Geographic Analysis of Trade-Offs Between Amenity and Supply Effects in New Office Buildings

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Abstract

The supply of new office buildings in the neighborhood both positively and negatively affects rents. This study attempts to deepen the quantitative knowledge of this trade-off relationship and estimate the correlation between new supply and rent within a specific geographic area based on a hedonic model. Although the results exhibit biases, they indicate that supply effects become apparent after construction is completed, and that they vary geographically and are related to local market characteristics.

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1 Introduction

With urban areas' development, numerous new office buildings have been built in the city centers. However, the impact of the supply of these new office buildings on such regions is unknown. Generally, the impact of real estate supply on a region can be explained by the trade-off between supply and amenity effects [6]. The supply effect relates to the availability of new real estate that absorbs demand and eases the upward pressure on rents. Accordingly, the filtering process used as a supply mechanism for affordable housing can cause rent to fall and result in a cascading transfer to higher-quality properties [9]. The amenity effect is related to the supply of new real estate that attracts high-income households and new amenities, thus increasing rent in that area. Particularly, the redevelopment in low-income neighborhoods can lead to gentrification, driving existing residents outside the area [3].

The trade-off between amenity and supply effects have been studied in recent years for the housing market. [4] and [1] demonstrated that the overall supply effect is stronger in the U.S. housing market. Do these results hold true for the office segment?

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Numerous researchers, who have analyzed office market dynamics at the city or country levels, have reported that the supply effect is consistently strong in the long term. Simultaneously, in the short run, the new supply has been observed to increase and decrease rents [8]. However, this issue – at the micro-level – has been underdiscussed.

Using data from 2000 to 2022, we answer the following three questions regarding the new supply of office buildings for the Tokyo office market, which has a high concentration of office buildings worldwide:

RQ1: What is the geographical extent of the impact of new office buildings?
RQ2: How do trade-offs between supply and amenity effects vary over time?
RQ3: Do these trade-offs vary geographically?

2 Data

This study focused on the rental office market in Tokyo's 23 wards. Sanko Estate Co. Ltd. provided the data for the analysis. This included quarterly attribute data for all rental office buildings identified by Sanko Estate Co., Ltd. The data also include information on asking rent for the advertised properties. The sample size, including asking rent and excluding missing data, was 523,566.

Tokyo's 23 wards have the world's most concentrated business cities in terms of office space, with approximately 5 million tsubo (≒16 million m^2) of new rental office space available between 2000 and 2022, leaving approximately 13 million tsubo (≒43 million m^2) rentable floor space at the end of 2022.

The indicator for neighborhood new office building supply (NNS^r_{it}) is the ratio of the rentable floor space of new office buildings to the rentable floor space within a radius of r meters, centered on office building i at time t. Here, r is the threshold of interest representing the spatial range affected by the new supply. Considering that r is an unknown threshold, it is empirically determined using the following method:

3 Method

3.1 Variable selection

We adopted a hedonic approach to estimate the impact of the new supply. This approach was proposed by Rosen [10] and has been widely used to used to explore the determinants of real estate prices (rents) [11].

$$lnR_{it} = \beta_0 + \sum_{k=1}^{K} X_{itk}\beta_k + NNS^r_{it}\beta_{NNS} + \varepsilon_{it} \tag{1}$$

where lnR_it represents the logarithmic asking rent; X_{itk} is the kth explanatory variable; ε_{it} is the error term; and β_0,β_k,β_{NNS} are parameters. Here, β_{NNS} is the parameter of most interest, with $\beta_{NNS} > 0$ implying a strong amenity effect and $\beta_{NNS} < 0$ implying a strong supply effect. The spatial range threshold r in NNS^r_{it} was determined to be from 100 to 1500 meters, based on the Akaike information criterion (AIC) minimization. See Table 1 for the details and basic statistics on the explanatory variables X_{itk}.

To answer the RQ2 question, we extended the base model. Here, we added the lagged variables of NNS^r_{it} to the model from five years ago (20 quarters) to three years later (12 quarters).

$$lnR_{it} = \beta_0 + \sum_{k=1}^{K} X_{itk}\beta_k + \sum_{p=-12}^{20} NNS^r_{i,t-p}\beta_{NNS,p} + \varepsilon_{it} \tag{2}$$

Table 1 Variables and description.

Variable	Content	Unit	Mean	SD
Asking rent	Monthly asking rent including common area maintenance charge	yen/tsubo (log)	9.582	0.346
Area per floor	The maximum leasable area on a standard office floor (3rd floor or higher) for each building	tsubo (log)	3.833	0.904
Age	Number of years since construction	year	25.422	11.681
Stories	Number of stories above ground	floor (log)	2.020	0.347
Time to the nearest station	Time to walk to the building from the nearest station	min	3.583	2.306
Neighborhood rentable area	Rentable gross floor area in the neighborhood	tsubo (log)	11.434	1.231
Vacancy rate	Vacancy rate of neighborhood office buildings	%	0.061	0.041
Air-conditioning	=1 if a building have air-conditioning system	{0, 1}	0.976	
Seismic performance	=1 if a building have seismic performance	{0, 1}	0.018	
Structural dummy	A set of dummy variables for building structure			
Time dummy	A set of dummy variables representing the quarter of tenant recruitment			
Area dummy	A set of dummy variables for submarkets as defined by Sanko Estate [2].			

For larger office buildings, leasing activity begins before construction is completed. In such cases, supply effects may become apparent even before construction is completed Similarly, rent increases may be associated with expectations of future regional revitalization.

Additionally, these trade-offs may vary from region to region (RQ3). Moreover, other determinants may have a less linear relationship with rent and vary spatially or non-spatially. To consider these relationships, the linear hedonic model was extended to spatially and non-spatially varying coefficient (SNVC) models [7].

$$lnR_{it} = f_{MC,0}(\mathbf{s}_i) + \sum_{k=1}^{K+1} X_{itk}\beta_{ik} + \varepsilon_{it}, \qquad \beta_{i,k} = b_k + f_{MC,k}(\mathbf{s}_i) + g_k(X_{itk}) \tag{3}$$

where β_{ik} represents the regression coefficient and comprises the constant mean b_k, spatially varying component $f_{MC,k}(\mathbf{s}_i)$, and non-spatially varying component $g_k(X_{itk})$. The spatially varying component is a function estimated based on Moran eigenvectors, and varies with the location of property $i(\mathbf{s}_i)$. The non-spatially varying component is represented by a function that varies with the value of the variable captured by the spline function. In the SNVC model, the coefficients of each variable are selected from the constant, SVC (Spatially Varying Coefficient), NVC (Non-spatially Varying Coefficient), or SNVC, given the Bayesian information criterion (BIC) minimization. Additionally, the explanatory variable X_itk includes NNS^r_{it}. Therefore, the number of variables increases from K to $K+1$.

4 Result

4.1 Geographic range of impact of new supply

This section identifies the geographic range of the new supply's impact. Figure 1 depicts the change in the AIC of the model and the coefficient of the new supply when using each threshold value. The AIC is at a minimum when the radius threshold is 1400 m. Furthermore, the coefficient of the new supply is positive in all cases, and the larger the radius, the larger the absolute value of the coefficient. This suggests that the amenity effect is significant in a tradeoff relationship. However, this result is also attributable to the fact that the larger the geographic area, the smaller the percentage of new supply (NNS^r_{it}).

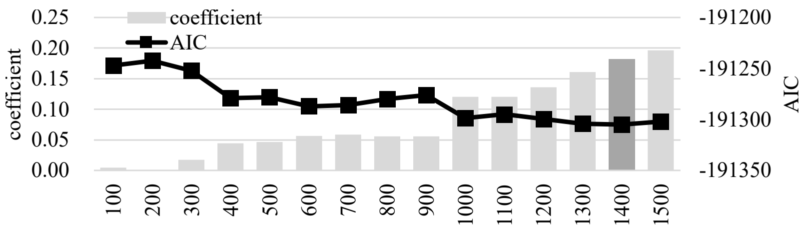

Figure 1 Identification of the geographic range of the impact of neighborhood new supply on rent. The horizontal axis represents the radius (spatial range).

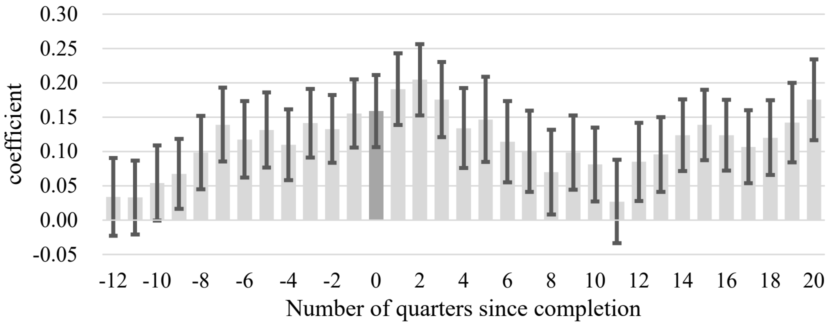

Figure 2 Impact of neighborhood new supply before and after completion of construction.

4.2 Change in trade-offs over time

The event study graph (Figure 2) based on Equation 2 depicts the impact of the new supply in pushing rentals up for approximately three years (nine quarters). Specifically, an increase in new office stock by 10% will increase rentals by 0.7% approximately two years before construction is completed and by 1.6% upon completion. After construction is completed, the effect of rising rents declines for one to three years only to increase again. The temporary decline in impact is thought to manifest a supply effect, as tenant relocations associated with the completion of construction generate secondary vacancies. Once secondary vacancies settle, the amenity effect occurs, raising rentals to sustainable levels even after five years.

However, this interpretation requires the consideration of any remaining biases. Property developers may know the optimal locations and times to reap development profits [1]. Moreover, the new building might be planned in fast-growing areas [4]. In this case, the estimates are biased in the positive direction. The phenomenon of rents increasing two years before construction is completed is not intuitive and indicates bias. However, various actions can be taken before the new supply. Property owners may lower the rent to fill vacancies before new buildings are completed. However, if the new supply involves redevelopment, then tenants need to be temporarily relocated before construction begins. In this case, demand for office space in the neighborhood during the construction period would be temporarily increased, which might result in rising rents. While there is insufficient evidence of a strong amenity effect here, clearly, the supply effect, which becomes apparent after the construction, is weakened over time.

4.3 Spatial heterogeneity of trade-offs

Finally, the SNVC model reveals that the impact of new supply varies spatially (Figure 3). Here, the coefficient of neighborhood new supply was estimated as SVC. This result is strongly related to the aforementioned bias. Areas with significantly positive coefficients can

Estimation results for OLS and SNVC model

	OLS	SNVC				
		Min	Median	Mean	Max	Type
(Intercept)	9.082	8.025	8.884	8.925	10.225	SVC
NNS	0.182	0.569	0.002	0.008	0.659	SVC
Age	-0.008	-0.019	-0.009	-0.009	0.003	SNVC
Area per floor	0.119	-0.173	0.050	0.047	0.218	SNVC
Stories	0.140	-0.501	0.091	0.085	0.402	SNVC
Time to the nearest station	-0.020	-0.080	-0.021	-0.021	0.032	SNVC
Neighborhood rentable area	0.047	0.035	0.045	0.044	0.048	NVC
Vacancy rate	-0.325	-2.233	-0.125	-0.130	1.525	SNVC
Air-conditioning	-0.071		-0.006			C
Seismic performance	0.037		-0.021			C
Adj-Rsq	0.662		0.759			

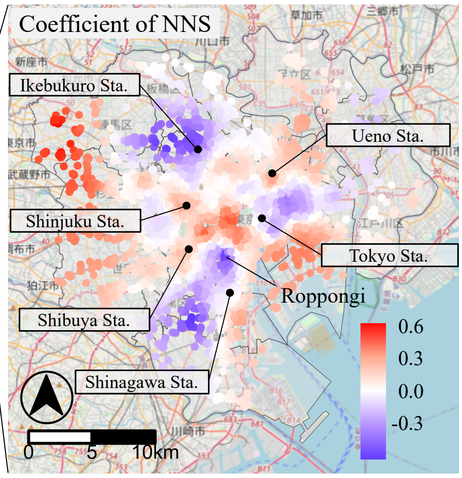

Figure 3 Estimation results and spatial distribution of NNS coefficients. Type indicates the type of coefficients, where C stands for Constant, SVC for spatially varying coefficients, NVC for non-spatially varying coefficients, and SNVC for spatially & non-spatially varying coefficients.

be interpreted as having strong amenity effect or biases. However, this does not necessarily imply that actively redeveloped areas have strong positive effects. In the case of the Roppongi and Tokyo Station areas, which underwent extensive redevelopment over the past two decades, the coefficients were either negative or zero.

This spatially heterogeneous trade-off may be related to the vacancy rate. Areas such as Shinjuku and Shibuya Sta. areas tend to have low vacancy rates in the long term, whereas Roppongi and Kanda (between Tokyo and Ueno Sta.) have high vacancy rates [5]. In localities with low vacancy rates, new buildings absorb latent demand and help boost rents, whereas in areas with high vacancy rates, secondary vacancies may become apparent and cause rents to fall.

The results of the SNVC model showed other interesting spatial heterogeneity in rent determinants, but due to volume constraints, we omit them here.

5 Conclusion

This study estimated the local impact of new office building supply. The results suggest that the model fits best when the impact of the new supply has a radius of 1400 meters. According to the results based on the linear model, the impact of the new supply was positive, but the presence of an upward bias should be considered in the discussion. However, event studies reveal that the supply effect became apparent post-construction, indicating a temporary decline in the impact of the new supply. Furthermore, the results of the SNVC model, which considers the spatial heterogeneity of the impact of the new supply, suggest that the trade-off between amenity and supply effects may be associated with high and low vacancy rates.

These results contribute to a wider discussion of the endogeneity of the new supply in terms of the location and trade-off relationship. They can be used to formulate informed policy decisions regarding office supply. If the supply effect is only temporary, the supply of quality office buildings to SMEs based on the filtering process may become complex and place financial strain on SMEs over time. However, appropriate location-based interventions are needed because of their locational variations.

Nevertheless, this study has several shortcomings as it is in its infancy. Specific strategies to remove bias and identify causation needs to be discussed. Furthermore, the new supply is interdependent on rent and vacancy rates.

References

1 Brian J Asquith, Evan Mast, and Davin Reed. Local effects of large new apartment buildings in low-income areas. *The Review of Economics and Statistics*, 105(2):359–375, 2023. doi:10.1162/rest_a_01055.

2 Sanko Estate. Office rentdata, 2023. URL: https://www.sanko-e.co.jp/pdf/rentdata/en/market2023.pdf.

3 Dan Immergluck. Large redevelopment initiatives, housing values and gentrification: The case of the atlanta beltline. *Urban Studies*, 46(8):1723–1745, 2009. doi:10.1177/0042098009105500.

4 Xiaodi Li. Do new housing units in your backyard raise your rents? *Journal of Economic Geography*, 22(6):1309–1352, 2022. doi:10.1093/jeg/lbab034.

5 Kazushi Matsuo, Morito Tsutsumi, and Toyokazu Imazeki. Spatial characteristics of the tokyo office market in terms of vacancy rates. *Theory and Applications of GIS*, 30(1):51–63, 2022 [in Japanese].

6 Raven Molloy. The effect of housing supply regulation on housing affordability: A review. *Regional Science and Urban Economics*, 80:103350, 2020. doi:10.1016/j.regsciurbeco.2018.03.007.

7 Daisuke Murakami and Daniel A Griffith. Balancing spatial and non-spatial variation in varying coefficient modeling: A remedy for spurious correlation. *Geographical Analysis*, 55(1):31–55, 2023. doi:10.1111/gean.12310.

8 Krzysztof Nowak, Michal Gluszak, and Stanislaw Belniak. Dynamics and asymmetric rent adjustments in the office market in warsaw. *International Journal of Strategic Property Management*, 24(6):428–440, 2020. doi:10.3846/ijspm.2020.13647.

9 Brendan O'Flaherty. An economic theory of homelessness and housing. *Journal of Housing Economics*, 4(1):13–49, 1995. doi:10.1006/jhec.1995.1002.

10 Sherwin Rosen. Hedonic prices and implicit markets: product differentiation in pure competition. *Journal of Political Economy*, 82(1):34–55, 1974. doi:10.1086/260169.

11 Stephen Sheppard. Hedonic analysis of housing markets. *Handbook of Regional and Urban Economics*, 3:1595–1635, 1999. doi:10.1016/S1574-0080(99)80010-8.