(2.13)^{1/10.5} - 1$). In contrast, Panel (b) indicates that the effect on total profit is insignificant for each interval in the entire treatment group. Overall, the opening of Omotesando Hills increases total local sales but not total profit in all industries.[22]

Figure 9 shows the estimated results by industries: Retail and wholesale of textiles and apparel in Panels (a) and (b) Food and beverage retail in Panels (c) and (d) and Restaurants in Panels (e) and (f).

The results for the retail and wholesale of textiles and apparel, reported in Panel (a), show that the opening of Omotesando Hills increased sales by about 3.02 log points in the nearest neighborhood, while it did not increase the total profit at the 5% statistically significant level. The substantial increase in total sales aligns with the active entry reported in Panel (b) of Figure 7.

The treatment effects on total sales are statistically significant for the food and beverage retail industry in the 500-1000 meter interval, as reported in Panel (c) of Figure 9. This result aligns with the active entry reported in Panel (c) of Figure 7. We again find no impact on profit for this industry.

The treatment effects on total sales and profit are not statistically significant for the restaurant industry, as reported in Panels (e) and (f) of Figure 9. This result aligns with the absence of the impact reported in Panel (d) of Figure 7. Although the restaurant industry might attract customers and increase the total sales or profit in the area, we find little impact on this industry. This contrasts with the textiles and apparel industry results, suggesting that consumers can purchase multiple clothes but cannot eat multiple meals at one time.

The results thus far are based on the analysis sample of single-establishment firms for capturing the shopping externality. We examine how the results change using multiple establishment firms as the analysis sample to shed more light on firm dynamics. To make the results succinct, we estimate a parsimonious model imposing an assumption that the treatment effect decays linearly with the distance from Omotesando Hills:

[22] Firms may adjust expenses to reduce profits to zero to save on taxes. Such manipulation attenuates the estimated impact; however, less than about 2.2% of firms in the apparel industry in the analysis sample have zero profit each year; thus, their impact could be minimal.

$$
\begin{aligned}
\ln v_{mt} = & \gamma_0 \times 1(d_{km,m} \leq 1.5km) \times 1(t \geq 2006) \\
& + \gamma_1 \times d_{km,m} \times 1(d_{km,m} \leq 1.5km) \times 1(t \geq 2006) + f_m + f_t + \epsilon_{mt},
\end{aligned} \tag{10}
$$

where the variable notation is the same as that in Equation (9). The parameter γ_0 captures the overall effect on the entire treatment group, and γ_1 captures the decay of the effect with the distance from Omotesando Hills.

Table 8 tabulates the estimation results. Panel A reports the analysis results using firms in all industries as the sample. Column (1) reassures a statistically significant spillover effect with a linear decay with distance among single-establishment firms. The average impact on the total sales in the 0-1500m intervals, where total sales increased by about 0.911 log points between the period before (between 1998 and 2005, the midpoint is 2001.5) and the period after (between 2006 and 2018, the midpoint is 2012). While this estimate might seem too large, this figure is the growth rate over a 10.5-year period. Thus the annual growth rate is about 9.0% ($= \exp(0.911)^{1/10.5} - 1$). Column (2), however, shows that using multiple-establishment firms changes the estimated impact to negative, meaning that the opening of Omotesando Hills reduced the total sales of neighboring firms. A statistically nonsignificant estimate for the distance term implies that the negative spillover effect was uniform within the 1500-meter distance. This negative effect suggests that multi-establishment firms fry out from the neighborhood. Larger firms that do not benefit from the location near Omotesando Hills moved out, probably due to the increased rent. Finally, we find no impact on profit regardless of the analysis sample, as reported in Columns (3) and (4).

Panel B Column (1) shows that the total sales significantly increase in the treatment group in the retail and wholesale textile and apparel industry, and this treatment effect declines linearly with distance. The average treatment effect within the treated area on the total sales is 1.453 log points, which means it annually increased by 14.8% ($= exp(1.453)^{1/10.5} - 1$). Column (2) shows that using multiple establishment firms as the sample doubles the estimates compared with using single-establishment firms as the sample. Its average treatment effect within the treatment area also doubles to 2.805 log points, which means it increased annually by 30.6% ($= exp(2.805)^{1/10.5} - 1$). Thus, the estimated spillover effect gets even more prominent for multi-establishment firms. This result suggests that the agglomeration of fashion-related firms induced the location of headquarters of multi-establishment firms in the neighborhood. The location of headquarters in the area arguably enables management to learn about new fashion trends and eases in-person information exchange through human networks. In contrast, Columns (3) and (4) show that the estimated impacts for profit are zero regardless of the sample used, reassuring that the firms do not benefit from increased sales, most probably due to the increased rent.

The analysis of the other two industries, food and beverage retail (Panel B) and restaurants (Panel C), confirms the absence of spillover effects for these two industries even if multi-establishment firms are used in the analysis sample.

6 Discussion

6.1 Synthesizing the impacts on land price, sales, and profits of neighboring shops

The empirical examination shows that the opening of Omotesando Hills increased land prices in the neighborhood and increased the sales of neighboring shops but had no impact on their profit. To understand these results in a synthesized way, we introduce a simple monocentric city model where shops with heterogeneous profitability are located in the Omotesando Hills area. The details of the theoretical model are relegated to the Appendix, and we explain the discussion outline below.

The model defines the equilibrium by the land rent, the shop's revenue, and the shop's spatial allocation. We consider the impact of the opening of Omotesando Hills, which increases the revenue of neighboring shops on the equilibrium. We show that the increase in revenue attracts entrant firms that can earn higher revenue than incumbent firms to the area and increases the demand for land. Since the land supply is assumed to be fixed, which is realistic in our setting, the demand increase entails an increase in rent. The marginal firm with the lowest productivity in the treatment area determines the equilibrium rent. Thus, the firm with higher productivity than the marginal firm in the treatment area enjoys positive profit by the amount of the difference between the marginal productivity and the equilibrium rent.[23] In contrast, in the absence of heterogeneity in the treatment effects, the increase in productivity is exactly canceled by the increase in the rent for all firms.

Our empirical findings that the spillover increases the land price but does not increase the profit are consistent with the absence of treatment effect heterogeneity. All shops in the treatment group enjoyed the same increase in revenue and experienced the rent hike that exactly cancels out the benefit from the externality. This scenario is probable given the

[23] Vigdor (2010) makes a similar argument in the context of urban revitalization.

active exit of shops from the area; under high rent pressure, only productive shops survive. As a result, heterogeneity in the treatment effects disappears among existing shops in the treatment area.

6.2 External Validity

We now discuss how much we can generalize the findings from our case study examining an urban redevelopment program in Tokyo. Our case study features the development of a shopping facility facing an open street in a dense shopping area, unlike a shopping mall studied by Gould et al. (2005). The difference between our setting and the shopping mall setting is the absence of a central planner; the landlord of the shopping mall can internalize the externality and thus has the incentive to coordinate the location of shops such that the externality is maximized. In our context, if the land developer of Omotesando Hill owned all the land in the neighborhood, they would have invited top-brand shops at a low rent to attract customers in the area, expecting a more significant spillover to the neighborhood. Thus, the size of the estimated externality should be understood in the context of the absence of such an intended spillover effect.

Our context is also different from the neighborhood effect of the entry of *big box* stores, such as Walmart or IKEA, which are the subject of numerous existing studies.[24] The case we focus on in this study differs from these big box cases regarding the variety of goods available at the opening facility. Omotesando Hills houses various small shops and restaurants in the facility, and the selected brands and cuisines are far from the complete list. In this sense, the variety of goods offered by the newly opened facility arguably complements the goods from neighborhood stores. In contrast, big box stores are large enough to offer a wide variety of goods and services and presumably offer a complete set of choices.[25] Therefore, the demand spillover is difficult to materialize, at least for the goods that belong to the same category of goods or services.

The limited land supply in the neighborhood is another essential feature for understanding the estimates of our case study. As explained in the land use analysis section, the area is already densely populated, and its land use is strictly regulated. Although we find a

[24]In the relatively recent literature since 2010, Daunfeldt et al. (2017, 2019) analyze the opening of IKEA, and Ellickson and Grieco (2013) and Arcidiacono et al. (2020) analyze the opening of Walmart. Indeed, *Economic Development Quarterly* Vol.26 Issue 4 is a special issue on the impacts of Walmart's entry. Papers using regionally aggregated data often find positive effects, while papers using individual data, such as incumbent retailers, often find negative effects of entry.

[25]There is some literature, such as Daunfeldt et al. (2019), that focuses on the complementarity and substitution effects from big-box entry, but they are still few.

substitution of building use within the limits of the zoning regulation, such substitution is relatively limited. With this limited land supply, the incidence of the positive spillover effect tends to fall on landlords through the land price increase.

Due to decentralized decision-making, our results are well generalized when a new shopping facility opens in a densely populated shopping district. Thus, the setting of our case is similar to that of Koster et al. (2019), who examine the degree of shopping externality in the context of urban shopping districts.

7 Conclusion

We estimated the impact of an urban redevelopment program on the neighborhood land value. The redevelopment program demolished 77-year-old apartment units and rebuilt a modern building complex for commercial and residential use. The redevelopment program significantly increased land price in the neighborhood; the land price of the treatment area increased by 0.96% annually, on average. At the same time, the share of commercial-related building use increased by about 0.2-0.3% points annually. The examination of firm data reveals that the sales of stores in the neighborhood increased by 9.0% annually, but their profit did not increase. This finding suggests that the benefit of the urban redevelopment program falls on the landlord in the neighborhood.

This paper shows that the redevelopment of a congested urban shopping area, initiated by a private developer, generated a significant externality. Such a positive externality implies private land developers' under-supply of such programs. A textbook solution to resolve this problem would be the combination of land taxation and providing subsidies to private land developers. Despite the simplicity of the idea, implementing such a policy is politically tricky, considering the opposition to land taxation on landlords. Furthermore, setting agreeable tax and subsidy levels would be difficult without a proper market for trading the externality.

As a practical solution to the problem, Japan's central and local governments introduced a zoning system called a special urban redevelopment zone. Once an area is designated as a special zone, the floor area ratio for the zone is significantly expanded. Thus, the private developer can construct a high-rise building that houses residential, office, and commercial facilities. Hence, the developer arguably internalizes the externality generated by the urban redevelopment program.[26] In this trend of land use deregulation, Omotesando Hills provides

[26]Minoru Mori, who was the CEO of Mori Building Ltd. between 1993 and 2010, proposed the concept of *vertical garden city,* that is, the giant high-rise building that houses all facilities relevant to all aspects of people's lives, including residential, commercial, and business office. Mori Building Ltd. has implemented

a rare case where the redeveloped area was not designated as a special urban redevelopment area, so it illustrates how central Tokyo would have developed without land-use deregulation. Instead of being concentrated in a single high-rise building, the stores would have been spread out in a plane-like arrangement at a sub-optimal level.

References

Arcidiacono, Peter, Paul B Ellickson, Carl F Mela, and John D Singleton, "The competitive effects of entry: Evidence from supercenter expansion," *American Economic Journal: Applied Economics*, 2020, *12* (3), 175–206.

Autor, David, Anne Beck, David Dorn, and Gordon H Hanson, "Help for the Heartland? The Employment and Electoral Effects of the Trump Tariffs in the United States," Working Paper 32082, National Bureau of Economic Research January 2024.

Autor, David H., Christopher Palmer, and Parag A. Pathak, "Housing market spillovers: Evidence from the end of rent control in Cambridge Massachusetts," *Journal of Political Economy*, 2014, *122* (3), 661–717.

Baum-Snow, Nathaniel and Daniel Hartley, "Accounting for central neighborhood change, 1980–2010," *Journal of Urban Economics*, 2020, *117* (C), 103228.

Bellemare, Marc F and Casey J Wichman, "Elasticities and the inverse hyperbolic sine transformation," *Oxford Bulletin of Economics and Statistics*, 2020, *82* (1), 50–61.

Bernard, Andrew B, Andreas Moxnes, and Yukiko U Saito, "Production networks, geography, and firm performance," *Journal of Political Economy*, 2019, *127* (2), 639–688.

Bradlow, Benjamin H., Stefano Polloni, and William Violette, "Public housing spillovers: Evidence from South Africa," *Journal of Urban Economics*, 2023, *134*, 103527.

Brueckner, Jan K, "Inter-store externalities and space allocation in shopping centers," *The Journal of Real Estate Finance and Economics*, 1993, *7*, 5–16.

Carvalho, Vasco M, Makoto Nirei, Yukiko U Saito, and Alireza Tahbaz-Salehi, "Supply chain disruptions: Evidence from the Great East Japan earthquake," *The Quarterly Journal of Economics*, 2021, *136* (2), 1255–1321.

several urban redevelopment programs according to this concept in the 1990s and 2000s.

Clapp, John M., Stephen L. Ross, and Tingyu Zhou, "Retail Agglomeration and Competition Externalities: Evidence from Openings and Closings of Multiline Department Stores in the U.S.," *Journal of Business & Economic Statistics*, 2019, *37* (1), 81–96.

Combes, Pierre-Philippe, Gilles Duranton, Laurent Gobillon, Diego Puga, and Sébastien Roux, "The productivity advantages of large cities: Distinguishing agglomeration from firm selection," *Econometrica*, 2012, *80* (6), 2543–2594.

Couture, Victor and Jessie Handbury, "Urban revival in America," *Journal of Urban Economics*, 2020, *119* (C), 103267.

Daunfeldt, Sven-Olov, Oana Mihaescu, Helena Nilsson, and Niklas Rudholm, "What happens when IKEA comes to town?," *Regional Studies*, 2017, *51* (2), 313–323.

_ , _ , _ , and _ , "Spillover effects when IKEA enters: Do incumbent retailers win or lose?," *Papers in Regional Science*, December 2019, *98* (6), 2295–2313.

Diamond, Rebecca, "The determinants and welfare implications of US workers' diverging location choices by skill: 1980-2000," *American Economic Review*, March 2016, *106* (3), 479–524.

Ellickson, Paul B and Paul LE Grieco, "Wal-Mart and the geography of grocery retailing," *Journal of Urban Economics*, May 2013, *75*, 1–14.

Glaeser, Ed, Jed Kolko, and Albert Saiz, "Consumer city," *Journal of Economic Geography*, 2001, *1* (1), 27–50.

Gould, Eric D., B. Peter Pashigian, and Canice J. Prendergast, "Contracts, externalities, and incentives in shopping malls," *The Review of Economics and Statistics*, 2005, *87* (3), 411–422.

Greenstone, Michael, Richard Hornbeck, and Enrico Moretti, "Identifying agglomeration spillovers: Evidence from winners and losers of large plant openings," *Journal of Political Economy*, 2010, *118* (3), 536–598.

Hsieh, Chang Tai and Enrico Moretti, "Housing constraints and spatial misallocation," *American Economic Journal: Macroeconomics*, 2019, *11* (2), 1–39.

Koster, Hans R. A. and Jos van Ommeren, "Place-Based Policies and the Housing Market," *The Review of Economics and Statistics*, 07 2019, *101* (3), 400–414.

Koster, Hans R.A., Ilias Pasidis, and Jos van Ommeren, "Shopping externalities and retail concentration: Evidence from dutch shopping streets," *Journal of Urban Economics*, 2019, *114*, 103194.

Leonardi, Marco and Enrico Moretti, "The agglomeration of urban amenities: Evidence from Milan restaurants," *American Economic Review: Insights*, June 2023, *5* (2), 141–57.

Miyauchi, Yuhei, Kentaro Nakajima, and Stephen J. Redding, "The economics of spatial mobility: Theory and evidence using smartphone data," Working Papers 295, Princeton University, Department of Economics, Center for Economic Policy Studies. April 2022.

Nakajima, Kentaro and Kensuke Teshima, "Identifying neighborhood effects among firms: Evidence from location lotteries of the Tokyo Tsukiji fish market," *Hitotsubashi University Working Paper*, 2017.

Rossi-Hansberg, Esteban, Pierre-Daniel Sarte, and Raymond Owens, "Housing externalities," *Journal of Political Economy*, 2010, *118* (3), 485–535.

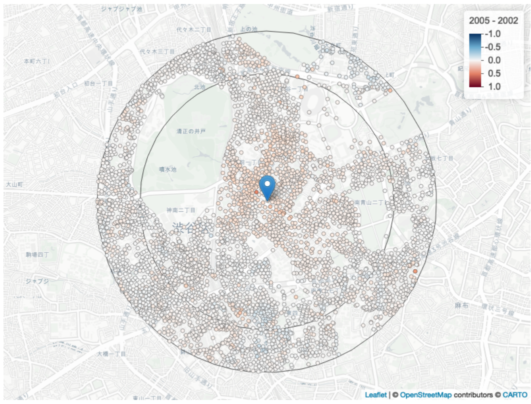
Saiz, Albert, "The geographic determinants of housing supply," *Quarterly Journal of Economics*, 2010, *125* (3), 1253–1296.

Stahl, Konrad, "Location and spatial pricing theory with nonconvex transportation cost schedules," *The Bell Journal of Economics*, 1982, *13* (2), 575–582.

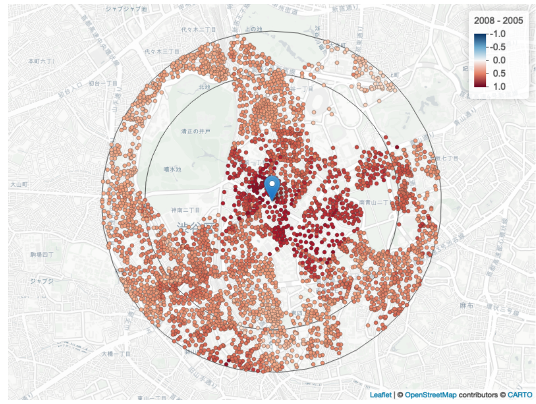
Teller, Christoph and Thomas Reutterer, "The evolving concept of retail attractiveness: what makes retail agglomerations attractive when customers shop at them?," *Journal of Retailing and Consumer Services*, 2008, *15* (3), 127–143.

Vigdor, Jacob L., "Is urban decay bad? Is urban revitalization bad too?," *Journal of Urban Economics*, 2010, *68* (3), 277–289.

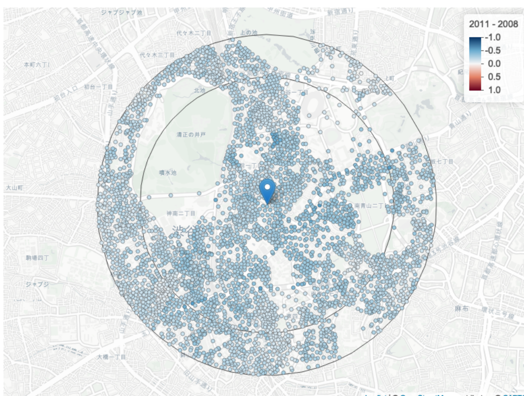
Figure 1: Changes in log of land price around Omotesando Hills



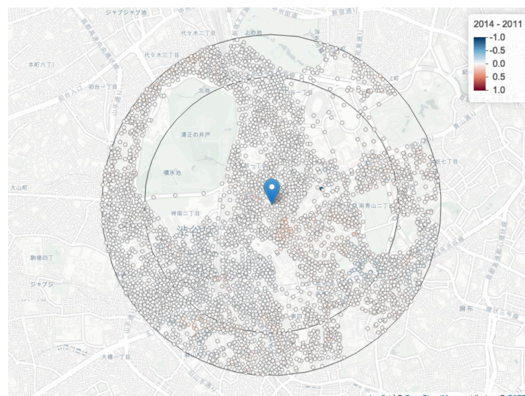
(a) Between 2002 and 2005



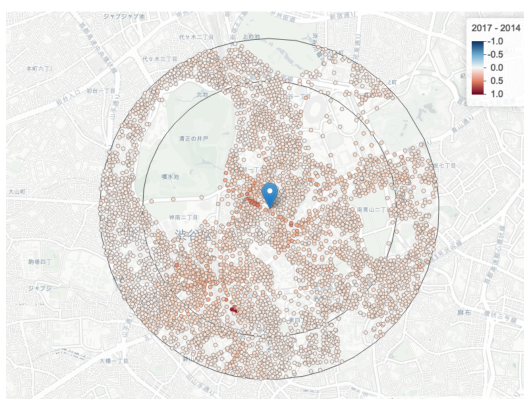
(b) Between 2005 and 2008



(c) Between 2008 and 2011



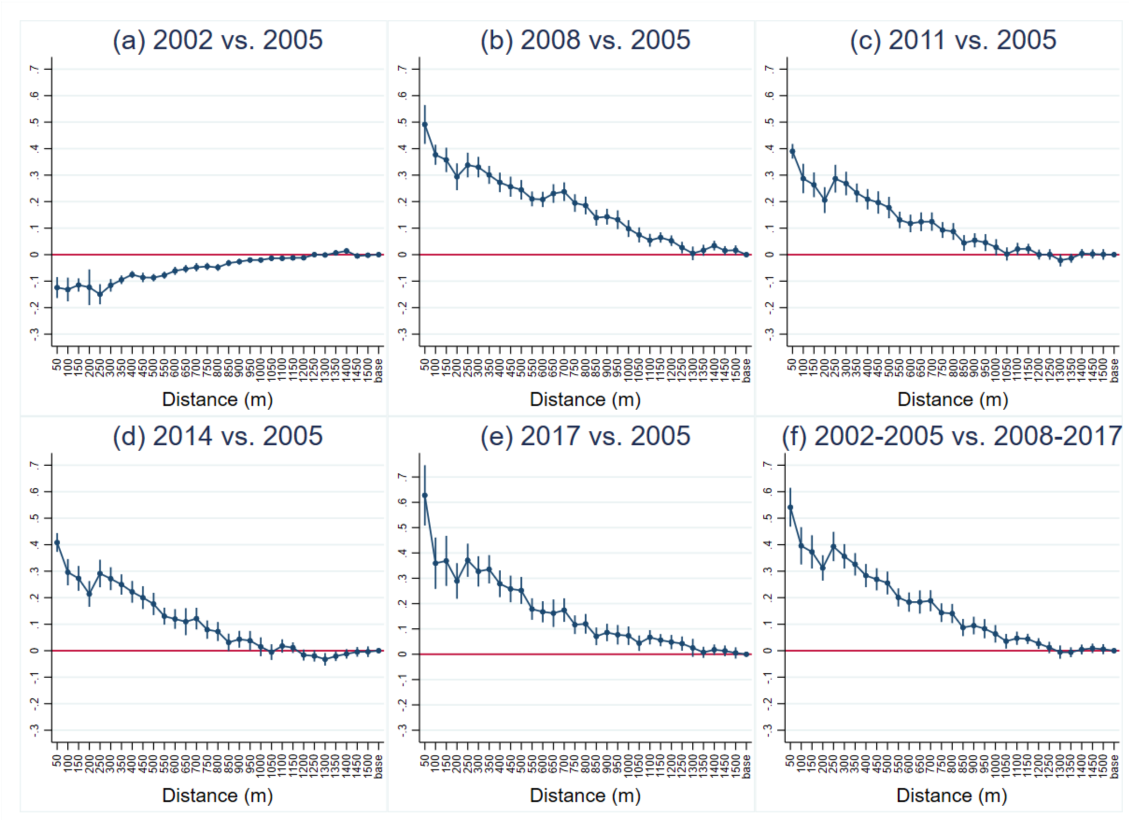
(d) Between 2011 and 2014



(e) Between 2014 and 2017

Notes: Each point represents road ID points, and the color of the points reflects the log difference of the average land price from the previous adjacent year for each point. A red (blue) color indicates positive (negative) growth, and a darker color indicates a larger absolute value. We winsorize the outliers of road IDs whose log difference in land prices is greater than one. The inner and outer circles represent the distance of 1.5 km and 2 km from Omotesando Hills, respectively. The area inside the inner circle is the treatment area, and the area between the inner and outer circles is the control area.

Figure 2: Changes in land prices by distance from Omotesando Hills, without controlling for pre-trend



Notes: Each point in Panels (a) - (e) shows the point estimates of β_{tA} for each 50m interval from

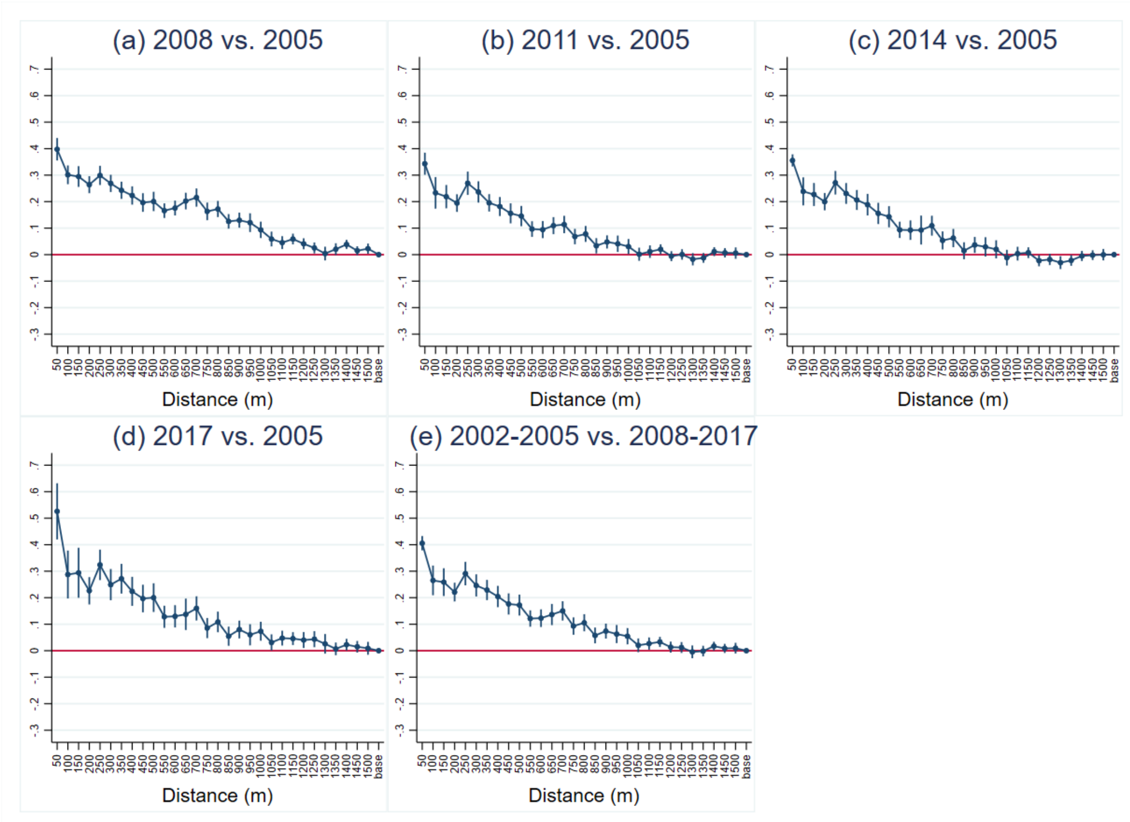
$$\ln p_{it} = \sum_{t \neq 2005} \sum_{A} \beta_{tA} \times g_A(d_i) + f_{r(i)} + f_t + \epsilon_{it},$$

where p_{it} is the land price of location i in year t and $g_A(d_i)$ is a set of dummy variables indicating the distance from Omotesando Hills, $f_r(i)$ is the road fixed effects, and f_t is the year fixed effects. A single Road ID includes several points i that vary over time. Panel (f) reports β_A from

$$\ln p_{it} = \sum_{A} \beta_A \times g_A(d_i) \times 1(t \geq 2006) + f_{r(i)} + f_t + \epsilon_{it}.$$

The error bars represent the 95% confidence intervals based on the standard errors robust against road ID-level clustering. The horizontal axis value represents the distance to the Omotesando Hills in 50m intervals. The base on the horizontal axis represents the control area, whose distance from Omotesando Hills is between 1.5 km and 2.0 km.

Figure 3: Changes in land prices by distance from Omotesando Hills (with control of pre-trend)



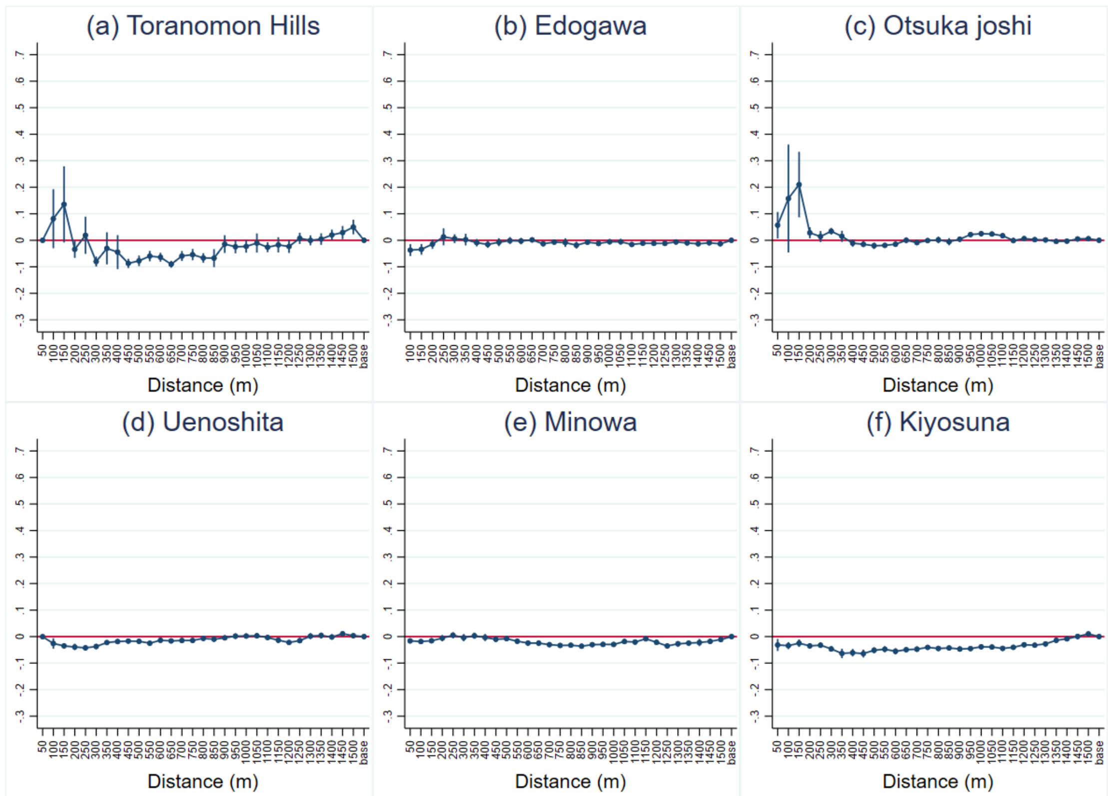
Notes: Each point in Panels (a) - (d) shows the point estimates of β_{tA} and β_A for each 50m interval from

$$\ln p_{it} = \sum_{t \neq 2002,2005} \sum_{A} \beta_{tA} \times g_A(d_i) + f_r + f_t + \delta_t \ln(p_{r2005}/p_{r2002}) + \epsilon_{it}$$

. The variable p_{it} is the land price of location i in year t, $g_A(d_i)$ is a set of dummy variables indicating the distance from Omotesando Hills, $f_r(i)$ is the road fixed effects, and f_t is the year fixed effects. A single road ID includes several points i that vary over time. The error bars represent the 95% confidence intervals based on the standard errors robust against road ID-level clustering. The horizontal axis value represents the distance from Omotesando Hills in 50m intervals, and base on the horizontal axis represents the control area within a radius of 1.5 km and 2.0 km from Omotesando Hills. Panel (e) reports the estimated coefficients of the model

$$\ln p_{it} = \sum_{A} \beta_A \times g_A(d_i) \times 1(t \geq 2006) + f_r + f_t + \delta_t \ln(p_{r2005}/p_{r2002}) + \epsilon_{it}.$$

Figure 4: Changes in land price by residential and office building redevelopment programs

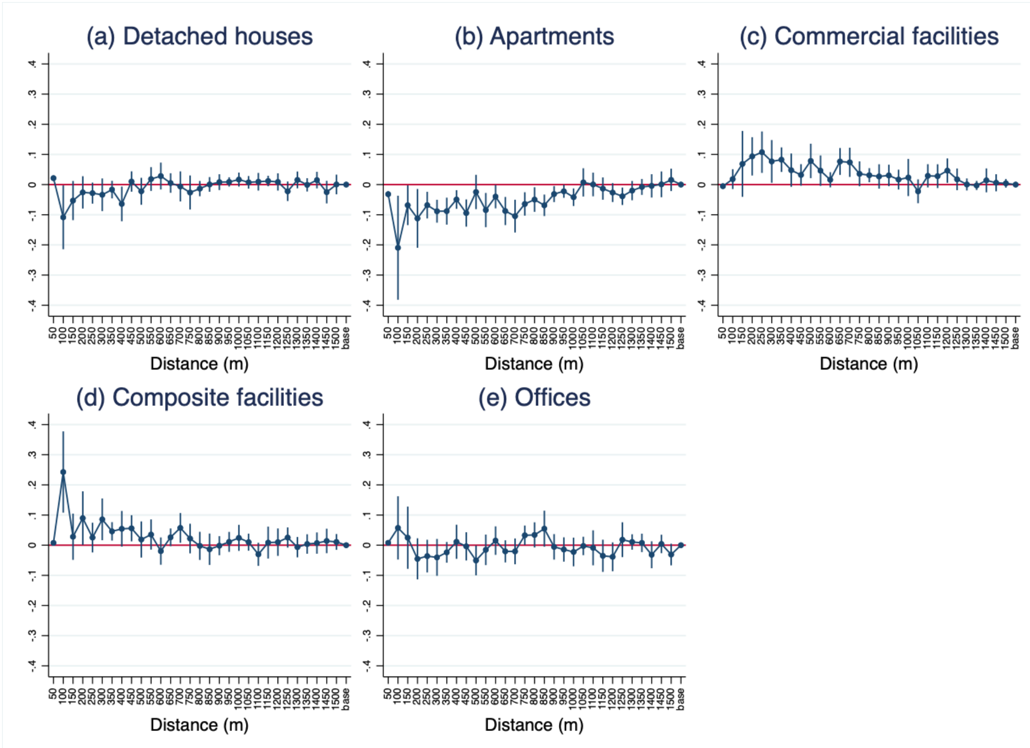


Notes: Each point in Panels (a) - (f) shows the point estimates of β_A for each 50m interval from

$$\ln p_{it} = \sum_A \beta_A \times g_A(d_i) \times 1(t \geq 2006) + f_r + f_t + \delta_t \ln(p_{r2005}/p_{r2002}) + \epsilon_{it}.$$

The variable p_{it} is the land price of location i in year t, $g_A(d_i)$ is a set of dummy variables indicating the distance from Omotesando Hills, $f_r(i)$ is the road fixed effects, and f_t is the year fixed effects. A single road ID includes several points i that vary over time. The error bars represent the 95% confidence intervals based on the standard errors robust against road ID-level clustering. Each panel examines the effects of residential and office building redevelopment programs in Tokyo: (a) opening of Toranomon Hills in 2014, (b) completion of the Edogawa apartment building in 2005, (c) completion of the Otsuka-Joshi apartment building in 2013, (d) completion of the Uenoshita apartment building in 2015, (5) completion of the Minowa apartment building in 2011, and (e) completion of the Kiyosuna apartment building in 2005. The treatment group is the area within a radius of 1.5 km, and the control group is within a 1.5 km and 2.0 km radius from each event. The horizontal axis value represents the distance from Omotesando Hills in 50m intervals. The base on the horizontal axis represents the control area, which is within a radius of 1.5 km and 2.0 km from the program.

Figure 5: Changes in building use by distance from Omotesando Hills

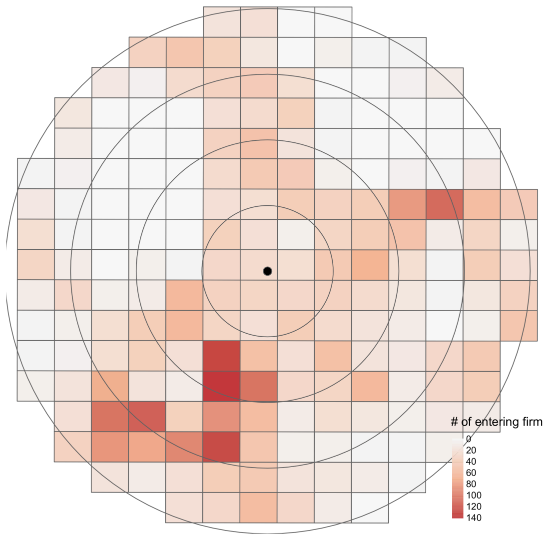


Notes: The outcome variables for each panel are as follows: (a) the share of detached houses, (b) the share of apartments, (c) the share of commercial use, (d) the share of composite facilities for residential and commercial use, and (e) the share of office facilities. Each point in Panels (a) - (e) shows the point estimates of β^j_{tA} for each 50m interval from

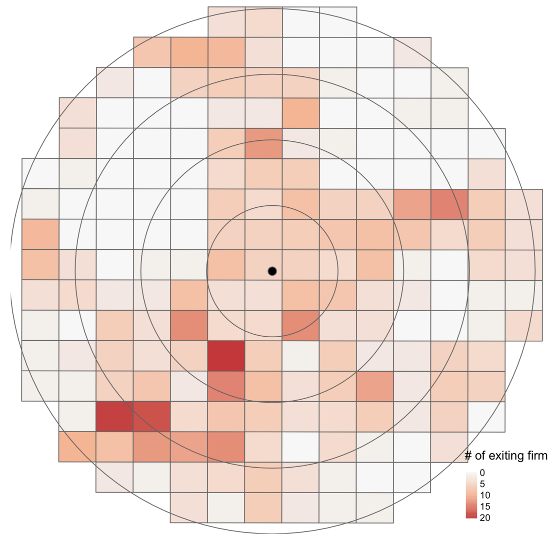
$$share^j_{it} = \sum_A \beta^j_{tA} \times g_A(d_i) \times 1(t \geq 2006) + f_r + f_t + \epsilon_{it^j},$$

where $share^j_{it}$ is the share of building use for j in the square mesh i in year t. The error bars represent the 95% confidence intervals based on the standard errors robust against road ID-level clustering. The horizontal axis value represents the radius to the outside of each 50m buffer. The base on the horizontal axis represents the control area, which is within a radius of 1.5 km and 2.0 km from Omotesando Hills.

Figure 6: Heatmaps of the number of entering/exiting firms in all industries



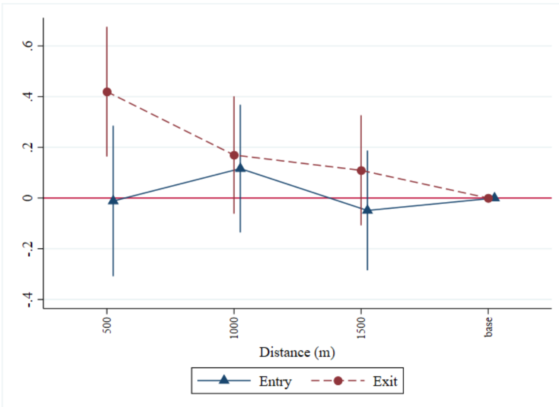
(a) Entering firms



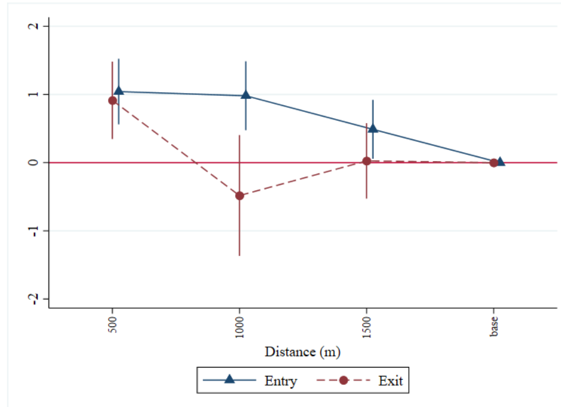
(b) Exiting firms

Notes: The sample includes only single-establishment firms. Panels (a) and (b) show the number of entering/exiting firms in all industries. A darker red color indicates a larger number of firms. The 1st, 2nd, 3rd, and 4th inner circles represent the distances of 0.5 km, 1 km, 1.5 km, and 2 km from Omotesando Hills, respectively. The area within the 3rd inner circle is the treatment area, and the area between the 3rd and 4th inner circles is the control area. Note that the values represented by the colors differ for the left and right panels. The control means of the number of entering and exiting firms in all industries are 19.39 and 2.74, respectively.

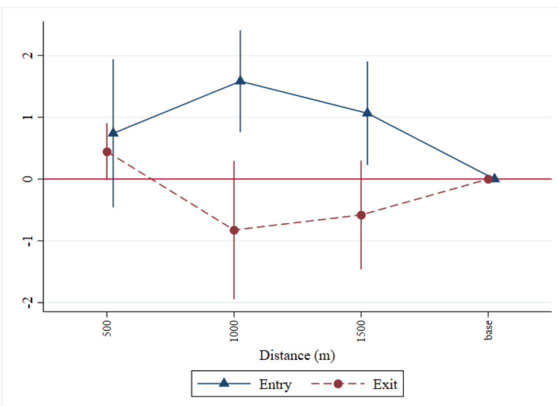
Figure 7: Effects on the number of entering/exiting firms in related industries by distance from Omotesando Hills



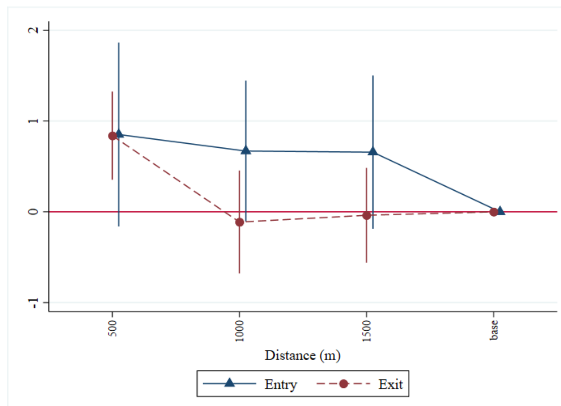
(a) All industries



(b) Retail and wholesale of textiles and apparel



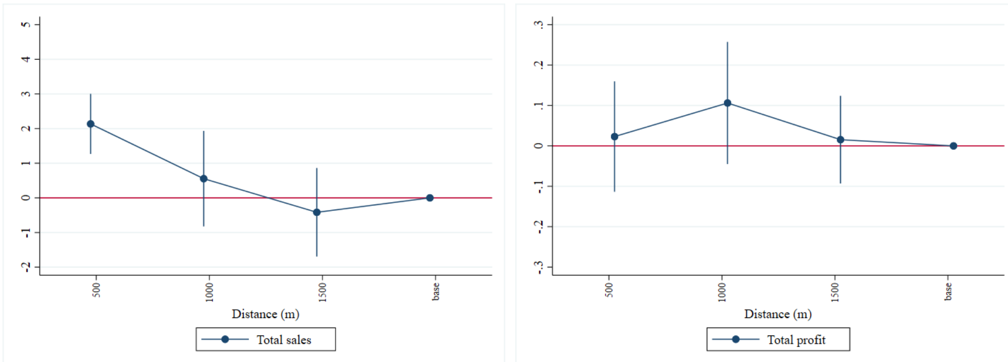
(c) Food and beverage retailing



(d) Restaurants

Notes: Outcome variables are the number of entering/exiting single-establishment firms in all industries and each industry for each mesh. Each point shows the point estimates of β_{lA} for each 500m interval from negative binomial regression $E(n_{lm}) = \exp(\alpha_l + \sum_A \beta_{lA} \times g_A(d_m) + \gamma_l \times N_{0m})$, where n_{lm} is the number of firms in category l (entering or exiting) in $250m^2$ mesh m and N_{0m} is the number of firms in the initial period. The error bars represent the 95% confidence intervals based on the standard errors robust against $250m^2$ mesh-level clustering. The value of the horizontal axis represents the radius to the outside of each 500m buffer, and the base on the horizontal axis represents the control area, which is within a radius of 1.5 km and 2.0 km from Omotesando Hills.

Figure 8: Effects on area aggregate sales and profits of firms in all industries by distance from Omotesando Hills

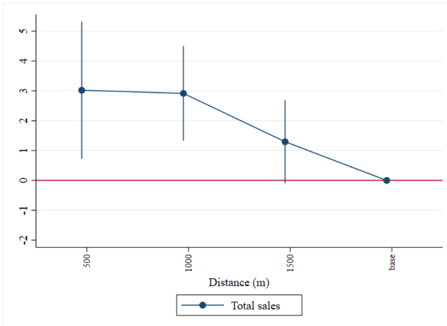


(a) Total sales

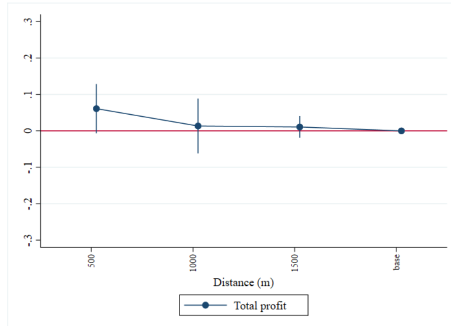
(b) Total profit

Notes: Each point shows the point estimates of β_A for each 500m interval from $\ln v_{mt} = \sum_A \beta_A \times g_A(d_m) \times 1(t \geq 2006) + f_m + f_t + \epsilon_{mt}$, where v_{mt} is either total sales or profit of $250m^2$ mesh m in year t. The error bars represent the 95% confidence intervals based on standard errors robust against 250m mesh-level clustering. The value of the horizontal axis represents the distance from Omotesando Hills in 500m intervals, and the base on the horizontal axis represents the control area within a radius of 1.5 km and 2.0 km from Omotesando Hills. Panels (a) and (b) show the effect on the log of total sales and total profit of single-establishment firms in all industries for each mesh, respectively. Note that the y-axis range is different for the left and right panels.

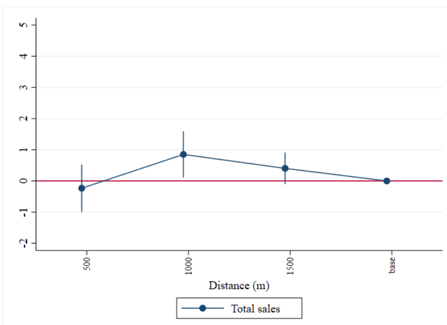
Figure 9: Effects on area aggregate sales and profits of firms in other industries by distance from Omotesando Hills



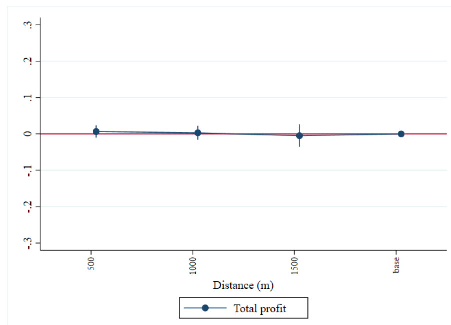
(a) Retail and wholesale of textiles and apparel - Total sales



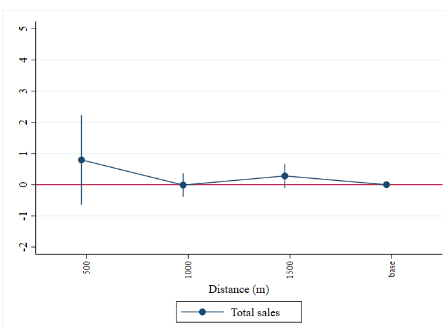
(b) Retail and wholesale of textiles and apparel - Total profit



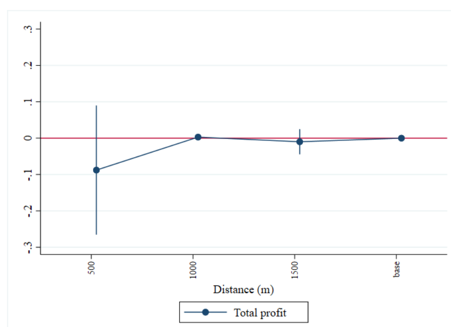
(c) Food and beverage retailing - Total sales



(d) Food and beverage retailing - Total profit



(e) Restaurants - Total sales



(f) Restaurants - Total profit

Notes: Each point shows the point estimates of β_A for each 500m interval from $\ln v_{mt} = \sum_A \beta_A \times g_A(d_m) \times 1(t \geq 2006) + f_m + f_t + \epsilon_{mt}$, where v_{mt} is either total sales or profit of $250m^2$ mesh m in year t. The error bars represent the 95% confidence intervals based on the standard errors robust against 250m mesh-level clustering. The value of the horizontal axis represents the radius to the outside of each 500m buffer, and the base on the horizontal axis represents the control area, which is within a radius of 1.5 km and 2.0 km from Omotesando Hills. Panels (a), (c), and (e) show the effect on the log of total sales of firms in each industry, while Panels (b), (d), and (f) display the effect on the log of normalized total profit. The profit is normalized such that the minimum profit of each analysis sample is zero. Note that the y-axis range is different for the left and right panels.

Table 1: Summary statistics of land price data

	(1) Treatment group	(2) Control group	(3) Mean difference
Land price (JPY/m^2)	1,372,592	752,699	619,894***
	[1,607,436]	[474,392]	(13,917)
Land price in 2005 (JPY/m^2) / Land price in 2002 (JPY/m^2)	1.053	1.020	0.033***
	[0.068]	[0.047]	(0.001)
Distance to the nearest station (m)	414	362	52***
	[213]	[187]	(2)

Notes: Summary statistics of the outcome variables and location-variant control variables used in Section 3 are reported. The unit of observation is a point for cross-sectional land prices and the distance to the nearest station. For the ratio of land prices between 2005 and 2002, the unit of observation is road ID. Means and standard deviations are calculated by the treatment group and control group. The treatment group is 0-1.5 km from Omotesando Hills, and the control group is 1.5-2.0 km from Omotesando Hills. The right column shows the result of the mean difference test with * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Values in brackets indicate standard deviations and values in parentheses indicate standard errors.

Table 2: Effects on land prices in each year relative to 2005

	(1)	(2)	(3)	(4)
$1(d_{i,km} \leq 1.5km) \times 1(t = 2008)$	0.313***	0.320***	0.337***	0.313***
	(0.010)	(0.009)	(0.010)	(0.010)
$1(d_{i,km} \leq 1.5km) \times 1(t = 2011)$	0.221***	0.230***	0.237***	0.226***
	(0.010)	(0.009)	(0.009)	(0.010)
$1(d_{i,km} \leq 1.5km) \times 1(t = 2014)$	0.221***	0.226***	0.227***	0.227***
	(0.011)	(0.010)	(0.010)	(0.011)
$1(d_{i,km} \leq 1.5km) \times 1(t = 2017)$	0.274***	0.286***	0.284***	0.280***
	(0.013)	(0.012)	(0.013)	(0.013)
$d_{i,km} \times 1(d_{i,km} \leq 1.5km) \times 1(t = 2008)$	-0.218***	-0.202***	-0.199***	-0.218***
	(0.008)	(0.008)	(0.008)	(0.008)
$d_{i,km} \times 1(d_{i,km} \leq 1.5km) \times 1(t = 2011)$	-0.175***	-0.168***	-0.164***	-0.176***
	(0.008)	(0.008)	(0.008)	(0.008)
$d_{i,km} \times 1(d_{i,km} \leq 1.5km) \times 1(t = 2014)$	-0.185***	-0.177***	-0.170***	-0.187***
	(0.009)	(0.008)	(0.009)	(0.009)
$d_{i,km} \times 1(d_{i,km} \leq 1.5km) \times 1(t = 2017)$	-0.199***	-0.198***	-0.190***	-0.200***
	(0.012)	(0.011)	(0.011)	(0.011)
Control pre-trend	Y	Y	Y	Y
Road ID F.E.	Y	Y	Y	Y
Year F.E.	Y	Y	Y	Y
Control group	1.5 - 2km	1.5 - 2.5km	2 - 2.5km	1.5 - 2km
Distance to the nearest station				Y
N	23538	38932	28150	23538
R^2	0.991	0.990	0.990	0.991
p-value for joint hypothesis test (1)	0.000	0.000	0.000	0.000
p-value for joint hypothesis test (2)	0.000	0.000	0.000	0.000

Notes: This table shows the point estimates of γ_{t0} and γ_{t1} from Equation (4). Standard errors are robust against road ID-level clustering. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. As an additional control variable, column (4) includes the distance from each road ID to the nearest station to control the effect of opening a new train station. The rows “Joint hypothesis tests (1)” and “Joint hypothesis tests (2)” show the p-values of the joint hypothesis test that the null hypothesis is γ_{t0} and γ_{t1} is equal for all years, respectively.

Table 3: Effects on land prices in the pre-period relative to the post-period

	(1)	(2)	(3)	(4)
$1(d_{i,km} \leq 1.5km) \times 1(t \geq 2006)$	0.257***	0.266***	0.271***	0.263***
	(0.011)	(0.009)	(0.010)	(0.010)
$d_{i,km} \times 1(d_{i,km} \leq 1.5km) \times 1(t \geq 2006)$	-0.194***	-0.186***	-0.181***	-0.195***
	(0.009)	(0.008)	(0.008)	(0.009)
Control pre-trend	Y	Y	Y	Y
Road ID F.E.	Y	Y	Y	Y
Year F.E.	Y	Y	Y	Y
Control group	1.5 - 2km	1.5 - 2.5km	2 - 2.5km	1.5 - 2km
Distance to the nearest station				Y
N	23538	38932	28150	23538
R^2	0.990	0.989	0.990	0.991
Average treatment effect	0.086	0.089	0.090	0.088

Notes: This table shows the point estimates of γ_0 and γ_1 from Equation (5). Standard errors are robust against road ID-level clustering. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. As an additional control variable, column (4) includes the distance from each road ID to the nearest station to control the effect of opening a new train station. Average treatment effect (i.e., the average treatment effect within the treated area) is calculated as $\frac{\int_0^{|\hat{\gamma}_0/\hat{\gamma}_1|}(\hat{\gamma}_0+\hat{\gamma}_1 x)\times 2\pi x dx}{|\hat{\gamma}_0/\hat{\gamma}_1|^2\pi}$ where $\hat{\gamma_0}$ and $\hat{\gamma_1}$ represent the point estimates of γ_0 and γ_1 from Equation (5).

Table 4: Effects on land prices in the pre-period relative to the post-period for residential and office building redevelopment programs other than Omotesando Hills

	(1) Toranomon	(2) Edogawa	(3) Otsuka	(4) Uenoshita	(5) Minowa	(6) Kiyosuna
$1(d_{i,km} \leq 1.5km)$	-0.083***	-0.005	0.003	-0.032***	-0.018***	-0.076***
$\times 1(t \geq Treatment\ year)$	(0.010)	(0.003)	(0.004)	(0.002)	(0.003)	(0.003)
$d_{i,km} \times 1(t \geq Treatment\ year)$	0.065***	-0.005	0.001	0.024***	-0.005**	0.044***
$\times 1(d_{i,km} \leq 1.5km)$	(0.009)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
Control pre-trend	Y	Y	Y	Y	Y	Y
Road ID F.E.	Y	Y	Y	Y	Y	Y
Year F.E.	Y	Y	Y	Y	Y	Y
Control group	1.5 - 2km	1.5 - 2km	1.5 - 2km	1.5 - 2km	1.5 - 2km	1.5 - 2km
N	20,438	31,152	37,876	46,587	41,330	25,193
R^2	0.989	0.988	0.984	0.991	0.985	0.985

Notes: This table shows the point estimates of γ_0 and γ_1 from Equation (5). Standard errors are robust against road ID-level clustering. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Each column examines the effects of each residential and office building redevelopment program in Tokyo: (1) the opening of Toranomon Hills in 2014, (2) completion of the Edogawa apartment building in 2005, (3) completion of the Otsuka-Joshi apartment building in 2013, (4) completion of the Uenoshita apartment building in 2015, (5) completion of the Minowa apartment building in 2011, and (6) completion of the Kiyosuna apartment building in 2005. The treatment group is the area within a 1.5 km radius, and the control group is within a 1.5 km and 2.0 km radius from each event.

Table 5: Distribution of building use around Omotesando Hills

	(1) Treatment group	(2) Control group	(3) Mean difference
Share of detached houses	0.183	0.282	-0.099***
	[0.249]	[0.313]	(0.005)
Share of apartments	0.196	0.302	-0.105***
	[0.268]	[0.313]	(0.005)
Share of commercial facilities	0.141	0.030	0.112***
	[0.277]	[0.118]	(0.004)
Share of composite facilities of residential and commercial use	0.196	0.186	0.010**
	[0.252]	[0.262]	(0.005)
Share of offices	0.283	0.200	0.083***
	[0.330]	[0.301]	(0.006)

Notes: Summary statistics of the outcome variables and location-variant control variables used in Section 4 are reported. The observation unit is a point. Means and standard deviations are calculated by the treatment group and control group. The treatment group is 0-1.5 km from Omotesando Hills, and the control group is 1.5-2.0 km from Omotesando Hills. The right column shows the result of the mean difference test with * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Values in brackets indicate standard deviations and values in parentheses indicate standard errors.

Table 6: Effects on building use in the pre-period relative to the post-period

	(1) Detached	(2) Apartment	(3) Commercial	(4) Coposite	(5) Offices
$1(d_{i,km} \leq 1.5km)$	-0.023**	-0.109***	0.084***	0.054***	-0.007
$\times 1(t \geq 2006)$	(0.010)	(0.011)	(0.011)	(0.012)	(0.011)
$d_{i,km} \times 1(d_i \leq 1.5km)$	0.021**	0.077***	-0.058***	-0.040***	-0.000
$\times 1(t \geq 2006)$	(0.009)	(0.010)	(0.010)	(0.011)	(0.011)
Road ID F.E.	Y	Y	Y	Y	Y
Year F.E.	Y	Y	Y	Y	Y
Control group	1.5 - 2km	1.5 - 2km	1.5 - 2km	1.5 - 2km	1.5 - 2km
N	12,108	12,108	12,108	12,108	12,108
R^2	0.921	0.884	0.902	0.879	0.916
Average treatment effect	-0.008	-0.036	0.028	0.018	

Notes: This table shows the point estimates of γ_0^j and γ_1^j from Equation (7). Standard errors are robust against road ID-level clustering. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The outcome variables for each column are as follows: (1) the share of detached houses, (2) the share of apartments, (3) the share of commercial use, (4) the share of composite facilities for residential and commercial, and (5) the share of offices. Average treatment effect (i.e., the average treatment effect within the treated area) is calculated as $\frac{\int_0^{|\hat{\gamma}_0^j/\hat{\gamma}_1^j|}(\hat{\gamma}_0^j+\hat{\gamma}_1^j x)\times 2\pi x dx}{|\hat{\gamma}_0^j/\hat{\gamma}_1^j|^2\pi}$ where $\hat{\gamma}_0^j$ and $\hat{\gamma}_1^j$ represent the point estimates of γ_0^j and γ_1^j from Equation (7). This average effect is calculated only when both γ_0^j and γ_1^j are significant.

Table 7: Summary statistics of firm performance

	(1) Treatment group	(2) Control group	(3) Mean difference
Total sales (1 million JPY, single-establishment firm, apparel)	245	107	138***
	[816]	[107]	(21)
Total sales (1 million JPY, single-establishment firm, Food)	17	8	9**
	[182]	[8]	(4)
Total sales (1 million JPY, single-establishment firm, Restaurant)	32	7	26**
	[540]	[7]	(11)
Total sales (1 million JPY, single-establishment firm, All industries)	4896	3155	1741***
	[8390]	[3155]	(229)
Total sales (1 million JPY, multi-establishment firm, apparel)	5058	2116	2943***
	[16945]	[2116]	(437)
Total sales (1 million JPY, multi-establishment firm, Food)	1341	251	1090***
	[8785]	[251]	(191)
Total sales (1 million JPY, multi-establishment firm, Restaurant)	1713	508	1204***
	[9163]	[508]	(208)
Total sales (1 million JPY, multi-establishment firm, All industries)	76436	43881	32555***
	[142862]	[43881]	(4087)
Total profit (1 million JPY, single-establishment firm, Apparel)	66	64	2***
	[16]	[64]	(0)
Total profit (1 million JPY, single-establishment firm, Food)	31	31	0*
	[6]	[31]	(0)
Total profit (1 million JPY, single-establishment firm, Restaurant)	206	206	0
	[24]	[206]	(1)
Total profit (1 million JPY, single-establishment firm, All industries)	502	454	48***
	[355]	[454]	(10)
Total profit (1 million JPY, multi-establishment firm, Apparel)	1647	1627	20**
	[322]	[1627]	(9)
Total profit (1 million JPY, multi-establishment firm, Food)	434	425	9*
	[176]	[425]	(5)
Total profit (1 million JPY, multi-establishment firm, Restaurant)	1174	1169	5
	[232]	[1169]	(6)
Total profit (1 million JPY, multi-establishment firm, All industries)	5624	4909	716***
	[4032]	[4909]	(111)
Number of entering firms (single-establishment firm, Apparel)	3.376	1.494	1.882***
	[3.679]	[1.494]	(0.422)
Number of entering firms (single-establishment firm, Food)	0.431	0.120	0.311***
	[0.699]	[0.120]	(0.080)
Number of entering firms (single-establishment firm, Restaurant)	0.303	0.157	0.146*
	[0.553]	[0.157]	(0.075)
Number of entering firms (single-establishment firm, All industries)	31.202	19.386	11.816***
	[30.813]	[19.386]	(3.745)
Number of exiting firms (single-establishment firm, Apparel)	0.385	0.229	0.156*
	[0.706]	[0.229]	(0.087)
Number of exiting firms (single-establishment firm, Food)	0.147	0.084	0.062
	[0.404]	[0.084]	(0.049)
Number of exiting firms (single-establishment firm, Restaurant)	0.202	0.181	0.021
	[0.486]	[0.181]	(0.070)
Number of exiting firms (single-establishment firm, All industries)	4.422	2.747	1.675***
	[4.122]	[2.747]	(0.539)
Number of pre-existing firms (single-establishment firm, Apparel)	0.752	0.410	0.343**
	[1.132]	[0.410]	(0.136)
Number of pre-existing firms (single-establishment firm, Food)	0.156	0.096	0.060
	[0.412]	[0.096]	(0.051)
Number of pre-existing firms (single-establishment firm, Restaurant)	0.211	0.217	-0.006
	[0.511]	[0.217]	(0.073)
Number of pre-existing firms (single-establishment firm, All industries)	20.908	13.831	7.077***
	[18.033]	[13.831]	(2.429)

Notes: Summary statistics of the outcome variables used in Section 5 are reported. The observation unit is a point. Means and standard deviations are calculated by the treatment group and control group. The treatment group is 0-1.5 km from Omotesando Hills, and the control group is 1.5-2.0 km from Omotesando Hills. The right column shows the result of mean difference test with * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Values in brackets indicate standard deviations, and values in parentheses indicate standard errors. *Apparel* stands for the industry *Retail and wholesale of textiles and apparel*; "Food" stands for the industry "Food and beverage retail"; "Restaurant" stands for the industry "Restaurants".

Table 8: Effects on sales and profit by industrial sector

	Log of total sales		Log of total profit	
	(1) Single	(2) Multiple	(3) Single	(4) Multiple
A: All industries				
$1(d_{i,km} \leq 1.5km) \times 1(t \geq 2006)$	2.734***	-1.918***	0.095	-0.117
	(0.816)	(0.731)	(0.101)	(0.111)
$d_{i,km} \times 1(d_{i,km} \leq 1.5km) \times 1(t \geq 2006)$	-2.550***	0.299	-0.048	0.143
	(0.804)	(0.579)	(0.095)	(0.125)
Mesh F.E.	Y	Y	Y	Y
Year F.E.	Y	Y	Y	Y
N	4,032	4,032	4,032	4,032
R^2	0.838	0.835	0.373	0.435
Average treatment effect	0.911			
B: Retail and wholesale of textiles and apparel				
$1(d_{i,km} \leq 1.5km) \times 1(t \geq 2006)$	4.360***	8.415***	0.054	-0.050
	(1.203)	(1.397)	(0.047)	(0.049)
$d_{i,km} \times 1(d_{i,km} \leq 1.5km) \times 1(t \geq 2006)$	-2.327**	-4.867***	-0.037	0.039
	(1.116)	(1.271)	(0.035)	(0.041)
Mesh F.E.	Y	Y	Y	Y
Year F.E.	Y	Y	Y	Y
N	4,032	4,032	4,032	4,032
R^2	0.450	0.484	0.094	0.084
Average treatment effect	1.453	2.805		
C: Food and beverage retail				
$1(d_{i,km} \leq 1.5km) \times 1(t \geq 2006)$	0.741	0.883	0.030	0.073
	(0.531)	(1.457)	(0.026)	(0.196)
$d_{i,km} \times 1(d_{i,km} \leq 1.5km) \times 1(t \geq 2006)$	-0.249	-0.249	-0.031	-0.033
	(0.446)	(1.211)	(0.032)	(0.164)
Mesh F.E.	Y	Y	Y	Y
Year F.E.	Y	Y	Y	Y
N	4,032	4,032	4,032	4,032
R^2	0.216	0.358	0.053	0.080
D: Restaurant				
$1(d_{i,km} \leq 1.5km) \times 1(t \geq 2006)$	0.248	1.382	-0.062	0.046
	(0.548)	(1.346)	(0.062)	(0.044)
$d_{i,km} \times 1(d_{i,km} \leq 1.5km) \times 1(t \geq 2006)$	-0.015	-0.138	0.048	-0.052*
	(0.471)	(1.171)	(0.055)	(0.030)
Mesh F.E.	Y	Y	Y	Y
Year F.E.	Y	Y	Y	Y
N	4,032	4,032	4,032	4,032
R^2	0.169	0.376	0.060	0.104

Notes: This table shows the point estimates of γ_1 and γ_2 from Equation (10). Standard errors are robust against mesh 250m-level clustering. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. As a sample in the estimation, Columns (1) and (2) use single-establishment firms other than headquarters, and Columns (3) and (4) use multiple establishment firms in all industries. The outcome variables in Columns (1) and (3) are the log of total sales for each mesh, and the outcome variables in Columns (2) and (4) are the log of total profit for each mesh. Average treatment effect (i.e., the average treatment effect within the treated area) is calculated as $\frac{\int_0^{|\hat{\gamma}_0/\hat{\gamma}_1|}(\hat{\gamma}_0+\hat{\gamma}_1 x)\times 2\pi x dx}{|\hat{\gamma}_0/\hat{\gamma}_1|^2\pi}$ where $\hat{\gamma}_0$ and $\hat{\gamma}_1$ represent the point estimates of γ_0 and γ_1 from Equation (10). This value is calculated only when both γ_0 and γ_1 are significant.

Appendix: Conceptual model

We propose an open city model with unrestricted heterogeneity. Suppose an open-commercial area consists of many discretized zone (z) and competitive land markets. Denote the area's treatment status as d; $d = 1$ means the area is treated, and $d = 0$ otherwise. Each zone inelastically supplies commercial land for tenants at a unique land rent of $p(z, d)$.

A tenant, indexed by $x \in X$, earns profits $\pi(x, z, d)$ with treatment status d in zone z. The profit function is defined as

$$\pi(x, z, d) = Y(x, z, d) - p(z, d),$$

where $Y(x, z, d)$ is pre-rent profit in the zone z with treatment status d. The tenant's profit on the outside, $u(x)$, does not depend on treatment status.

Let $\Omega(z, d) \subset X$ be an equilibrium set of tenants in commercial zone z with treatment status d. In the following discussion, we characterize the equilibrium conditions given the equilibrium set.

Finally, $s(x, z, d) = Y(x, z, d) - u(z)$ is referred to as the pre-rent surplus. The surplus is a crucial value to characterize the equilibrium.

Equilibrium conditions

The competitive equilibrium condition determines the equilibrium land rent. The equilibrium is defined with the individual surplus $\pi(x, z, d) - u(x)$, which is the profit difference between location z and the outside.

The equilibrium condition is

$$\pi(x, z, d) - u(x) \geq 0, \text{for any} x \in \Omega(z, d),$$

and

$$\min_{x \in \Omega(z,d)} \{\pi(x, z, d) - u(x)\} = 0.$$

The first condition ensures a positive surplus in the equilibrium. The second condition is the zero-surplus condition for a tenant with the lowest surplus (the marginal tenant) in location z in the equilibrium. The latter condition characterizes the equilibrium rent $\hat{p}(z, d)$ as

$$\hat{p}(z,d) = s(x_{min}(d,z), z, d),$$

where x_{min} is a type of the lowest surplus as $x_{min}(d,z) = \arg\min_{x\in\Omega(d)}\{\pi(x,z,d) - u(x)\}$.

The equilibrium profit is then.

$$\hat{\pi}(x,z,d) = Y(x,z,d) - \hat{p}(z,d).$$

$$= Y(x,z,d) - s(x_{min}(d,z), z, d).$$

The equation implies that equilibrium profits depend on not only the tenant's own pre-rent profit but also the marginal tenant's individual surplus.

The equation also shows that the equilibrium profit must be positive if the profit in the outside option is positive, because

$$\hat{\pi}(x,z,d) = Y(x,z,d) - s(x_{min}(d,z), z, d)$$

$$> s(x,z,d) - s(x_{min}(d,z), z, d)$$

$$\geq 0.$$

The equilibrium condition ensures the second inequality, because $s(x,z,d)) \geq s(x_{min}, z, d)$ and $s(x_{min}, z, d) = 0$.

Theoretical implications of treatment effects

The equilibrium conditions allow us to theoretically describe the treatment effect of d by the pre-rent surplus. The following discussion supposes the binary change of treatment d from $d = 0$ to $d = 1$. First, the impact on equilibrium profit can be described.

$$\hat{\pi}(x,z,1) - \hat{\pi}(x,z,0)$$

$$= \underbrace{Y(x,z,1) - Y(x,z,0)}_{Direct\ effect\ on\ x}$$

$$- \underbrace{[\hat{p}(z,1) - \hat{p}(z,0)]}_{Rent\ effect}$$

The equation implies that if the rent effect dominates over the direct effect on a tenant x, there are zero or negative impacts on the equilibrium profit.

The impact on the equilibrium rent is

$$\hat{p}(z,1) - \hat{p}(z,0)$$

$$= s(x_{min}(1,z), z, 1) - s(x_{min}(0,z), z, 0).$$

The change in the marginal tenant's surplus determines the impact on the equilibrium rent. The rent effect can be decomposed into direct and selection effects;

$$\hat{p}(z,1) - \hat{p}(z,0)$$

$$= \underbrace{s(x_{min}(1,z), z, 1) - s(x_{min}(0,z), z, 1)}_{Selection\ effect}$$

$$+ \underbrace{s(x_{min}(0,z), z, 1) - s(x_{min}(0,z), z, 0)]}_{Direct\ effect\ on\ marginal\ tenant}$$

The selection effect captures the reallocation effects on land price. Treatment may encourage the reallocation of tenants between area z and outside. As a result, the type of marginal tenant also may change, as may the equilibrium land price.

The direct effect on marginal tenants captures the profit change without the selection effect. Even without reallocation, treatment may change the profits of marginal tenants and the land price.

Those equations show that the equilibrium profit effects are zero even though treatment effects are uniformly positive on all tenants. Formally, even though all direct effects are positive, $\hat{\pi}(x,z,1) - \hat{\pi}(x,z,0) = 0$ if

$$\text{Direct effect} = \text{Direct effect on marginal tenant} + \text{Selection effect} \quad (A1)$$

The zero-profit effect implies that the direct effect on a tenant x is canceled out by increasing the marginal tenant's individual surplus. There are two scenarios: the marginal tenant is not changed, but her/his profit is increased (direct effect scenario), and the more profitable tenant becomes the marginal tenant (selection scenario).

The structural relationship between the treatment and firm type has implications for the effects of equilibrium profits. An interesting case is a very small profit effect, consistent with our empirical results. The selection effect can be theoretically bounded, mainly. Equation (A1) with Profit effect $\simeq 0$ means

$$\text{Selection effect} \simeq \text{Direct effect} - \text{Direct effect on marginal tenant}$$

The selection effect is then positive if and only if the treatment and firm type are complements in which $Y(x,z,1)-Y(x,z,0) \geq Y(x',z,1)-Y(x',z,0)$ for any $x \subset X$. If they are substitutes, the selection effect is negative.

Another interesting case is the homogeneous treatment effect, which means $s(x,z,1) - s(x,z,0) = s(x',z,1) - s(x',z,0)$ for all $x \in X$. In this case, the empirical effect on tenants' profit equals the selection effect.