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Evidence from the Jakarta's Mass Rapid Transit (MRT)

By

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Abstract

Urban transportation infrastructure remains underdeveloped in many low- and middle-income countries and quantitative evidence on impact is limited. We examine the effect of the Jakarta Mass Rapid Transit (MRT), Indonesia's first urban railway project, on property values. Using a panel dataset of rents for commercial offices and residential apartments along the MRT line, we apply a difference-in-differences estimation to assess the impact of the MRT opening in a quasi-natural experimental setting. We find negative and significant impact of the MRT opening on commercial office rents in areas close to MRT stations, while no significant impact is observed on residential apartments. We argue that the negative impact on commercial offices may be driven by oversupply of rental office properties. Our results suggest that property values may not necessarily increase with urban transit development, posing a challenge for practitioners pursuing transit-oriented development (TOD) and land value capture (LVC) financing for infrastructure.

Keywords: Mass rapid transit (MRT), property values, rents, Indonesia, Jakarta.

1. Introduction

Urban transportation infrastructure provides an essential base of daily living for residents and commuters, addressing economic and social needs by alleviating traffic congestion and reducing environmental burdens. However, in many low- and middle-income countries, urban transportation systems remain underdeveloped and are heavily reliant on road infrastructure dominated by private transport use. These countries now face serious challenges as the number of vehicles grows rapidly while road infrastructure development lags behind. In developing Asia, for example, urban populations increase by about 44 million annually while generating 80% of the region's economic growth. Consequently, the number of urban vehicles doubles every six years, far exceeding the pace of road infrastructure development (ADB, n. d.).

In response to these conditions, there have been increasing calls for the introduction of efficient mass public transit systems in heavily congested urban areas. In developing Asia, it is estimated that over 30% of the total annual infrastructure investment of 1.7 trillion US dollars will need to be allocated to transportation infrastructure until 2030 if the region aims to sustain reasonable economic growth (ADB, n.d.). Given the limited resources available for transportation infrastructure and the large financial burden required for its development, rigorous evidence regarding its impact is essential for policymakers and academics. However, to our knowledge, few studies have examined the impact of urban transportation infrastructure in developing countries. Among the limited literature, quantitative evidence on transportation infrastructure has been concentrated on rural road construction and pavement, with less attention given to urban transport (Raitzer, Blöndal, and J. Sibal 2019).

This paper examines the impact of the Jakarta Mass Rapid Transit (Moda Raya Terpadu Jakarta, henceforth "Jakarta MRT"), an urban transit system introduced in spring 2019, as the first subway in Indonesia. The MRT is one of the largest urban public transport systems in megacities across developing Asia. When Jakarta MRT commenced operations, the city was considered to have the worst traffic density in the world (Cookson 2018; Tomtom 2019). Since most large cities in developing countries suffer from heavy traffic congestion in central areas, resulting in severe air pollution, the provision of a public mass transport system is considered a promising solution to a variety of urban issues.

In this paper, we provide new evidence on the impact of the Jakarta MRT opening, focusing on property values by examining commercial office and residential apartment rents. In doing so, we aim to contribute to the literature in three key ways. First, as stated above, the evidence on urban transportation infrastructure, especially urban railways, has been scarce in developing countries. This is partly due to the underdevelopment of public transportation systems and the small number of projects suitable for impact evaluation. Thus, the evaluation of the Jakarta MRT project will be useful for other developing countries. Second, we utilize a panel dataset on rents of commercial offices and residential apartments covering the period before and after the start of the MRT operations. While there have been some partial attempts to examine the impact of the Jakarta MRT, we measure the impact in a quasi-experimental setting, controlling for the pre-trends. This approach is required for a difference-in-differences (DID) estimation, enhancing the precision of the estimates of causal effect. Third, and most importantly, we focus on the impact on property values, thereby capturing the overall economic benefits. More specifically, we use property rents to allow us to gauge the overall impact, which is indispensable to policymaking. By doing so, we argue that our findings relate to the heavily debated transit-oriented development (TOD) and land value capture (LVC) financing of infrastructure (ADB 2021).[1]

This paper proceeds as follows. The next section provides a literature review. Section 3 describes the Jakarta MRT project and the dataset used in this study. Section 4 explains the empirical strategy. Section 5 presents and discusses the estimation results. The final section provides some concluding remarks and discusses the limitations of the research.

2. Literature review

The body of literature examining the impact of railway transportation in developing countries is relatively small compared to the extensive research on road transportation, particularly in rural areas. Among the limited studies on railways, about half examine the effect of non-urban public transportation, while papers dealing with urban railways or metro systems comprise less than 10 percent of all papers that examine transport interventions (Raitzer, Blöndal, and Sibal 2019), despite the huge fiscal expenditure involved.[2]

Most previous studies demonstrated the positive effect of railways on GDP or income.[3] Donaldson (2018)

[1] We acknowledge that household/individual-level data is also useful for examining the MRT's impact, which is possibly heterogeneous, but it is often difficult to obtain datasets covering pre- and post-periods of new transportation infrastructure and the treated and untreated groups.
[2] Malhotra et al. (2021) argue that the existing evidence on railway investment, including inter-regional and high-speed railways, concentrates on East Asian cases, especially China.
[3] In addition, some studies have examined the environmental impact of transportation infrastructure, finding that urban transit improved air quality in Taipei (Chen and Whalley 2012), the Delhi Metro (Goel and Gupta 2017), and the Beijing Metro (Guo and Chen 2019). It also reduced automobile energy consumption in China (Lin and Du 2017).

showed that the extensive railroad network in colonial India increased trade and real incomes. Wang and Wu (2015) reported that the Qingzang Railway in China substantially improved local GDP along the line, with the positive effect particularly pronounced in the manufacturing industry. Yoshino and Abidhadjaev (2017) showed that the new railway network in Uzbekistan (Tashguzar–Baysun–Kumkurgan Railway) increased regional GDP growth rates in the affected regions, driven by the industrial and services sectors. Zou, Chen, and Xiong (2021) found that market access through the high-speed railway network across prefectures increased real income, with a prominent impact on the service sector. In contrast, Qin (2017) reported that high-speed rail upgrades in China had a negative impact on GDP in affected counties due to the concurrent drop in fixed asset investment.

In contrast, there is some literature on the impact of railways on land and property values (Debrezion, Pels, and Rietveld 2007; Mohammad et al. 2013). Mohammad et al. (2013) conducted a meta-analysis of empirical estimates from 23 studies to examine the impact of railways on changes in land and property values. They found several factors that affect land and property values, such as the types of land use, rail services and real estate (land or property), rail system life cycle maturity and geographical location, including the distance to stations and accessibility to roads. Moreover, the impact is larger on land value than property price, larger on commercial properties than residential properties, and larger on commuter rail (e.g., metro) than light rail systems. At the same time, they argued that the positive impact of railway projects on changes in prices and rents is similar.

We note two key points regarding the literature on property values. First, most studies examined the impact of the purchase price of residential property in developed countries. Only a few papers, largely limited to developed countries, have investigated the impact of office rents—an approach that is relevant to this study. Second, most studies utilized cross-sectional data, taking a hedonic approach to investigate the impact of railway projects. Due to data limitations, they did not explore the impact in a (quasi-) experimental setting, and as a result, the findings may suffer from serious estimation bias. Even recently, only a small number of studies have examined the impact of railway projects using a difference-in-differences approach— for further discussion, see Mohammad, Graham, and Melo (2015) regarding the Dubai Metro and Forouhar (2016) on the Tehran Metro.

Some studies have examined the impact of railways in Asian countries, finding an affirmative impact of urban railway projects in several cities across China (Li, Chen, and Zhao 2017; Pan and Zhang 2008; Xu, Zhang, and Aditjandra 2016; Wen et al. 2018), Malaysia (Dziauddin, Powe, and Alvanides 2015), India (Rastogi, Paul, and Malhotra 2020) and the Philippines (Pacheco-Raguz 2010). While most of these studies revealed the positive impact of railways on land or property values, the impacts are not analyzed in a causal way using robust estimation methods. The literature on the impact of the Jakarta MRT on land and property values is very limited. Saputra, Dewi, and Murdapa (2022) provided a non-statistical assessment of changes in land use and land value by the Jakarta Metro and argued that the commercial and trade-purposed land use has replaced residential use, and the land value increased in the areas close to the MRT stations. However, the study did not statistically identify the MRT impact on real estate values. Furthermore, they compared the areal statistics on land only in 2014 and 2021, and thus, the results may not fully take into account changes that occurred before the opening of the MRT in 2019. To our best knowledge, no research has formally investigated the causal impact of the Jakarta MRT on property values.[4]

3. The Jakarta MRT and data description

The Jakarta Mass Rapid Transit (MRT) is the first subway system to operate in Jakarta, the capital city of Indonesia at the time of its opening. The project was supported by the Japan International Cooperation Agency (JICA) through Japanese Official Development Assistance (ODA) loans for the construction of a 15.7-kilometer segment of the line (Phase 1) connecting the southwestern part to the city center.[5] Jakarta is one of the largest megacities in Southeast Asia, with a population of 10 million in the metropolitan area and an estimated 35 million in the broader urban region. Jakarta has witnessed rapid population growth in the metropolitan area along with an increase in the number of commuters traveling to the city center. However, transportation of passengers and cargo in Jakarta depends heavily on the road network, increasing traffic congestion and air pollution while undermining the investment environment. By 2010, road construction was not able to keep pace with the rapid 9.5% growth in vehicles between 2005 and 2010, while public transportation in Jakarta served only 56% of commuter trips (Rini 2010).

[4] One exception is Berawi et al. (2020a), who discussed and identified the variables affecting residential property prices around the Jakarta MRT station, focusing on the correlations between variables. Other attempts to assess the effect of Jakarta MRT include Purba (2020), who provided an overview of the short-term impact, while Sianturi, Nasrudin, and Yudhistira (2022) employed a regression discontinuity design to estimate the price (fare) elasticity of demand of MRT ridership. Widita et al. (2023) revealed a modest and largely localized short-term reduction in congestion following the Jakarta MRT opening. Puryanti and Yudhistira (2023) estimated that the opening of Jakarta MRT reduced air pollution by 27.4%. Moreover, Berawi et al. (2020b) investigated the impact of the LRT on commercial property prices in Jakarta.

[5] The ODA loan (engineering services loan) was signed in November 2006 for up to 1.869 billion yen. The main loans were signed for up to 48.15 billion yen in March 2009 and for up to 75.218 billion yen in December 2015, respectively.

Under these circumstances, the introduction of a mass public transportation system was seen as a promising solution. The Jakarta MRT project has been planned since the 1980s (Purba 2020). The local government of Jakarta included it in the "Transportation Plan 2007," aiming to promote a modal shift from automobiles to public transportation to meet higher demand for transportation. The project was expected to alleviate traffic congestion, reduce the environmental burden, and improve investment opportunities (JICA 2018).

The construction of Phase 1 of the project began in October 2013, and the MRT North-South line officially commenced operations in March 2019, running between Bundaran HI station in Central Jakarta and the Lebak Bulus Grab station in South Jakarta. Bundaran HI station is located in the central business district (CBD), where many commercial offices are concentrated. This area serves as the hub for head offices of both local and international companies in Indonesia, as well as the financial district, with many embassies and expatriate residents living in high-rise residential apartments.[6] South Jakarta is primarily a residential area with mid- to high-income households and is also a newly emerging CBD. The Phase 1 section consists of 13 stations—seven elevated and six underground—along 15.7 kilometers of track (see Figure 1).[7] The segment comprises the southern part of the North-South Line, operated by PT Mass Rapid Transit Jakarta and is expected to serve 212,000 passengers per day.[8] As of late 2023, daily ridership has increased to about 91,000 people, up from around 40,000 in 2022, partly due to the travel restrictions under the COVID-19 pandemic.[9] The fare for a trip on the MRT starts at Rp. 3,000 (approximately 20 US cents) and increases by Rp. 1,000 for every station passed.

We utilize annual data on the rents of commercial offices and residential apartments located along the Jakarta MRT. The dataset was collected and compiled by PT Leads Property Services Indonesia. Established in 2010, the company is one of the largest real estate companies in Indonesia, covering the largest number of

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[6] The CBD is a "golden" triangle area extending between Thamrin City, SCBD (Sudirman Central Business District) and Rasuna Said area.
[7] The MRT started as a free service on 24 March 2019 and began commercial operations on 1 April 2019 at half fare. The full fare was introduced 13 May 2019.
[8] The remaining section (Phase 2) of the line from Bundaran HI to Kampung Bandan in North Jakarta (7.8 kilometers) is also supported by JICA through ODA loans. The ODA loan was signed for up to 70.021 billion yen for the extension in October 2018.
[9] See ANTARA (2024), "Jakarta MRT Targets Passenger Traffic of 33.6 mln in 2024." https://en.antaranews.com/news/304152/jakarta-mrt-targets-passenger-traffic-of-336-mln-in-2024#:~:text=According%20to%20her%2C%20as%20against,increase%20in%20ridership%20every%20year" and MRT Jakarta (2022). "Tengah Tahun 2022, 7,2 Juta Orang Naik MRT Jakarta." https://jakartamrt.co.id/id/info-terkini/tengah-tahun-2022-72-juta-orang-naik-mrt-jakarta. See also Sianturi, Nasrudin, and Yudhistira (2022) for a discussion of lower utilization.

properties in the country and offering a comprehensive and integrated range of property advice, as well as marketing and management services. The data on office buildings available for rent was collected annually from 2017 to 2021 from sites located in areas within a 10-kilometer radius of each station along the North-South MRT line, completed in Phase 1. The number of property sites increased from 360 in 2017 to 380 in 2021. The data covered commercial offices in the five main concentration areas (corridors), including MH Thamrin, Jendral Sudirman, SCBD, Senayan and TB Simatupang.[10] The CBD—the main financial district—contributed 63.4% of the supply distribution of offices for rent in Jakarta in 2021.

The data covered all commercial buildings for rent with a grade of C or above (Premium, A, or B) within a 10-kilometer radius of each station. The data includes asking and estimated rents (offer prices and contracted rents) and service charges for a typical case, surveyed toward the end of each year. The service charges must be paid monthly in proportion to the leased space in addition to the agreed base rents. The composition of the service charges varies by property and covers cleaning and maintenance costs of the common areas, reception and security costs, and shared energy costs such as gas and electricity for common areas. Additionally, the service charges may include a portion of the operational costs for the specific leased unit. The dataset also includes a variety of property characteristics such as location (longitude and latitude), grade, year of completion, total and typical floor size of an office plot, number of office suites and total number of stories in the building.[11] These characteristics remain constant throughout our data period.

The residential apartment rent data was collected annually from 2017 to 2022 from the sites within 10 kilometers of the North-South MRT stations. The number of sites increased from 82 in 2017 to 92 in 2022. The residential dataset is confined to high-rise rental apartments of more than 10 stories with two bedrooms as standard, covering all properties along the MRT line. The rental apartments in the data are either serviced or non-serviced, designated for long-stay periods, and are mostly occupied by expatriates.[12] The dataset includes information on base rental (asking and estimated transactions) per sqm per month, location (longitude and latitude), type (serviced or non-serviced), grade, operator type and group, year of completion, number of rooms,

[10] Almost all buildings were located in Central Jakarta or South Jakarta. Some offices located in Tangerang, specifically the Bintaro area in South Tangerang City, were also included.
[11] The definition of office grade is shown in Table A1 in the appendix.
[12] There are many international serviced apartment operators that have entered the Indonesian market, especially Jakarta, for instance, Ascott, Frasers, Marriott, and Shangri-La.

room type and size, number of floors as well as facility charges (e.g., water supply, sewage, electricity, and gas).[13] These characteristics are constant over the years covered by the dataset.

While the datasets on rents of commercial offices and residential apartments are collected in the same way, we note that the location of those properties differs along the line. Figure 2 shows the distribution of commercial offices and residential apartments according to the nearest station. The commercial offices are concentrated in the northern area, which includes the CBD. In contrast, the residential apartments are more evenly distributed along the MRT line since they are also located in the south residential areas.

Table 1 presents the summary statistics of the outcome variables (rents for offices and residential properties) used in the analysis. Tables A-2 and A-3 in the appendix show the summary statistics of the characteristics of the office/residence properties, which are constant over the dataset years.

4. Empirical strategy

This study employs a difference-in-differences (DID) approach to measure the impact of the Jakarta MRT on commercial office and residential apartment rents. The DID methodology combines before/after and with/without comparisons, identifying the causal impact of the project by subtracting the common trend from the change in the treatment sites. The central assumption for the validity of the DID methodology is the "parallel trend," which holds that any changes without the intervention, caused by unobserved characteristics, are common between the treated and the untreated (control) groups. In other words, the untreated group serves as the counterfactual of the trend that the treated units would have followed had they not been treated. In this case, the pre-trend of property values moves in parallel between the treatment group (likely to be affected by the MRT opening) and the control group (likely to be unaffected by the MRT opening) before the opening of the Jakarta MRT. The post-trend may change after the operation of MRT commenced. We will employ the canonical DID specification as follows:

$$Y_{it} = \sum_{T=\underline{y}}^{\bar{y}} D_{it}^{T} \beta_{T-\bar{T}} + \lambda_t + \mu_i + \epsilon_{it} \qquad (1)$$

where i refers to an individual property (a commercial office or a residential apartment) and t is time (t =2017, 2018, 2019, 2020 and 2021[14]). Y_{it} is the dependent variable which is the rent of a commercial office or a

[13] The distinction between serviced and non-serviced is shown in Table A1 in the Appendix.
[14] The data on the residential rent is also available in 2022.

residential apartment in Indonesia Rupee (per square meter per month). For property *i* in the treatment group D_{it}^{T} takes 1 if $t = T$ and 0 otherwise. D_{it}^{T} always takes 0 for property *i* in the control group. We will take several definitions for treatment and control groups, as discussed below. In what follows, we basically define the treatment group by a circle of a certain distance from MRT stations. If a property is located within the circle, it is included in the treatment group. We experiment over several arbitrarily defined distance circles for comparison. As a convention, we set the period $T = \bar{T} - 1$ as reference where $\bar{T}$ is the year of the intervention (commercial opening of the MRT for our case), and we drop $D_{it}^{\bar{T}-1} = 1$ from the estimation equation. Since the MRT began operating in 2019, we set year 2018 as the reference. Our data period expands from 2017 to 2021 and thus $\underline{y}$ is 2017 and $\bar{y}$ is 2021[15]. λ_t is year fixed effects and μ_i is fixed effect of the assignment. ϵ_{it} is an *i.i.d.* error term. βs are the parameters to be estimated.

We rewrite the specification as follows. Note that our data is collected annually toward the end of each year and the first data after the MRT opening (spring 2019) refers to 2019. Thus, $D_{it}^{2018}\beta_{-1}$ is dropped from estimation:

$$Y_{it} = D_{it}^{2017}\beta_{-2} + D_{it}^{2019}\beta_0 + D_{it}^{2020}\beta_1 + D_{it}^{2021}\beta_2 + X_i\gamma + \lambda_t + \mu_i + \epsilon_{it} \qquad (2)$$

The pre-trend is assessed by the significance of the coefficient before the intervention. In this case, if β_{-2} is not significantly different from zero, we argue that the parallel trend assumption is not violated. In order to remove heterogeneity between properties, we add X_i , a vector of variables of a set of those characteristics, such as number of stories, year of completion, grades and the dummy variable for the nearest station from each property. All these characteristics of the buildings are constant over time, which makes X_i time-invariant.

We augment the basic specification in two ways. One is distance in meters from each property to the nearest station. We interact the distance (*dis*$_i$) with the treatment dummy variable since the impact of MRT opening may depend on the distance from each station, even in the catchment area. By doing so, we take a more nuanced approach to measure the impact.

The augmented specification is written as follows:

$$Y_{it} = \sum_{T=\underline{y}, T\neq\bar{T}}^{\bar{y}} D_{it}^{T}\beta_{T-\bar{T}} + \sum_{T=\underline{y}, T\neq\bar{T}}^{\bar{y}} (D_{it}^{T} * dis_i)\xi_{T-\bar{T}} + X_i\gamma + dis_i\delta + \lambda_t + \mu_i + \epsilon_{it} \qquad (3)$$

where all notations are the same as (2) except *dis*$_i$. The other specification defines the distance from the nearest

[15] $\bar{y}$ is 2022 for the case of the residential rent.

station as a continuous treatment variable instead of using the discrete treatment variable shown in (2) and (3). This alternative specification is written as follows:

$$Y_{it} = \sum_{T=\underline{y},T\neq\bar{T}}^{\bar{y}} (dis_i * year_t^T)\beta_{T-\bar{T}} + X_i\gamma + dis_i\delta + \lambda_t + \epsilon_{it} \qquad (4)$$

where $year_t^T$ takes 1 if $t = T$ and 0 otherwise. In addition to introducing the linear variable, as in (4), we also estimate the model with the squared and cubed terms of dis_i to capture the non-linearity of the impact of MRT on rents with respect to the distance.

We employ an ordinary least squares (OLS) estimation to obtain the coefficients for all specifications.

5. Empirical results and discussion

Table 2 presents the estimation results on commercial office rents with the specification of (2).[16] The coefficients of interest are β_{-2}, which tests the parallel trend assumption (pre-trend) and β_0, β_1 and β_2, which capture the post-trend impact of the Jakarta MRT. In this regression, we defined the treatment area in three different ways based on distance from the closest station. The control group includes commercial offices located outside of the treatment areas.

Column (1) presents the estimation results when the treatment area is defined as properties located within 500 meters of the closest station. We observe that β_{-2} (the interaction term with the 500-meter distance circle and the year dummy for 2017) is not statistically significant, suggesting that the parallel trend assumption is not violated. We also find that β_0 is not significant for the year 2019 but β_1 (for 2020) and β_2 (for 2021) are negative and statistically significant. This means that the opening of the Jakarta MRT started affecting office rents near the stations within one year after its commercial opening. The coefficients suggest that the opening of MRT reduced the average rent of properties within 500m from the stations by 24 thousand IDR per square meter per month in 2020 and 2021, compared to those outside of the distance circle. While not shown in the table, some characteristics of the properties in the vector X_i are significantly associated with the rent as follows; the size of the building in terms of total floor area is positive and significant, higher grades are associated with higher rent, and the properties in Central Jakarta and North Jakarta Region are significantly more expensive, while those in

[16] We report the estimation to take the sum of estimated rent and service charge" as the dependent variable. The results are qualitatively same across different definitions of dependent variables, namely, estimated rent without charges and asking rent with/without charges. Table A4 in the Appendices shows a comparison of results for different definitions of the dependent variable.

South Jakarta Region are significantly cheaper compared to the properties in CBD Region.

The results differ when we change the distance for the treatment group. Column (2) reports the coefficients when the treatment area is defined as a donut of distance from 500 meters to 1000 meters and Column (3) shows the coefficients if the donut is set for greater than 1000m and less than 1500m. In all cases, β_0, β_1 and β_2 are not statistically different from zero and it is found that the MRT opening reduced the office rent only within the areas closest to the stations. Figure 3 shows the event study graphs of the regression reported in Table 2 to visualize the impact that changes over time and varies across different definition of the treatment.

Table 3 presents the results of a more nuanced approach using the augmented model (3), combining the distance circle treatment with distance. This specification allows us to explore the heterogeneous impact along with the distance from each station by interacting dummy variables for some segments of distance from the station with the main covariates. Column (1) shows that the coefficients β_1 and β_2 are negative and significant when the treatment area is defined as properties within the 500m distance circle, while the ξ_1 and ξ_2, the coefficients of the interaction terms with the distance in 2020 and 2021 are positive and significant. This means that the negative impact on the commercial office rent becomes weaker as the distance from the station increases. Within the 500m distance circle, if the distance increases by 100m, the average rent also increases by 9,300 IDR in 2020 and by 10,400 IDR in 2021. These impacts are not observed when the treatment area is defined as 500–1000m (Column 2) and 1000–1500m (Column 3), again confirming that the negative effects are only significant within a relatively shorter distance from stations. In all cases, the parallel trend assumption is confirmed as β_{-2}, which is not significantly different from zero.

Table 4 reports the coefficients using specification (4), which incorporates linear or polynomial functions of continuous distance from the nearest MRT. Column (1) shows the case for the linear distance specification, and the estimated coefficients suggest that the closer a property is to the MRT, the cheaper the office rent becomes. Column (2), however, suggests that the negative impact is not simply universal across space. The rent increases as distance from the station grows but at a diminishing rate. According to the coefficients reported in Column (2), the highest rent could be located around 7500m from the station in 2020, while the peak reduces to 6000m from the station in the case of 2021.

Table 5 shows the results of the impact of the MRT opening on residential apartment rents. The coefficient of interest is the same as with commercial offices, and we defined treatment and control groups in the same way as the commercial offices. β_{-2} is not statistically significant, suggesting that the parallel trend assumption is not violated in the case of residential apartment rents. β_0, β_1 and β_2 are not statistically different from zero, showing that Jakarta MRT did not stimulate residential apartment rents significantly. The result is not altered if we change the definitions of distance for the treatment group.

Table 6 reports the results considering non-linearity along with the distance from stations, corresponding to Table 3 for commercial offices. Table 7 reports the coefficients using the continuous distance model. In contrast to the results of commercial offices, we find that the coefficients are not statistically significant for any distance segments from stations.

Our findings are summarized as follows. First, the Jakarta MRT opening reduced the rent of commercial offices that were located very close to stations (within 500m) but had no effect on those located further away from stations. Second, the MRT opening did not stimulate the rent of residential apartments regardless of distance from stations. Thus, our results show that the economic benefit of MRT depends on distance from the station and the type of property.

We argue that there are several possibilities to explain why Jakarta MRT reduced the commercial office rent in proximity to stations and did not alter the rental price of residential apartments regardless of distance from stations. First, one may perceive a decline in environmental and safety standards in the proximity to stations, which can have negative impacts on land and property values (Mohammad et al. 2013), an issue that has frequently been discussed in the transportation literature.[17] However, this is not the case for Jakarta MRT because the stations are new, clean and safe and the surrounding areas are being newly developed, especially in the southern areas. To our knowledge, there is no evidence of a deterioration in the environment or safety around the MRT line following the opening. Rather, Puryanti and Ydhistira (2022) showed that the opening of Jakarta MRT contributed to reducing the air pollution index by around 27% in the areas close to the MRT stations.

Second, our results may be linked to the well-known "bid rent theory" discussed in urban economics (Alonso 1964). The theory assumes that demand for real estate changes based on the distance from the central business district, varying among the demanders such as retailers, manufacturers, and residents. The MRT provides easier access to the CBD, leading to changes in the return on holding a unit of floor space across different

[17] Mohammad et al.(2013) showed that after controlling a wide variety of covariates, land/property value changes between 501 meters and 805 meters is significantly higher than those for land/properties at more than 805 meters away but those within 200 meters or 201 meters to 500 meters are not significantly higher.

demanders. Moreover, the composition of the demanders may also shift following the opening of the MRT. For example, business enterprises may bid higher for locations near the CBD or railway stations connected to the CBD than other demanders. However, if the opening of the MRT lowered the bid rent curve for business enterprises near stations compared to those of other demanders, this could reduce the demand for office space near the MRT stations. Another possible explanation is that work-from-home or telecommuting has become common among white color workers in Jakarta due to the COVID-19 pandemic, which emerged almost at the same time the Jakarta MRT began operating (Rachmawati et al. 2021). The prevalence of work-from-home may reduce the return on holding a business plot near the CBD because of the reduced agglomeration benefits from locating in the center. This can lead to a kind of "donut phenomenon" (Ramani and Bloom 2022) or "return to the city center," where the return of residential plot seekers replaces business in the center plots (Ihara 2023).

Third, the oversupply of commercial office space near the MRT stations following its opening may explain our results. Jakarta's real estate market underwent a "property boom" between 2012 and 2015, during which demand for office space surged amid limited annual supply. During this period, rents increased significantly, encouraging developers to continue investing in new office spaces up until the onset of the pandemic in 2020. During this period, the Indonesian government did not regulate the supply of real estate, allowing free entry into the market. This resulted in oversupply in both the CBD and non-CBD areas, leading to lower occupancy rates and service charges even before the opening of the Jakarta MRT. In fact, as shown in Figure A1, between 2017 and 2021, the supply of office space in the CBD steadily increased by more than 1 million square meters while the increase outside the CBD was about half this amount. Reflecting this, the occupancy rate in the CBD remained low (Figure A2).[18] After the opening of the MRT, during the period of the COVID-19 pandemic, the annual growth in office supply slowed to 2.6 percent up to 2021, and many construction projects had to be halted, resulting in delays in the opening of new office projects. Despite these circumstances, the supply of office space near the MRT stations has continued to increase significantly and persistently.

Table 8 shows the estimation results using specifications (2) and (3), taking the supply of office floor space as the dependent variable. We calculated the density of office floor space in every 250m x 250m mesh within 10km of each MRT station and used it as the dependent variable to estimate the impact of MRT on the supply of

[18] See Figure A2 for the relationship between MRT stations, CBD, the Study Area (10km Buffer from the MRT Stations), and office properties.

office properties.[19] Column (1) shows that the MRT opening increased the supply of office floor space near the MRT stations (within 500m). In addition, Column (2) indicates that supply decreases as the distance from the station increases.[20] While these results show the impact of taking the 500m radius as the treatment area, no significant impact of MRT was observed for the 500m to 1000m or the 1000m to 1500m circles. In other words, even during the pandemic, the supply of new office space continued and was greater in areas near the MRT stations after operations began. Since the development of office buildings typically requires several years, our results indicate that the supply side reacted more significantly in anticipation of the MRT opening compared to the smaller or delayed demand for office space after the opening.[21]

We favor the over-supply explanation over other interpretations when assessing the economic benefits of the Jakarta MRT. The development of an urban transit system is closely tied to reshaping public transportation and urban development. Our findings are highly relevant to the concepts of TOD and LVC, which have been intensively debated in the recent policy arena on urban infrastructure.[22] TOD is an approach to developing urban areas that places public transit─especially railways─as the primary focus for planning. Land is allocated to optimize the accessibility and convenience of public transit, reducing reliance on private vehicles. As public transit stations become urban hubs where people can gather and interact, the land value in the surrounding catchment area is expected to increase with the development of public transit systems. This increase in land value forms the financial foundation of TOD, helping to finance costly public transport infrastructure. LVC refers to the government's ability to recover financial resources by triggering an increase in land values through urban planning focused on access to public transport, capturing the land value increment through tax or other

[19] To construct the variable of office floor supply, we calculate the total floor area of commercial office properties in our data located within each of 250m x 250m mesh on the map by year. The distance of the mesh from each MRT stations is represented by the distance between the centroids of the mesh and the station. The summary statistics are shown in Table A5 in the appendix.

[20] The standard errors of the estimates for the interaction terms are the same across different years in Table 8 because all the right hand side variables except for the year dummies are identical across different years. There is no change in the sample size across years since the observation is the same 250m x 250m meshes,

[21] Figure A3 shows the event study graph of the result of Column (1) of Table 8.

[22] Jakarta MRT is assigned as the main operator in charge of developing TOD along the line through a variety of functions in accordance with Governor Regulation No. 140/2017, MRT (Purba 2020); to coordinate land and or building owners in regional planning and development, to encourage efforts to accelerate the development of TOD infrastructure and facilities in accordance with the city design guidelines, to coordinate the land and or building owners, tenants and other stakeholders in the TOD area management, maintenance and supervision, and to monitor the TOD area development.

mechanisms, and using the proceeds for recovery or future investment (Suzuki et al. 2015).[23]

It is often assumed in TOD and LVC discussions that an urban transportation project contributes to increasing the value of land and properties in the catchment area. Quantitative case studies on the impact of public transit development have shown that property values tend to rise near stations─see Table 2.1 in Suzuki et al. (2015). In contrast, we demonstrated a negative impact of the introduction of a public transit system on office rental values, which we attribute to the oversupply of properties. This may be a peculiar exception to the commonly accepted findings. We argue that our results highlight the potential challenges that LVC can face in practice. LVC aims to capture the land value increments attributable to public investment from private property owners or developers. There are a variety of instruments, which are largely categorized into tax- and fee-based instruments and development-based instruments. The tax- and fee-based instruments include property taxes, betterment charges, and tax increment facility (TIF). For these instruments, the public authority does not directly intervene in the ownership of land or property in the catchment of the transit facilities. Therefore, the real estate development remains market-based, and a portion of the developments benefit is captured through taxes or value assessments. In contrast, development-based instruments involve more direct public authority involvement in property development. Major schemes in this category include land sales, lease of development rights, joint development and land readjustment.

Our findings are more relevant to the tax- and fee-based instruments. Suzuki et al. (2021) pointed out that this type of LVC is, in principle, an intra-government adjustment on the allocation of public revenue. In the absence of LVC, taxes and charges on real estate collected by the finance authority are directly put into their general account for flexible use, benefiting the public. The tax- and fee-based LVC is thus an arrangement to reallocate a portion of such government revenues attributable to the investment in public transit for the exclusive use of the public transit authority. As such, it is essential that the public transit authority and revenue authority coordinate and agree on mechanisms for sharing government revenue. In most cases, the tax- and fee-based LVC assumes that revenue is shared only when the development benefit is positive. However, in cases where there are negative effects, like the Jakarta MRT, coordination between authorities could be jeopardized since the tax

[23] LVC is defined as "the financial instrument highlighted to recover costs from property owners or developers by capturing increased land value attributable to transport infrastructure investment (and related effort)." (Suzuki et al. 2015)

authorities and private owners/developers may regard LVC schemes as one-sided and could potentially request compensation payments if the assessment of the spillover shows some negative impact.[24]

6. Conclusion

This paper examined the impact of an urban mass rapid transit system on the real estate market in a megacity in developing Asia, using the Jakarta MRT as a case study. We employed DID estimation on commercial office and residential rent data from 2017 to 2021 (2022 for housing rent). Our analysis found that the opening of MRT stations had a negative and significant impact on the rental prices of commercial offices located within 500m of the stations. We also showed that the negative impact of the office rent may be a consequence of the oversupply of offices induced by the opening of the MRT. For the residential rents, by comparison, there was no significant impact of the MRT opening.

We should acknowledge that there are some limitations in our study. First, the duration of our dataset is relatively short, covering only 4–5 years after the opening of the MRT, which may not be sufficient to capture the longer-term impact. In particular, our data period overlapped with the COVID-19 pandemic, making it difficult to distinguish the MRT impact from that of COVID-19. Second, our dataset covers only a few segments of the real estate market, specifically high-end (luxurious) commercial offices and residential properties. Since the structure of the real estate market varies across different submarkets, it is essential to collect similar datasets from other submarkets to gain a more comprehensive understanding of the impact. Third, our analyses did not address the characteristics of the demanders (firms and residents) and providers (owners, developers, and government). The impact may be heterogeneous based on characteristics such as income level, gender and educational attainment. Understanding the heterogeneous impact will be crucial in promoting more equitable urban transit development.

[24] Our results may not mean the asset value of the property is negatively affected by the MRT opening since we observe the rent, a flow value of properties, instead of the asset value of real estate properties, However, the persistent decline of the rent will reduce the asset value as well and thus the rent reduction in the short-mid run could be alarming for the property owners.

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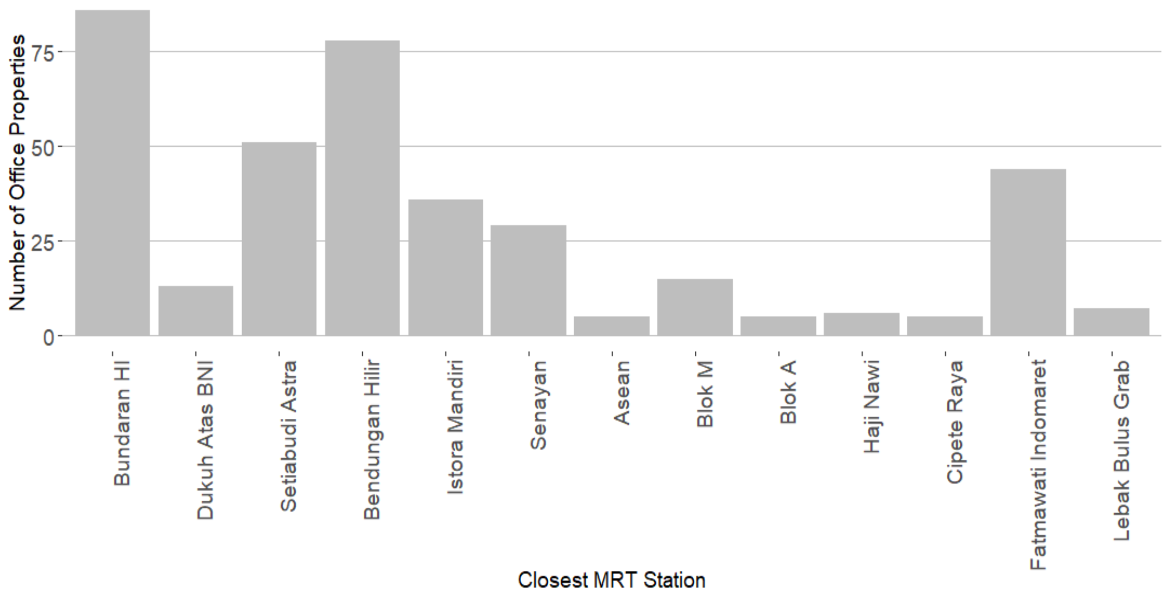
Figure 1 Map of the Jakarta MRT

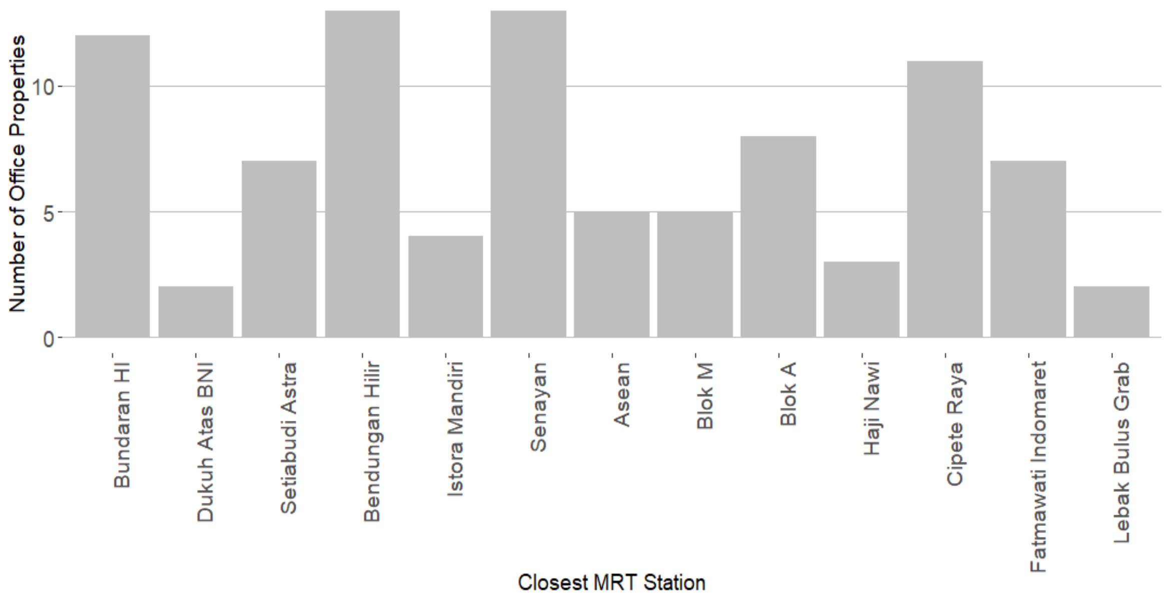
Source: Read Property Inc.

Figure 2 Location of properties

(1) Number of office properties (2021)

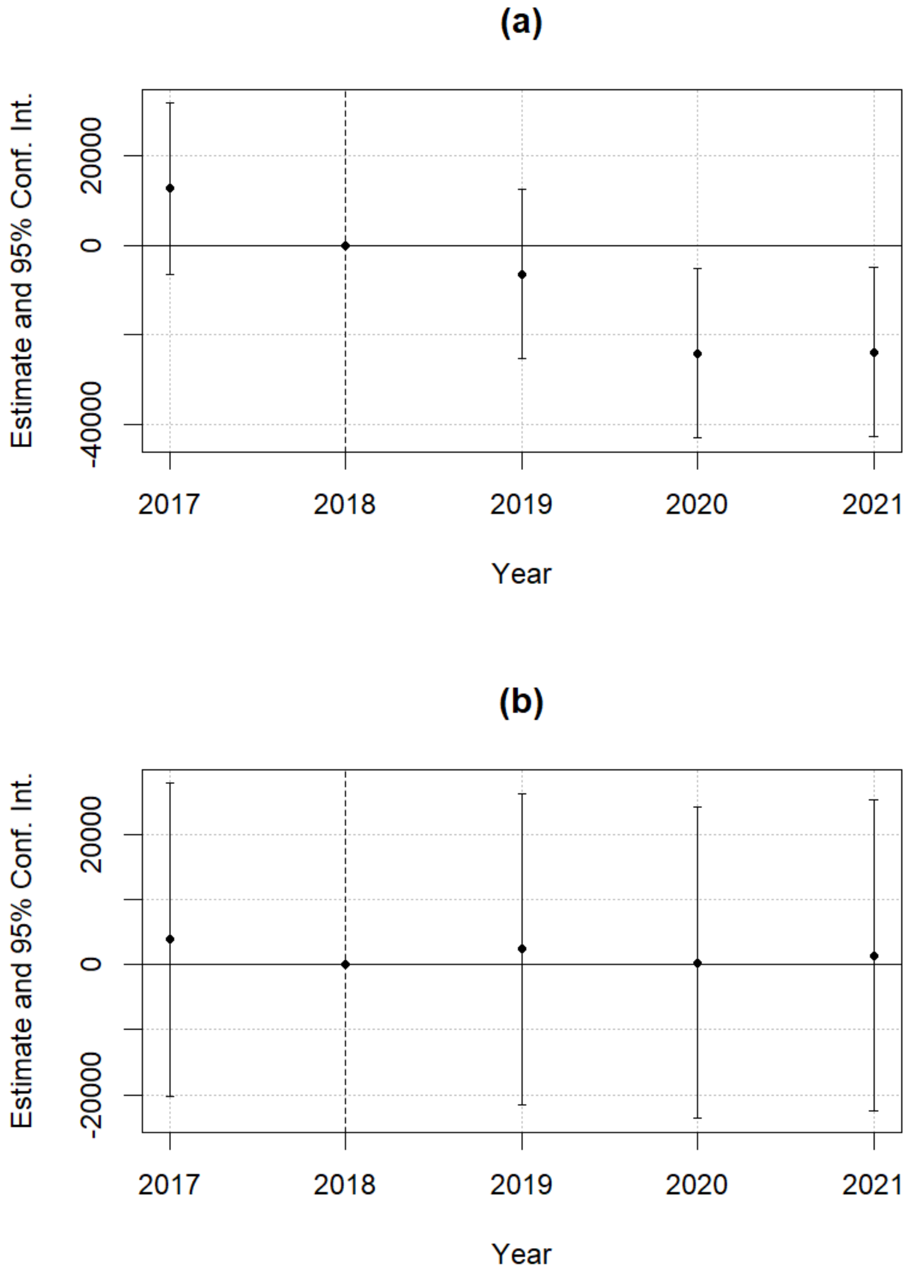


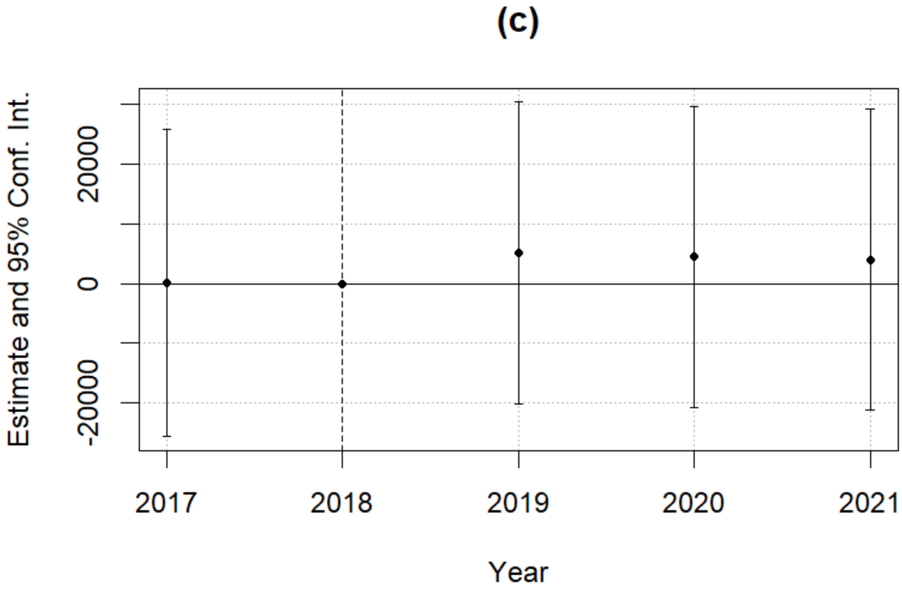
(2) Number of residential properties (2022)



Source: Authors' calculation.

Figure 3 Impact of MRT opening on office rent (event study graph)





Note: Figures show the estimates of the coefficient ($\beta_{T-\bar{T}}$) on the interaction term of the treatment dummy and year dummy with their 95% confidence intervals. The unit of y-axis is Indonesian Rupee per square meter per month. Graph (a) shows the results when the treatment is defined by the 500m distance circle from the nearest MRT station, which corresponds to the results shown in Column (1) of Table 2. Similarly, Graph (b) shows the results when the treatment is defined by the circle between 500m to 1000m (Column (2)), and (c) shows that for the circle between 1000m to 1500m (Column (3)), respectively.

Table 1 Summary statistics of the outcome variables

	N	Mean	St. Dev.	Min	Max
<Estimated Rent of Office>					
2017	360	185,906	81,601	70,000	580,000
2018	368	185,861	73,796	80,000	480,000
2019	374	183,160	65,768	80,000	440,000
2020	376	158,128	54,451	60,000	440,000
2021	380	162,903	54,474	63,500	420,000
<Asking Based Rent of Office>					
2017	360	223,760	95,542	90,000	650,000
2018	368	221,632	84,710	90,000	520,000
2019	374	217,691	74,260	90,000	500,000
2020	376	200,959	66,089	80,000	480,000
2021	380	200,267	63,564	85,000	450,000
<Service Charge of Office>					
2017	360	66,804	30,746	0	158,000
2018	368	68,945	38,527	0	500,000
2019	374	69,547	31,184	0	158,000
2020	376	70,377	30,687	0	158,000
2021	380	70,378	32,045	0	210,000
<Rent of Residential Apartment>					
2017	82	269,936	149,278	83,114	813,754
2018	84	274,282	150,092	84,093	827,320
2019	86	267,268	150,429	79,551	800,523
2020	88	257,216	145,044	65,789	775,662
2021	90	266,913	150,810	73,152	790,551
2022	92	281,943	159,642	80,251	810,811

Table 2 Impact of MRT opening on office rent: Distance circle model

	(1)	(2)	(3)
d_500 x yr2017 (β_{-2})	12,648 (9,794)		
d_500 x yr2019(β_0)	-6,547 (9,642)		
d_500 x yr2020(β_1)	-24,262** (9,638)		
d_500 x yr2021(β_2)	-23,910** (9,630)		
d_500_1000 x yr2017(β_{-2})		3,857 (12,244)	
d_500_1000 x yr2019(β_0)		2,353 (12,172)	
d_500_1000 x yr2020(β_1)		239 (12,170)	
d_500_1000 x yr2021(β_2)		1,362 (12,165)	
d_1000_1500 x yr2017(β_{-2})			51 (13,102)
d_1000_1500 x yr2019(β_0)			5,175 (12,879)
d_1000_1500 x yr2020(β_1)			4,482 (12,815)
d_1000_1500 x yr2021(β_2)			3,998 (12,810)
Constant	514,733* (308,781)	1,081,164*** (306,099)	1,012,705*** (304,311)
Observations	1,823	1,823	1,823
R^2	0.519	0.499	0.503
Adjusted R^2	0.511	0.491	0.496

Notes: ***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level. The Unit of Observation is an office plot with rent information. The dependent Variable is the sum of estimated rent and service charges in IDR per square meter per month. The independent variables include the number of stories of the building, number of office sites in the building, year of completion of the property, total floor area of the office in the office plot, grade dummy, region dummy, distance circle dummy, year dummy, distance from the (nearest) MRT station, planned MRT/monorail stations, railway stations. “d_500 x yr2017” is the interaction term of the 500m distance circle dummy and the year dummy for 2017.

Table 3 Impact of MRT opening on office rent: Augmented model

	(1)	(2)	(3)
d_500 x yr2017(β_{-2})	21,044 (17,973)		
d_500 x yr2019(β_0)	-16,205 (17,658)		
d_500 x yr2020(β_1)	-41,543** (17,651)		
d_500 x yr2021(β_2)	-45,640*** (17,645)		
d_500_1000 x yr2017(β_{-2})		11,616 (59,050)	
d_500_1000 x yr2019(β_0)		-2,139 (59,038)	
d_500_1000 x yr2020(β_1)		-12,615 (59,037)	
d_500_1000 x yr2021(β_2)		5,824 (59,036)	
d_1000_1500 x yr2017(β_{-2})			10,470 (124,458)
d_1000_1500 x yr2019(β_0)			61,482 (122,391)
d_1000_1500 x yr2020(β_1)			-13,446 (119,040)
d_1000_1500 x yr2021(β_2)			-61,053 (119,040)
d_500 x yr2017 x disMRT (ξ_{-2})	-35 (56)		
d_500 x yr2019 x disMRT (ξ_0)	53 (56)		
d_500 x yr2020 x disMRT (ξ_1)	93* (56)		
d_500 x yr2021 x disMRT (ξ_2)	104* (56)		
d_500_1000 x yr2017 x disMRT(ξ_{-2})		-13 (76)	
d_500_1000 x yr2019 x disMRT(ξ_0)		10 (76)	
d_500_1000 x yr2020 x disMRT(ξ_1)		26 (76)	
d_500_1000 x yr2021 x disMRT(ξ_2)		2 (76)	
d_1000_1500 x yr2017 x disMRT(ξ_{-2})			-9 (96)
d_1000_1500 x yr2019 x disMRT(ξ_0)			-42 (94)
d_1000_1500 x yr2020 x disMRT(ξ_1)			18 (92)
d_1000_1500 x yr2021 x disMRT(ξ_2)			54

			(92)
Constant	525,662* (308,025)	1,075,645*** (305,305)	1,042,724*** (303,981)
Observations	1,823	1,823	1,823
R^2	0.524	0.504	0.508
Adjusted R^2	0.514	0.494	0.498

Notes: ***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level. The Unit of Observation is an office plot with rent information. The dependent Variable is the sum of estimated rent and service charges in IDR per square meter per month. The independent variables include the number of stories of the building, number of office sites in the building, year of completion of the property, total floor area of the office in the office plot, grade dummy, region dummy, distance circle dummy, year dummy, distance from the (nearest) MRT station, planned MRT/monorail stations, railway stations. "d_500 x yr2017" is the interaction term of the 500m distance circle dummy and the year dummy for 2017.

Table 4 Impact of MRT opening on office rent: Continuous distance model

	(1)	(2)	(3)
disMRT x yr2017	-1.241 (1.887)	-7.300 (5.552)	-14.111 (11.838)
disMRT x yr2019	1.610 (1.873)	4.871 (5.499)	2.520 (11.699)
disMRT x yr2020	3.920** (1.872)	14.930*** (5.498)	19.102 (11.691)
disMRT x yr2021	3.465* (1.867)	12.270** (5.483)	23.377** (11.648)
disMRT^2 x yr2017		0.001 (0.001)	0.003 (0.004)
disMRT^2 x yr2019		-0.000 (0.001)	0.000 (0.003)
disMRT^2 x yr2020		-0.001** (0.001)	-0.003 (0.003)
disMRT^2 x yr2021		-0.001* (0.001)	-0.005 (0.003)
disMRT^3 x yr2017			-1.781e-07 (2.694e-07)
disMRT^3 x yr2019			-6.284e-08 (2.665e-07)
disMRT^3 x yr2020			1.054e-07 (2.663e-07)
disMRT^3 x yr2021			2.858e-07 (2.651e-07)
Constant	1,112,520*** (303,736)	1,016,807*** (303,603)	784,866** (304,878)
Observations	1,823	1,823	1,823
R^2	0.501	0.508	0.516
Adjusted R^2	0.494	0.499	0.506

Notes: ***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level. The Unit of Observation is an office plot with rent information. The dependent Variable is the sum of estimated rent and service charges in IDR per square meter per month. The independent variables include the number of stories of the building, number of office sites in the building, year of completion of the property, total floor area of the office in the office plot, grade dummy, region dummy, distance circle dummy, year dummy, distance from the (nearest) MRT station, planned MRT/monorail stations, railway stations. "d_500 x yr2017" is the interaction term of the 500m distance circle dummy and the year dummy for 2017.

Table 5 Impact of MRT opening on residential rent: Distance circle model

	(1)	(2)	(3)
d_500 x yr2017(β_{-2})	-13,240 (38,828)		
d_500 x yr2019(β_0)	12,877 (38,227)		
d_500 x yr2020(β_1)	7,251 (38,181)		
d_500 x yr2021(β_2)	3,254 (38,139)		
d_500 x yr2022(β_3)	11,679 (37,684)		
d_500_1000 x yr2017(β_{-2})		5,460 (37,522)	
d_500_1000 x yr2019(β_0)		-726 (36,651)	
d_500_1000 x yr2020(β_1)		-6,013 (36,293)	
d_500_1000 x yr2021(β_2)		6,614 (35,731)	
d_500_1000 x yr2022(β_3)		12,940 (35,467)	
d_1000_1500 x yr2017(β_{-2})			-4,197 (40,890)
d_1000_1500 x yr2019(β_0)			-15,726 (40,251)
d_1000_1500 x yr2020(β_1)			-14,278 (40,204)
d_1000_1500 x yr2021(β_2)			-10,766 (40,161)
d_1000_1500 x yr2022(β_3)			-18,101 (40,123)
Constant	-834,356 (909,343)	-1,065,536 (924,672)	-1,069,848 (923,047)
Observations	522	522	522
R^2	0.603	0.594	0.593
Adjusted R^2	0.581	0.571	0.571

Notes: ***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level. The unit of observation is a residential plot with rent information. The dependent variable is the observed average rent in IDR per square meter per month. The covariates include the number of rooms in the building, year of completion of the property, type dummy, grade dummy, region dummy, distance circle Dummy, year dummy, distance from the (nearest) MRT station, planned MRT/Monorail stations and railway stations. "d_500 x yr2017" stands for the interaction term of the 500m distance circle dummy and the 2017 year dummy.

Table 6 Impact of MRT opening on residential rent: Augmented model

	(1)	(2)	(3)
d_500 x yr2017	-10,977 (112,823)		
d_500 x yr2019	-5,271 (112,063)		
d_500 x yr2020	-16,674 (112,022)		
d_500 x yr2021	-21,689 (111,970)		
d_500 x yr2022	-19,555 (111,022)		
d_500_1000 x yr2017		-19,431 (199,273)	
d_500_1000 x yr2019		-69,035 (188,246)	
d_500_1000 x yr2020		-104,486 (188,229)	
d_500_1000 x yr2021		-46,554 (185,526)	
d_500_1000 x yr2022		-17,580 (184,941)	
d_1000_1500 x yr2017			45,167 (377,730)
d_1000_1500 x yr2019			168,567 (375,225)
d_1000_1500 x yr2020			113,346 (375,218)
d_1000_1500 x yr2021			159,177 (375,209)
d_1000_1500: x yr2022			181,660 (375,201)
d_500 x yr2017 x disMRT	-8 (332)		
d_500 x yr2019 x disMRT	66 (331)		
d_500 x yr2020 x disMRT	87 (331)		
d_500 x yr2021 x disMRT	74 (331)		
d_500 x yr2022 x disMRT	85 (325)		
d_500_1000 x yr2017 x disMRT		39 (278)	
d_500_1000 x yr2019 x disMRT		94 (258)	
d_500_1000 x yr2020 x disMRT		137 (258)	
d_500_1000 x yr2021 x disMRT		73	

		(256)	
d_500_1000 x yr2022 x disMRT		40 (255)	
d_1000_1500 x yr2017 x disMRT			-40 (307)
d_1000_1500 x yr2019 x disMRT			-150 (304)
d_1000_1500 x yr2020 x disMRT			-103 (304)
d_1000_1500 x yr2021 x disMRT			-139 (304)
d_1000_1500 x yr2022 x disMRT			-164 (304)
Constant	-743,235 (925,935)	-913,046 (938,875)	-1,110,377 (931,248)
Observations	522	522	522
R^2	0.604	0.596	0.596
Adjusted R^2	0.572	0.564	0.564

Notes: ***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level. The unit of observation is a residential plot with rent information. The dependent variable is the observed average rent in IDR per square meter per month. The covariates include the number of rooms in the building, year of completion of the property, type dummy, grade dummy, region dummy, distance circle Dummy, year dummy, distance from the (nearest) MRT station, planned MRT/Monorail stations and railway stations. "d_500 x yr2017" stands for the interaction term of the 500m distance circle dummy and the 2017 year dummy.

Table 7 Impact of MRT opening on residential rent: Continuous distance model

	(1)	(2)	(3)
disMRT x yr2017	1.037 (8.256)	9.943 (26.005)	7.154 (53.169)
disMRT x yr2019	0.177 (8.226)	-3.129 (25.861)	-12.740 (52.770)
disMRT x yr2020	1.120 (8.218)	0.778 (25.818)	4.622 (52.630)
disMRT x yr2021	-0.890 (8.202)	-6.578 (25.753)	-2.271 (52.557)
disMRT x yr2022	-2.552 (8.185)	-15.072 (25.661)	-18.443 (52.396)
disMRT^2 x yr2017		-0.001 (0.003)	-0.000 (0.017)
disMRT^2 x yr2019		0.000 (0.003)	0.004 (0.017)
disMRT^2 x yr2020		0.000 (0.003)	-0.001 (0.017)
disMRT^2 x yr2021		0.001 (0.003)	-0.001 (0.017)
disMRT^2 x yr2022		0.002 (0.003)	0.003 (0.017)
disMRT^3 x yr2017			-8.529e-08 (1.412e-06)
disMRT^3 x yr2019			-2.944e-07 (1.406e-06)
disMRT^3 x yr2020			1.184e-07 (1.403e-06)
disMRT^3 x yr2021			1.326e-07 (1.403e-06)
disMRT^3 x yr2022			-1.033e-07 (1.402e-06)
Constant	-971,682 (920,445)	-235,006 (921,685)	-272,069 (943,860)
Observations	522	522	522
R^2	0.592	0.608	0.609
Adjusted R^2	0.570	0.583	0.578

Notes: ***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level. The unit of observation is a residential plot with rent information. The dependent variable is the observed average rent in IDR per square meter per month. The covariates include the number of rooms in the building, year of completion of the property, type dummy, grade dummy, region dummy, distance circle Dummy, year dummy, distance from the (nearest) MRT station, planned MRT/Monorail stations and railway stations. "d_500 x yr2017" stands for the interaction term of the 500m distance circle dummy and the 2017 year dummy.

Table 8 The impact on the supply of office floor space

	(1)	(2)
d_500 x yr2017(β_{-2})	-850 (1,044)	-2,494 (3,103)
d_500 x yr2019 (β_0)	1,844* (1,044)	6,583** (3,103)
d_500 x yr2020 (β_1)	1,923* (1,044)	6,846** (3,103)
d_500 x yr2021 (β_2)	1,893* (1,044)	6,749** (3,103)
disMRT x d_500 x yr2017(ξ_{-2})		5.354 (8.753)
disMRT x d_500 x yr 2019(ξ_0)		-14.454* (8.753)
disMRT x d_500 x yr 2020(ξ_1)		-15.220* (8.753)
disMRT x d_500 x yr 2021(ξ_2)		-15.208* (8.753)
Constant	3,020*** (149.8)	2,659*** (238.1)
Observations	43,620	43,620
R^2	0.054	0.067
Adjusted R^2	0.054	0.066

Notes: ∗∗∗Significant at the 1 percent level. ∗∗Significant at the 5 percent level. ∗Significant at the 10 percent level. Unit of Observation is 250m mesh within 10km distance from existing MRT stations. The dependent variable is the total office floor area (m2) within the 250m mesh in each year. Year dummies and distance from the centroid of the mesh of MRT station are also included.

Table A1 Definition of office grade and apartment service

(1) Commercial offices

	Premium	Grade A	Grade B	Grade C
Floor plate size (SGFA – sq.m)	>1,800 sqm	1,400-2,000 sqm	1,000-1,400 sqm	<1,000 sqm
Total size per tower (SGFA – sq.m)	>40,000 sqm	40,000-60,000 sqm	15,000-30,000 sqm	<15,000 sqm
Furnishings	High grade imported materials	Imported and local materials	Local materials (standard grade)	Local materials (lower grade)
Tenant profile	International (global top companies) and local companies	International and local companies	Local and international companies	Local companies
Facilities	Mixed-use; offices, retails (mall), hotels and apartments.	Retail facilities (restaurants, banks and services)	Retail facilities (usually restaurants and banks)	No retail facilities (usually cafeterias)

(2) Residential apartments

	Serviced	Non-serviced
Length of stay	Long stay: Minimum 6 months but often available for daily/weekly stay	Long stay: Minimum 6 months
Pricing	Higher than non-serviced	Lower than serviced
Operator	Professional local/international service operator	Owner-operator or designated local operator
Services	Complete services including housekeeping, laundry and/or F&B, included in rent	Self-serviced, excluded from rent
Utilities charge	Including in rent	Excluded from rent, separately metered

Source: RT Leads Properties with modifications by the authors.

Table A2 Summary statistics of the covariates (office rent)

	N	Mean	St. Dev.	Min	Max
Year of completion of the building	380	2,003	12	1,973	2,022
Total office floor area in the building	380	27,302	22,839	1,170	144,000
Number of stories in the building	380	20	12	3	60
Number of office sites in the building	378	118	179	1	2,880
Distance to commissioned MRT station (m)	380	2,289	2,256	0	10,072
Distance to railway station (m)	380	1,951	1,199	122	5,961
Distance to planned MRT/Monorail station (m)	380	5,266	3,599	51	15,885
Distance to planned MRT East-West (m)	380	2,157	1,763	43	7,067
Regions					
CBD	380	0.516	0.500	0	1
Central Jakarta	380	0.100	0.300	0	1
East Jakarta	380	0.005	0.072	0	1
North Jakarta	380	0.050	0.218	0	1
South Jakarta	380	0.239	0.427	0	1
Tangerang	380	0.011	0.102	0	1
West Jakarta	380	0.079	0.270	0	1
Grades					
P	380	0.016	0.125	0	1
A	380	0.255	0.437	0	1
B+	380	0.003	0.051	0	1
B	380	0.326	0.469	0	1
C	380	0.400	0.491	0	1

Table A3 Summary statistics of the covariates (residential rent)

	N	Mean	St. Dev.	Min	Max
Year of completion of the building	92	2,003	12	1,974	2,022
Number of rooms in the building	92	100	77	4	358
Distance to commissioned MRT Station (m)	92	1,726	1,799	137	8,947
Distance to railway station (m)	92	2,079	1,280	63	5,097
Distance to planned MRT/Monorail station (m)	92	6,362	3,462	705	15,461
Distance to planned MRT East-West (m)	92	2,425	1,615	266	7,748
Regions					
CBD	92	0.359	0.482	0	1
Central	92	0.065	0.248	0	1
North	92	0.043	0.205	0	1
South	92	0.478	0.502	0	1
Tangerang	92	0.022	0.147	0	1
West	92	0.033	0.179	0	1
Grades					
Luxury	92	0.065	0.248	0	1
Midscale	92	0.554	0.500	0	1
Upper Midscale	92	0.033	0.179	0	1
Upper Upscale	92	0.098	0.299	0	1
Upscale	92	0.250	0.435	0	1
Types					
Non-Serviced Apartment	92	0.370	0.485	0	1
Serviced Apartment	92	0.630	0.485	0	1

Table A4 Estimation of MRT impact on the office rent (different rent definitions)

	Estimated rent	Estimated rent+charge	Asking rent	Asking rent+charge
	(1)	(2)	(3)	(4)
d_500 x yr2017	17,380	21,044	23,442	27,106
	(16,109)	(17,973)	(17,841)	(19,703)
d_500 x yr2019	-17,044	-16,205	-18,485	-17,646
	(15,827)	(17,658)	(17,529)	(19,358)
d_500 x yr2020	-42,212***	-41,543**	-32,730*	-32,061*
	(15,820)	(17,651)	(17,521)	(19,350)
d_500 x yr2021	-46,223***	-45,640***	-46,931***	-46,348**
	(15,815)	(17,645)	(17,516)	(19,344)
d_500 x yr2017 x disMRT	-37.382	-34.570	-51.008	-48.196
	(50.621)	(56.479)	(56.065)	(61.916)
d_500 x yr2019 x disMRT	41.484	53.252	40.436	52.203
	(49.868)	(55.639)	(55.231)	(60.996)
d_500 x yr2020 x disMRT	82.100*	92.599*	74.301	84.799
	(49.868)	(55.639)	(55.231)	(60.995)
d_500 x yr2021 x disMRT	85.165*	104.226*	103.242*	122.303**
	(49.868)	(55.639)	(55.231)	(60.995)
Constant	-479,705*	525,662*	-495,869	509,498
	(276,076)	(308,025)	(305,765)	(337,677)
Observations	1,823	1,823	1,823	1,823
R^2	0.492	0.524	0.531	0.556
Adjusted R^2	0.482	0.514	0.522	0.547

Notes: ***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level. The unit of observation is an office plot with rent information on the number of stories of the building, number of office sites in the building, year of completion of the property, total floor area of the office in the office plot, grade dummy, region dummy, distance circle dummy, year dummy, distance from the nearest MRT station, planned MRT/Monorail stations and railway stations.

Table A5 Summary statistics for analysis on the supply of floor areas

	N	Mean	St. Dev.	Min	Max
<Covariates>					
Distance to MRT station	8,724	5,722	2,748	32.942	9,999
Distance to planned MRT or monorail station	8,724	2,845	2,553	7.008	12,949
Distance to railway station	8,724	2,336	1,471	4.946	6,899
<Average floor area in a 250m x 250m mesh>					
Floor area within mesh (2017)	8,724	925	8,250	0	250,362
Floor area within mesh (2018)	8,724	975	9,096	0	339,000
Floor area within mesh (2019)	8,724	1,038	9,889	0	339,000
Floor area within mesh (2020)	8,724	1,064	10,013	0	339,000
Floor area within mesh (2021)	8,724	1,094	10,184	0	339,000

Notes: Distance is measured as Euclidean distance between the centroid of the station and the centroid of the mesh in meters. Floor area is measured in square meters.

Figure A1: Office supply in CBD and out of CBD

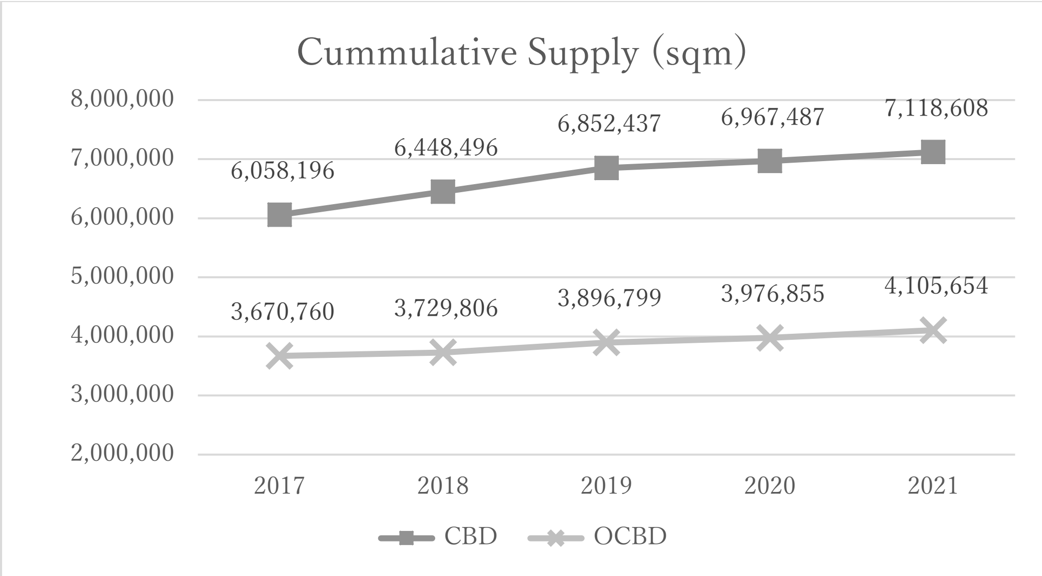


Figure A2: Occupancy rate in CBD and out of CBD

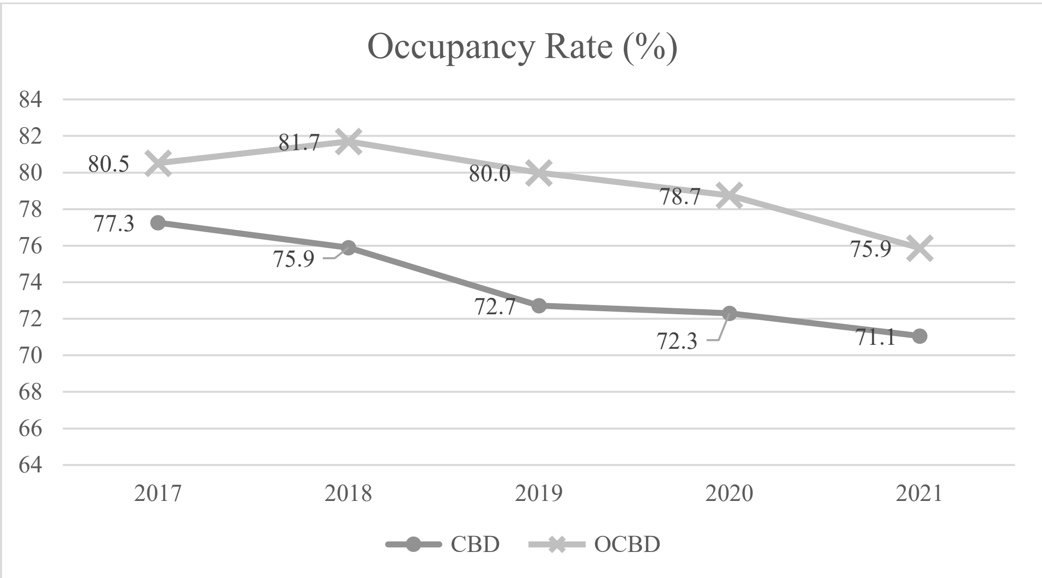
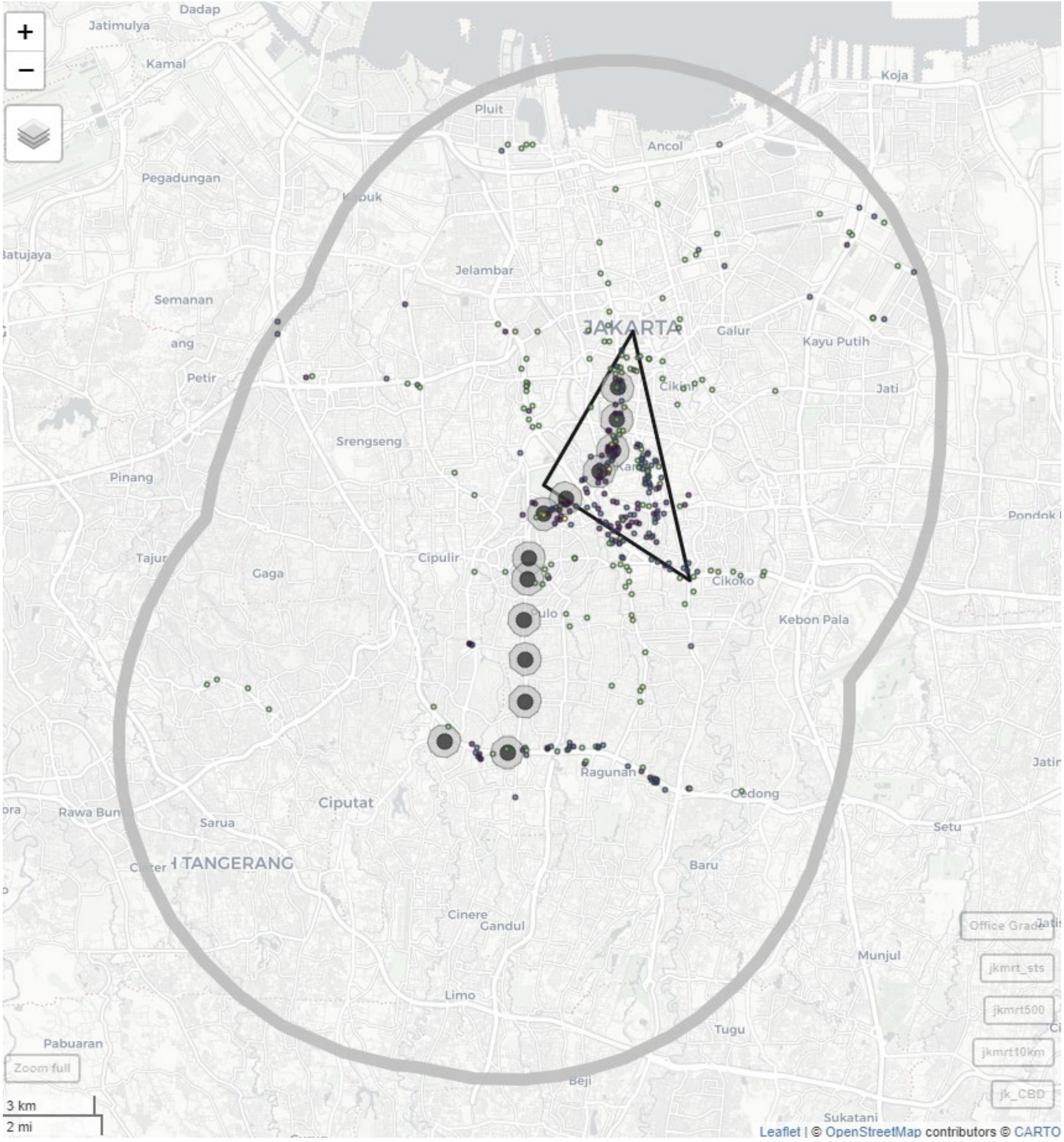
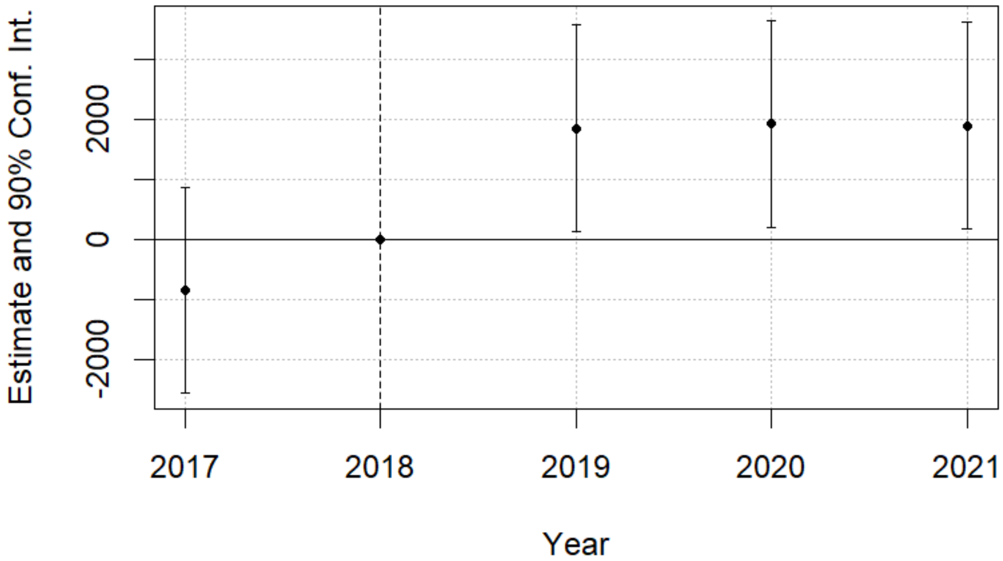


Figure A2 Office Locations



Notes: Small dots are location of office properties. Black points indicate already-operating MRT stations, the grey circles surrounding them show 500m buffer from the station, the black solid triangle depicts CBD area, and the grey and thick boundary shows total study area (10km from each MRT station).

Figure A3 Impact of MRT on office space supply (event study graph)



Note: This Figure shows the estimates of the coefficient ($\beta_{T-\bar{T}}$) on the interaction term of the treatment dummy and year dummy with their 90% confidence intervals. The unit of y-axis is square meters. The figure shows the results when the treatment is defined by the 500m distance circle from the nearest MRT station, which corresponds to the results shown in Column (1) of Table 8.