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Estimation of the anticipation effects of the metro project on real estate dynamics in Bogotá, Colombia

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Abstract: Studies of the impacts of rail-based mass transit systems on land values and real estate prices are scarce in the Colombian context. Most studies have focused on estimating the impacts of bus rapid transit systems (BRT), mainly in Bogotá. There is an emerging literature on rail-based systems impacts on urban development and land values in Medellín, Colombia, while there is also an emerging interest regarding the effects of the announcements of the two metro projects of Bogotá in the city's urban spatial structure. This paper develops a quasi-experimental research design looking at the anticipatory effects of the two lines of the Bogota Metro program on real estate market dynamics between 2007 and 2023. We used databases generated by the private sector with new housing developments including housing unit attributes and we estimated spatial variables and urban attributes associated with the location of each real estate development project. Through hedonic price models with control variables that incorporate attributes at different scales, our study estimates the effects of the Bogota Metro Line 1 project (in construction since 2021) on prices per square meter of real estate development projects over time. Results of the analysis suggest that the regulations implemented by the city, establishing an 800-meter impact area along Line 1, have had positive effects on real estate market prices after 2016, while results found no changes on real estate development dynamics in terms of prices per square meter due to the announcements of the planned second line of the metro project. We also included statistical analysis using isochrones based on walking distances to future metro stations. We found that the positive effects are taking place in all isochrones for the first line, while there are differences in the case of the second line of the metro project. Based on these findings, we provide guidelines for future research including public policy recommendations for the local and national government regarding value capture opportunities associated with the announcement of large-scale rail based urban transport projects.

Keywords: Metro, real estate, anticipation effects, hedonic price analysis, Latin America

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1 Introduction

Although there is an extensive literature regarding the impacts of metro systems on the urban spatial structure, such as those conducted in North America (Benjamin & Stacy Sirmans, 1996; Bowes & Ihlanfeldt, 2001; Cervero & Landis, 1997a; Cervero & Duncan, 2002; Damm et al., 1980; Landis et a., 1995; Lewis-Workman & Brod, 1997; McDonald & Osuji, 1995; McMillen & McDonald, 2004), in Europe (Du & Mulley, 2007; Gibbons & Machin, 2005; Mejia-Dorantes et al., 2011), and Asia (Bae et al., 2003; Kim & Zhang, 2005; Salon et al., 2014), there are few studies of this kind in the context of Latin America and the Caribbean LAC region (Agostini & Palmucci, 2008; Rosanovich & Di Giovambattista, 2019).

The Bogotá Metro Line 1 project has had a series of important milestones in its recent history (EMB, 2023). One of the most important is the study of the Urban Transportation Master Plan prepared by the Japan Cooperation Agency drafting a heavy rail metro network of 40km (JICA, 1996). In 2006, the Bogotá Mobility Master Plan was adopted, which defined a network of the Integrated Public Transportation System including the metro system (Bogotá, 2006). Between 2008 and 2011, the city carried out the conceptual engineering study of this project, defining a first line of 27.5km between the southwest (BRT Terminal Americas) and the city center (Sener et al., 2009a, 2009b, 2010, 2011). Between 2013 and 2015, the city also hired the basic engineering studies for this line with an underground infrastructure from the Bosa urban district (BRT Terminal *Américas*) to the north of the city, initially to Calle 127 and Carrera 9 (Bogotá, 2015).

In 2016, the Bogotá Metro Company (EMB in Spanish) was created, as head of the design, implementation, and operation of the metro lines of the city and the urban development of its influence area (Concejo, 2016). In 2017, the National Council of Economic and Social Policy CONPES approved document No. 3900 through which the project of the Metro's First Line was declared of strategic importance, endorsing the alignment and the elevated viaduct typology for the 23.4 km of the corridor. Per the CONPES, Metro Line 1's commencement and railyards are located within the Bosa urban district (close to the BRT Terminal *Américas*) and the viaduct runs up to Calle 72 with Av. Caracas, (CONPES, 2017). In 2018, CONPES approved document No. 3945 in which the project of the First Metro Lines, the projects of the BRT trunks of Avenida 68 and the Avenida Ciudad de Cali, as feeders of the metro system (CONPES, 2018). In 2021, the CONPES approved the document No. 4034, which describes the co-financing between the national and local governments for the railway component of the First Line of the Metro Project of Bogotá (PLMB for its Spanish acronym) and the BRT feeder lines (Av. 68, Av. Ciudad de Cali) and other complementary trunk lines (Carrera 7 between Calle 32 and Calle 200 and Av. Caracas between *Molinos* and the *Usme* portal) financed by the local government, as well as the recommendation to advance the structuring studies of Line 2 of the Metro Project towards the *Engativá* and *Suba* urban districts (CONPES, 2021).

Regarding Line 2 of the Metro Project, in 2021, FDN, a publicly-owned local development bank, signed an MoU with EMB to carry out the comprehensive structuring of the Line 2 project of the Bogotá Metro, including the legal, risk, technical, and financial components (FDN, 2021). In 2022, CONPES approved document No. 4104 declaring the line 2 project of the Bogotá metro project of regional strategic importance, including a financing agreement for complementary works related to the mass transportation corridors on Calle 13 (CONPES, 2022a). In the same year, CONPES approves document No. 4109, authorizing EMB to secure loans with multilateral organizations to finance Bogotá Metro Line 2 (CONPES, 2022b).

In 2019, EMB awarded a 27-year design-finance-build-operate-maintain-transfer (DFBOMT) concession contract to a Chinese-led concessionaire. Works officially commenced in October 2020, and the project is expected to start operations in 2027 (EMB, 2023). In 2021, the City hired the designs of Line 2 (L2MB), including the legal, risk, technical, and financial components (FDN, 2021). The prequalification bid for the process was launched in March 2023, and the request for bids was announced in October 2023. A DFBOMT concession contract, similar to L1's, is expected to be awarded by December 2024. As shown in the figures, the layout of line 1 is defined from the southwest of the city to the northeast, while the layout of line 2 serves the northwest of the city, completing a "U"-shaped layout in line with the approaches of the JICA Master Plan (JICA, 1996). Between 2016 and 2019, the city formulated a new Mobility Master Plan, which served as the basis for the formulation of the new PMSS Safe and Sustainable Mobility Master Plan adopted in 2023 following the guidelines defined by the Ministry of Transportation. Figure 1 shows the PLMB and L2MB with isochrones areas.

A recent study looking at the anticipation effects of the announcement of the Metro project of Bogotá on asking prices of properties for rent suggests that there are premiums for proximity to the planned infrastructure project (Cárdenas et al., 2023). However, there is a gap in the literature in terms of the anticipation effects of the announcement of the first line of the metro project of Bogotá on new real estate development projects. The present papers provide new evidence on this regard as part of an ongoing research project that seeks to provide new evidence regarding the anticipatory effects of the metro project on the urban spatial structure of Bogotá. This paper develops a quasi-experimental research design to study the effects on real estate activity due to the announcement of the first two lines of the metro project of Bogotá between 2006 and 2023. We used a data set collected by the private agency *Galeria Inmobiliaria* which includes information on real estate development projects in the whole city between 2007 and 2023.

The paper is structured in five sections. First, the literature review provides an overview of the studies and methods applied in the analysis of rail-based systems on the urban spatial structure. Then, the methodology section includes the description of the study area, the real estate development projects database, and the statistical data analysis implemented in this study. The results section includes the research findings based on the statistical analysis regarding the effects on real estate development project prices by the announcement of the first line of the metro project of Bogotá. The discussion section compares the results of this paper with previous studies and discusses emerging issues associated with the policy implications of the research findings. The conclusion section includes recommendations based on the research findings.

2 Literature review

2.1 Metro systems and their effects on prices and the real estate market

United States cities have been the subject of most of the early studies of the impacts of mass transit systems on the real estate market, specifically in terms of changes in real estate, land prices, and their dynamics. There is a predominance of publications on cities in North America, then an evolution towards cities in Europe and Asia, and an emerging literature in Latin America.

One of the first studies corresponds to the announcement of the subway project of the city of Washington DC. Results show anticipation effects on property prices in the real estate market with an increase depending on the proximity to the future stations of the system meter (Damm et al., 1980). Once the system was in operation, a second study was

carried out on the prices of rent and real estate for sale in the city, establishing that for every increase in a tenth of a mile to the subway stations, a reduction was observed. 2.5% of the rental prices of residential properties (Benjamin & Stacy Sirmans, 1996).

In California, these impacts have been also measured for the BART system (Bay Area Rapid Transit) in San Francisco Bay area and in the Los Angeles Metropolitan Area (Illustration 2). The analysis of housing prices in areas served by BART proved that for every meter closer to the stations, an increase in prices of $2.39 dollars is observed, while urban redevelopment processes were also found around some stations (Landis et al., 1995). The analysis of several cities in North America allowed us to establish that the location of properties in the San Francisco Bay area has a higher price of $15.78 dollars for every 0.3 meters closer to a BART system station, while in the analysis of housing supply in New York City, it was found that prices decrease for each meter of distance to a station of the subway system (Lewis-Workman & Brod, 1997) In the Los Angeles case, multifamily developments near the B line (formerly called Red line) have the largest positive effects, above 6%, while the study authors argue that effects observed in the Ventura BRT corridor may be associated with control variables related to proximity to highways and their intersections. Analysis of this LA Metro shows land value benefits for multifamily housing developments in areas near metro stations (Cervero & Duncan, 2002).

(Lewis-Workman & Brod, 1997)The cities of Chicago and Atlanta, and the urban areas of Massachusetts, have also been the subject of studies on the relationship between rail-based mass transportation systems and their effects on the urban spatial structure. McDonald and Osuji (1995) analyzed the effects of the rail-based transportation system in the city of Chicago (Illinois) and showed how the expansion of the system had effects in terms of increasing the values of residential properties by 17% (in an area of influence of half a mile from the stations) and increases of 1.9% in real estate prices for each mile of distance closest to the business center (Central Business District CBD) of the city, a section in which the system infrastructure is elevated when the properties are located within a half-mile influence area of the system stations (McDonald & Osuji, 1995). The opening of the midway line in Chicago also had effects on real estate prices, the analysis of housing prices suggests an increase of 6.89% when the properties are located near the stations of this transit system (McMillen & McDonald, 2004).

In the case of the city of Atlanta (Georgia), a 19% increase was observed in the sales prices of properties that were within a quarter mile of the stations of the Metropolitan Rapid Transportation Authority's transit system (MARTA). The findings also showed how the focus of the city's infrastructure in terms of promoting a car-oriented development is linked to the findings. The findings suggest that housing units with a location more than three miles from a transit were sold with 4.7% premiums if the stations included private vehicle parking infrastructure (Bowes & Ihlanfeldt, 2001). Regarding the analysis of the urban areas served by the commuter train in the state of Massachusetts, the analysis by Armstrong and Rodríguez shows that real estate prices have higher values, between 9.6% and 10.1%, compared to properties located in urban areas without access (Armstrong & Rodriguez, 2006). In the same way, the assessment of the impact of the metro extension in Montreal to the suburb city of Laval found that the effects of transit infrastructures on real estate dynamics can vary considerably according to temporal and spatial factors. In this case, even though no significant effect was observed while analyzing all stations together, the decomposition of the effect over each station demonstrated the positive impact on prices of single-family properties concentrated around a single station (Devaux et al., 2017)

More recent studies provide evidence of the impacts of transit on Asian cities' urban spatial structure. In Seoul (South Korea), the effects on real estate prices have been

studied, showing increases of $7.54 dollars for each meter closer to a city center station, and with an 8.9% anticipation effect on the increase of real estate prices in a 1km area (Bae et al., 2003). In Guangzhou (China), by doubling the distance to a station of the metro system, residential property prices decreased 4.7%, while also observed joint positive effects between the rail system and the BRT (Bus Rapid Transit) system on real estate prices (Salon et al., 2014). In the case of Hong Kong, He's study (2020) uses a model, estimating the regional accessibility benefits of the MTR transit system on residential property prices, establishing that at the regional level, there is a positive effect of 10%, while increases in properties in the two years of study were 3.52% in 2001 and 4.73% in 2011.

Regarding studies carried out in Europe, the analyses in the United Kingdom and Spain stand out. In the early 1990s, a study was conducted on the relationship between the expansion of the rail mass transit system and the housing market in London, with an increasing 9.3% in housing prices with transit access, compared to the prices elsewhere (Gibbons & Machin, 2005). However, another study in Sunderland (United Kingdom) found no significant changes when comparing data before and after the implementation of the system (Du & Mulley, 2007). The analysis of the accessibility impacts of the Madrid Metrosur station on real estate dynamics suggests that housing prices change according to location. The further from the transit infrastructure, the lower the prices, between 2.18 % and 3.18% about the cost of properties closer to the station (Mejia-Dorantes et al., 2011).

In the Latin American and Caribbean regions, emerging studies examine the relationship between the implementation of transit systems and their effects on the urban spatial structure (Vergel-Tovar, 2022). Effects of anticipation of the announcement of Line 4 of Santiago de Chile's system (Chile) provides findings on the impact in terms of increases in real estate prices between 4.2% and 7.9%, and with the announcement of where the stations will be located, there were increases between 3.1% and 5.5% in the prices of properties with transit access (Agostini & Palmucci, 2008). The Buenos Aire's case suggests non-linear effects, since changes of -5% in prices were observed in a distance range of 200 meters to the stations, while positive effects of 3.6% were observed between 200 and 600 meters away from the stations (Rosanovich & Di Giovambattista, 2019). The non-linear effects found in the Buenos Aires metro study suggest that there are differences in land uses, specifically for residential uses, and their proximity to stations. In the case of Bogotá, the announcement of the Metro project had positive effects on the asking prices of properties for rent, a study showed an increase in prices of 10.5% for apartments and 6.5% for houses located within a 1.5 km radius of future metro stations (Cárdenas et al., 2023).

Among the methodologies used to estimate the effects of rail-based systems on property prices and the real estate market, the hedonic price model predominates, controlling for attributes of the housing units, location, and accessibility characteristics. The implementation of this type of statistical analysis includes the estimation of spatial data variables to capture the effects in terms of proximity to mass transit infrastructure.

However, other econometric methodologies have also been implemented to quantify these effects, McDonald and Osuji (1995) used a logistic regression model to estimate changes in property prices in the city of Chicago. Moreover, Cervero and Landis (1997b) estimated the effects of BART on land development in the San Francisco Bay area using logistic regression and ordinary least squares models. Finally, it should be noted that Cárdenas et al. (2023) implemented a statistical model to identify changes in the asking prices of properties after the announcement of the extension of the metro project of Bogotá. The latter, found that the sale prices of housing around the future stations of the

Bogotá Metro Line 1 project increased by 10.5% for flats and 6.5% for houses since the announcement of the award contract for its construction in October 2019, while the results for change in rental prices for the same area were not statistically significant (Cárdenas et al., 2023).

2.2 Light Rail Transit (LRT) systems and their effects on prices and the real estate market

Studies of cities and counties in the United States show mixed results regarding the relationship between light rail transportation investments and property values. Two cities in the state of Oregon examined these effects In Portland, a hedonic price model analysis of single-family housing sales in 1988 found an increase of US$663 for every 0.03 km closer to an LRT MAX station (Al-Mosaind et al., 1993), while another study looking at median home values found an increase of US$2,300 for properties within a distance of 0.06 km to a LRT MAX station (Dueker & Bianco, 1999). In Seattle, station-level LRT analysis of property values found positive associations for one station's catchment area and negative associations for the other two stations (Ransom, 2018). In Los Angeles County, California, an analysis of LRT impacts on land values found positive associations between proximity to the LRT system and commercial and multifamily housing uses (Cervero & Duncan, 2002).

In Buffalo, New York,, findings suggest increases in residential property prices of $3.0 for each meter closer to LRT stations, and a premium in property values between $1,300 and $3,000 for housing units located within a quarter mile of streetcar stations (Hess & Almeida, 2007). In New Jersey, residential properties suggest increases between 8.3% and 9.8% within the rail transit influence area, premiums for properties located near the stations experienced an average rate of 18.4% higher than properties without access to the rail-based system (Kim & Lahr, 2014). In Charlotte-Mecklenburg County (North Carolina, property prices per square foot decrease when properties are located further from LRT stations, during the project announcement, and after the system starts operating (Ke & Gkritza, 2019). The study of the METRORail system in Houston, Texas found positive associations with residential property values. These effects were observed in properties that are located within a distance of 3 miles from the METRORail system stations , because the study is on a regional scale, however, the strongest positive effect is observed in the first quarter mile from the stations (Pan, 2019).

Some studies carried out in European cities also found differing results. In Manchester, United Kingdom, outcomes from the hedonic pricing methodology suggest increases in house prices between 2.1% and 8.1% when properties are located closer to an LRT station (Forrest et al., 1996). However, the spatial statistical analysis of the impacts of the “Supertram” LRT project on house prices in Sheffield, United Kingdom, suggests negative associations during the construction period of the rail-based system and positive effects after the opening date (Dabinett, 1998).

In Latin America, quantitative and qualitative data papers yield mixed results regarding the implementation of LRT projects. In Cuenca, Ecuador, an analysis of residential and commercial uses proposes that residential rental prices decrease when properties are located near the LRT corridor, but the opposite association was found for commercial rental prices with increments when properties are closer to the LRT corridor (Hermida et al., 2018). (Freitas, 2017; Gutiérrez Torres, 2019). The analysis of the effects of the Ayacucho Tram system in Medellín on cadastral values determined effects of up to 4% (Vergel Tovar et al., 2023).

The literature on the effects of rail-based infrastructure on the urban spatial structure is extensive. In this review, we were able to summarize the studies by region focusing on

Metro and LRT systems. Most studies rely on hedonic price models, incorporating both property and location attributes. Few studies have included land-use planning variables as a control; it is desirable to continue adding this type of control given that urban regulations influence the type of outcomes on real estate prices and their dynamics.

3 Methodology

3.1 Study area

Our study area is the city of Bogotá and the influence area of the first and second lines of the metro project as shown in Figure 1. Bogotá is the capital of Colombia and has a total population of 7.929.539 inhabitants according to the projections of the National Statistics Department (DANE). Bogotá recently adopted a new Urban Master Plan (*Plan de Ordenamiento Territorial* POT in Spanish) in 2021, in which the urban regulations are promoting urban renewal measures along mass transit corridors, especially around the future metro stations (Bogotá, 2021). In 2023, the city approved the new Urban Mobility Plan (Plan de Movilidad Segura y Sostenible PMSS in Spanish), which defines the rail-based systems as the transportation system of higher hierarchy in the city (Bogotá, 2023).

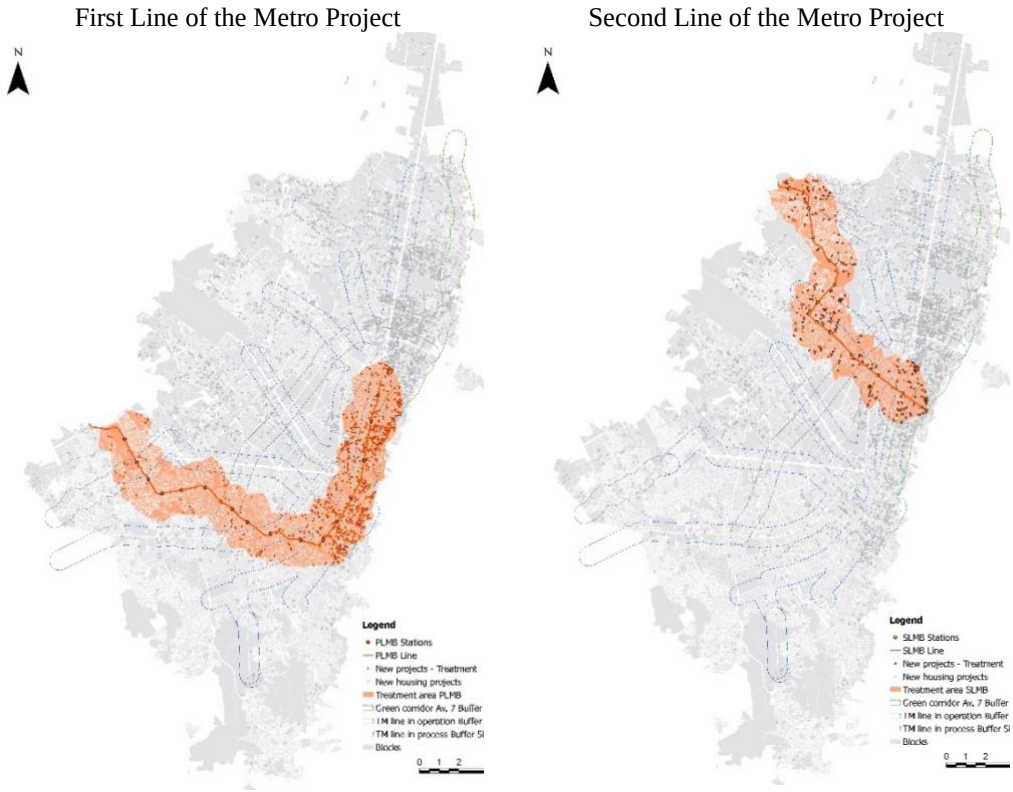


Figure 1. Isochrones metro project map – Lines 1 and 2
Sources: Own elaboration by geoprocessing Galería Inmobiliaria data bases and geodata bases from the City Planning Department and the Mobility Department of Bogota on ArcGIS (ESRI, 2024b)

3.2 Data

The main source of information is the database of the *Galería Inmobiliaria* (GI) agency, in particular new real estate projects in the city of Bogotá between 2002 and 2023. The database contains attributes about new housing projects such as address, neighborhood, start date of sales and construction and units built, likewise, it also includes characteristics of each housing unit, such as the number of bedrooms, bathrooms, parking spaces, built area and price. Additionally, using public data sources such as those provided by the EMB, it was possible to calculate the distance of each project to the layout and the closest station of the PLMB and the L2MB. We also defined isochrones using the walking distance to the future metro stations developed accessibility measures in line with the literature (Lahoorpoor & Levinson, 2020; O'Sullivan, Morrison, & Shearer, 2000). Likewise, databases from the City Planning Department and the Citizenship Safety Department were used to calculate attributes specific to the project and the sector, such as population density, distance to the park and nearest equipment, proportion of roads, and indices of homicides and robberies.

Along the same lines, the georeferencing of the projects also made it possible to identify those located within the isochrones of the future PLMB and L2MB stations. We identified 4 isochrones around the future stations of the two lines based on walking distances: 5-minute isochrone, 10-minute isochrone, 15-minute isochrone, and 20-minute isochrone, and those projects located within each of the isochrones. We processed the data through the STATA software and created treatment variables that contemplate four isochrones (Figure 2): we identified 4 treatment zones, corresponding to the projects located within each of the isochrones and the rest of the city is taken as control. It is important to highlight that the analyses differentiate between those projects in the areas of influence of the PLMB and those in the L2MB.

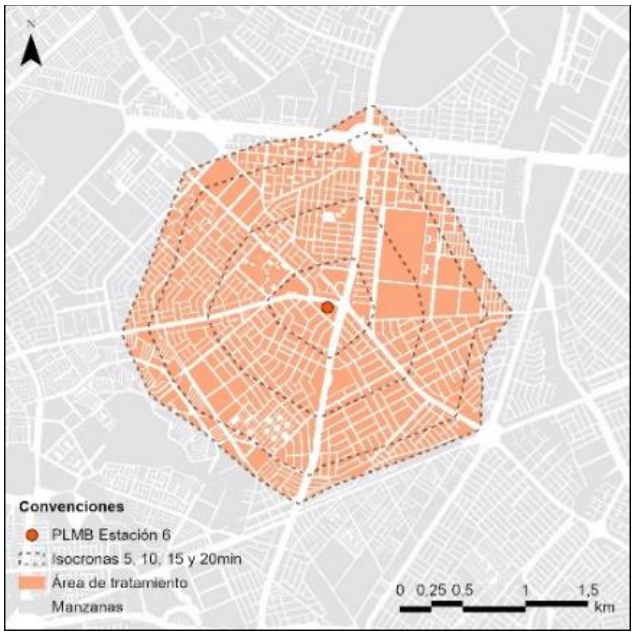


Figure 2. Isochrones and treatment areas.
Sources: Own elaboration by geoprocessing Metro Agency of Bogota data bases and geodata bases from the City Planning Department and the Mobility Department of Bogota on ArcGIS (ESRI, 2024b).

We also generated urban regulation variables as well as accessibility variables, such as the distance to the Central Business District located on Calle 72 and Carrera 7ª (Central Business District, CBD) and the nearest economic center. The GI data also included information about whether the housing unit is affordable housing (Social Housing or VIS due to its acronym on Spanish), market value (Non-Social-Housing) or Microapartment, small housing units that are new product in the real estate market. We also estimated urban attributes related to public facilities, road space and parks. Table 1 shows all the variables used in the models.

Table 1. List of variables included in the statistical analysis

Variable	Description	Level of measurement	Source
Ln Price psqmt	Natural logarithm of the average price per m2 of the housing unit	Housing unit (annual mean value)	Own calculation based on information from the GI
Rooms	Number of bedrooms from 1 to 4	Housing unit	GI
Housing typology	Categorical variable (Microapartment=1; Affordable housing=2, Market value housing unit =3)	Housing unit	GI
Socioeconomic level	Categorical variable that ranges from 1 to 6 depending on the socioeconomic level where the project is located	Real estate development project	GI
Ln population density	Natural logarithm of the number of people/hectares of the project location	Real estate development project	Own calculation based on information from DANE
Ln Distance to the nearest park	Natural logarithm of the Euclidean distance in meters from the project to the nearest park	Real estate development project	Own calculation based on information from the City Planning Department
Ln Distance to the nearest public facility	Natural logarithm of the Euclidean distance in meters from the project to the nearest facility	Real estate development project	Own calculation based on information from the City Planning Department
Ln Proportion of road space	Natural logarithm of the percentage of roads in the cadastral sector where the project is located	Real estate development project	Own calculation based on information from the City Mobility Planning
Ln Distance to the CBD	Natural logarithm of the Euclidean distance in meters from the project to the CBD	Real estate development project	Own calculation on GIS
Ln Distance to the nearest main activity node	Natural logarithm of the Euclidean distance in meters from the project to the nearest economic center	Real estate development project	Own calculation on GIS
Ln Distance to the PLMB line or the L2MB line	Natural logarithm of the Euclidean distance in meters from the project to the PLMB viaduct or the L2MB route	Real estate development project	Own calculation with data from the Metro Agency of Bogotá
Ln Homicide Rate	Natural logarithm of the number of homicides by locality	Yearly	Own calculation based on information from the City Security Planning

Ln Thefts rate	Natural logarithm of the number of thefts by location	Yearly	Own calculation based on information from the City Security Planning
Buffer 500mt BRT corridor	Dummy variable (BRT corridor =1; Otherwise =0)	Real estate development project	Own calculation
Buffer 500mt BRT corridor under construction	Dummy variable (BRT corridor under construction =1; Otherwise =0)	Real estate development project	Own calculation
Buffer 500mt 7th Street Corridor	Dummy variable (7th Street Corridor =1; Otherwise =0)	Real estate development project	Own calculation
Urban Renewal Partial Plan	Dummy variable (Urban renewal partial plan =1; Otherwise =0)	Real estate development project	Own calculation based on the Urban Master Plan
Development Partial Plan	Dummy variable (Urban development partial plan =1; Otherwise =0)	Real estate development project	Own calculation based on the Urban Master Plan

Sources: Own elaboration by geoprocessing Metro Agency of Bogota data bases, Galeria Inmobiliaria data bases, and geodata bases from the City Planning Department and the Mobility Department of Bogota.

3.3 Data analysis

3.3.1 Statistical analysis

We developed hedonic price models to estimate the anticipation effects of the metro project on new housing prices. For both scenarios we used logarithmic regressions models. The first regression or base model incorporates dummy variables by year, interaction variables between treatment and year, and thirteen variables that incorporate different attributes of the real estate development projects. The second model incorporates control variables for projects within partial plan areas (urban renewal or development), while the third model includes the variables that indicate whether the project is within the area of influence of the BRT corridors (under operation and under construction). The fourth model incorporates all the control variables. Regarding elements of endogeneity, the variables used are supported by the literature review regarding previous studies on the effects of mass transportation systems on the real estate market, while statistical validation tests were carried out. We included robust standard errors in all regressions and the logarithmic transformation of all models for the estimations allowed us to address heteroskedasticity. We also estimated the Variance Inflation Factor (VIF) to verify for multicollinearity (Aladwan & Ahamad, 2019), we found the VIF estimations in all models is less than 4, which implies a low correlation between the independent variables. Regarding the treatment and control groups, we performed parallel trend tests, which allowed us to establish that before 2015, prices in the treatment and control areas of the isochrones in the PLMB and L2MB showed parallel trends.

The quasi-experimental design allows the models to estimate the capitalization by real estate project developers of the future accessibility benefit that the metro project will generate, but in this case, through an analysis of the anticipation effects, identifying milestones of the metro project. Since the Real Estate Gallery database includes real

estate development projects throughout the city, the quasi-experimental design takes the rest of the city as a control area so that the statistical analysis can capture the real estate dynamics throughout the city during the study period. The statistical analysis consists of two hedonic models according to the research design used in previous studies (Agostini & Palmucci, 2008; Cárdenas et al., 2023; Mejia-Dorantes et al., 2011; Rosanovich & Di Giovambattista, 2019). These models consider the natural logarithm (ln) of the price per square meter (average for each year) of new housing project properties in the city from 2007 to 2023 as the dependent variable. Also, control variables with attributes of housing units, urban indicators, and crime, as well as information related to urban treatment areas, partial plans, and the influence area of BRT trunk corridors were also included.

The model estimates a quasi-experimental research design with a hedonic price model function having the four isochrones as the treatment area:

$$\ln(y_i) = \beta_0 + \sum_{j}^{15} \beta_j * X_{ij} + \vec{\beta}_{SES}\overrightarrow{SES_i} + \vec{\beta}_{Housing\ typology}\overrightarrow{Hopusing\ typology_i} + \vec{\beta}_{Bedrooms}\overrightarrow{Bedrooms_i} + \sum_{i}^{16} \alpha_i * Year_i + \sum_{i}^{17} \delta_i * Year_i * T_1 + \sum_{i}^{17} \delta_i * Year_i * T_2 + \sum_{i}^{17} \delta_i * Year_i * T_3 + \sum_{i}^{17} \delta_i * Year_i * T_4 + \varepsilon_i$$

Where:

$\ln(y_i) = Logarithm\ of\ price\ per\ sqmt\ housing\ unit\ i$
$\beta_0 = Intercept$
$\beta_j = Estimated\ coefficients\ associated\ with\ independent\ variables\ X_j\ of\ housing\ unit\ i$
$X_{ij} = j\ independen\ variables\ of\ housing\ unit\ i\ (table\ 1)$
$\beta_{SES} = Vector\ of\ estimated\ coefficients$
$\overrightarrow{SES_i} = Vector\ of\ six\ dummy\ variables\ (one\ as\ reference)\ with\ socioeconomic\ level\ of\ housing\ unit\ i$
$\beta_{Housing\ typology} = Vector\ of\ estimated\ coefficients$
$\overrightarrow{Housing\ typology_i} = Vector\ of\ three\ dummy\ variables\ (one\ as\ reference)\ with\ housing\ typology\ of\ housing\ unit\ i$
$\beta_{Bedrooms} = Vector\ of\ estimated\ coefficients$
$\overrightarrow{Bedrooms_i} = Vector\ of\ four\ dummy\ variables\ (one\ as\ reference)\ with\ number\ of\ bedrooms\ of\ housing\ unit\ i$
$\alpha_i = Estimated\ coefficient\ for\ effect\ of\ year\ i$
$Year_i = Dummy\ variables\ for\ years\ 2007\ to\ 2023$
$\delta_i = Estimated\ coeffcicient\ of\ treatment\ effect\ for\ year\ i$
$Year_i = Dummy\ variables\ for\ year\ i\ from\ 2006\ to\ 2023$
$T_1 = Dummy\ variable = 1\ if\ the\ project\ is\ located\ within\ the\ 5\ minutes\ walking\ distance\ isocrone\ from\ one\ future\ metro\ station$
$T_2 = Dummy\ variable = 1\ if\ the\ project\ is\ located\ within\ the\ 10\ minutes\ walking\ distance\ isocrone\ from\ one\ future\ metro\ station$
$T_3 = Dummy\ variable = 1\ \ if\ the\ project\ is\ located\ within\ the\ 15\ minutes\ walking\ distance\ isocrone\ from\ one\ future\ metro\ station$
$T_4 = Dummy\ variable = 1\ \ if\ the\ project\ is\ located\ within\ the\ 20\ minutes\ walking\ distance\ isocrone\ from\ one\ future\ metro\ station$

3.3.2 Spatial data analysis

Spatial data analysis addresses two components. The first consists of spatially analyzing the price variation trends based on the difference between the predicted and observed values of the average price per m2 of real estate development projects in the city to establish the relationship between the concentration of the supply of new housing and the layout of the PLMB and the L2MB. In this, on the one hand, a cluster analysis is carried out to identify the groupings made up of projects that share similar characteristics with their neighboring projects and, on the other hand, a kernel density analysis, to identify the concentration points. of projects weighted by the value of the difference between the predicted and observed values. The second consists of carrying out spatial regression analyzes with the variables used in the hedonic price models to complement the exercise considering elements of spatial autocorrelation. The spatial data analyzes are carried out in Geographic Information Systems GIS (ESRI, 2024b), taking the databases generated in STATA for the analysis of statistical models(STATA, 2024).

4 Results

4.1 First line of the metro project isochrone analysis (four treatment zones)

Table 2 presents the descriptive statistics of the real estate projects in the treatment area (isochrons) for the PLMB and in the control area (rest of the city) for the year we have as a baseline (2007), while table 3 presents the descriptive statistics for the year 2023. The data corresponds to the information provided by the GI with the registration of new projects in the city. In the descriptive statistics for the year 2007 (table 2), it is observed that the price per square meter variable (natural logarithm) in the treatment areas has similar values to those observed in the rest of the city, with a slightly lower value. for treatment zone 2. Regarding socioeconomic levels, a greater concentration of projects is observed in sectors of stratum 4 in the treatment zones with around 65% in the projects in zone 1 and 2, 58% in the zone 3 and 31% in zone 4. In the number of rooms in the housing units, a greater concentration of properties with 3 rooms is observed in the control zone (48.8%), while in the treatment zones there is a greater concentration of real estate projects of housing units with 1 and 2 bedrooms. A higher population density is observed in the treatment areas compared to the control area. Although real estate projects in the treatment areas have greater proximity to parks, real estate projects in the control zone have greater proximity to urban facilities. The crime data show similar values between the treatment and control areas, with slightly higher values in the control area. Regarding the typology of housing supply, it is observed that the Non-Social Housing typology is the one with the greatest presence in both the treatment and control areas. A greater concentration of projects in partial development plans is observed in the treatment areas compared to the control area.

In the descriptive statistics for the year 2023 (Table 3), an increase in the price per square meter variable (natural logarithm) is observed in relation to the year 2007, both for the projects in the treatment areas and those located in the control zone. In zone 1 an increase of 6.8% was recorded, in zone 2 of 7.4%, in zone 3 of 6.7% and in zone 4 of 4.6%, while in the control zone a growth was recorded. of 5.9%. Regarding socioeconomic levels, an increase in real estate projects is observed for the treatment zones in stratum 3 in relation to 2007, going from 10.6% to 55.7% in zone 1, from 23.6% to 56.1% in zone 2, from 13.7% to 23.2% in zone 3 and from 4.0% to 20.8% in zone 4. Although there is an increase in one-bedroom real estate projects for 2023 in relation to 2007, this change is greater for the zones of treatment areas, that is, the supply of one-bedroom housing units increased mainly in the treatment areas by 2023. The supply of micro apartments increases in the city; however, this increase is greater in the treatment areas. Likewise, a slight increase in real estate projects is observed in partial urban renewal plans for two of the four treatment zones (isochrones).

Table 2. Descriptive statistics isochrone analysis year 2007 – PLMB

	Year 2007																			
	Treatment 1 (N=47)				Treatment 2 (N=157)				Treatment 3 (N=431)				Treatment 4 (N=225)				Control (N=6,227)			
Variable	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**
Dependent variables																				
Log. Price per sqmt	14.238	0.674	12.78	15.08	14.062	0.602	12.12	14.98	14.304	0.542	12.30	15.48	14.634	0.522	12.91	16.03	14.260	0.633	10.27	15.53
Log. Distance to PLMB viaduct	5.168	0.382	4.04	5.72	5.610	0.738	3.58	6.72	6.648	0.390	5.17	7.18	6.930	0.216	6.49	7.25	8.316	0.600	6.73	9.59
Log. Distance to CBD. 72	8.419	0.539	7.97	9.51	8.225	0.722	6.95	9.57	7.518	0.831	5.94	9.58	7.224	0.890	6.09	9.47	8.628	0.572	6.36	9.80
Log. Distance to nearest activity center	7.694	0.429	6.90	8.13	7.645	0.455	5.55	8.20	7.533	0.685	4.80	8.22	7.158	0.641	5.89	8.20	8.272	0.662	4.30	9.59
One	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00
Two	0.149	0.360	0.00	1.00	0.146	0.355	0.00	1.00	0.053	0.225	0.00	1.00	0.027	0.161	0.00	1.00	0.041	0.199	0.00	1.00
Three	0.106	0.312	0.00	1.00	0.236	0.426	0.00	1.00	0.137	0.344	0.00	1.00	0.040	0.196	0.00	1.00	0.138	0.345	0.00	1.00
Four	0.745	0.441	0.00	1.00	0.618	0.487	0.00	1.00	0.580	0.494	0.00	1.00	0.316	0.466	0.00	1.00	0.248	0.432	0.00	1.00
Five	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.111	0.315	0.00	1.00	0.307	0.462	0.00	1.00	0.237	0.425	0.00	1.00
Six	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.118	0.323	0.00	1.00	0.311	0.464	0.00	1.00	0.336	0.472	0.00	1.00
Bedrooms																				
One	0.213	0.414	0.00	1.00	0.191	0.394	0.00	1.00	0.202	0.402	0.00	1.00	0.191	0.394	0.00	1.00	0.094	0.292	0.00	1.00
Two	0.404	0.496	0.00	1.00	0.338	0.474	0.00	1.00	0.325	0.469	0.00	1.00	0.244	0.431	0.00	1.00	0.234	0.423	0.00	1.00
Three	0.362	0.486	0.00	1.00	0.446	0.499	0.00	1.00	0.436	0.496	0.00	1.00	0.533	0.500	0.00	1.00	0.609	0.488	0.00	1.00
Four	0.021	0.146	0.00	1.00	0.025	0.158	0.00	1.00	0.037	0.189	0.00	1.00	0.031	0.174	0.00	1.00	0.063	0.243	0.00	1.00
Bathrooms	1.706	0.544	1.00	3.00	1.819	0.680	1.00	4.00	2.232	0.896	1.00	5.00	2.621	0.896	1.00	5.00	2.559	0.967	1.00	6.00
Neighborhoods attributes																				
Log. Population density	5.030	2.354	0.00	6.48	4.985	2.091	0.00	7.14	5.327	1.757	0.00	7.62	5.107	1.763	0.00	7.13	4.776	2.209	0.00	7.50
Log. Distance to nearest park	4.380	0.853	2.54	5.82	4.148	1.364	-1.27	5.77	4.209	0.994	-0.45	5.92	3.367	1.097	-3.50	5.83	3.810	1.392	-6.81	5.93
Log. Distance to nearest equipment	3.685	0.246	2.70	4.21	3.653	1.338	-3.11	5.90	3.893	0.904	1.22	5.70	4.289	0.803	2.38	5.46	4.428	0.881	0.58	7.06
Roads Index / Ratio	-1.190	0.492	-1.67	-0.44	-1.615	0.312	-2.48	-0.44	-1.811	0.402	-2.68	-0.80	-1.739	0.355	-2.38	-1.31	-1.971	0.463	-4.73	1.37
Crime																				
Log. Homicides	3.640	0.974	2.83	5.40	3.497	0.934	0.69	5.40	2.914	0.782	0.69	5.40	3.080	0.601	2.83	5.40	4.013	0.663	2.83	5.40
Log. Thefts	6.941	0.311	6.41	7.21	6.670	0.556	5.04	7.21	6.847	0.616	5.04	7.21	6.974	0.421	5.91	7.21	7.137	0.399	4.99	7.39

(Table continues on the next page)

	Year 2007																			
	Treatment 1 (N=47)				Treatment 2 (N=157)				Treatment 3 (N=431)				Treatment 4 (N=225)				Control (N=6,227)			
Variable	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**
Type of housing																				
Micro-apartments	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00
Affordable housing	0.106	0.312	0.00	1.00	0.096	0.295	0.00	1.00	0.039	0.195	0.00	1.00	0.009	0.094	0.00	1.00	0.055	0.227	0.00	1.00
Market housing	0.894	0.312	0.00	1.00	0.904	0.295	0.00	1.00	0.961	0.195	0.00	1.00	0.991	0.094	0.00	1.00	0.945	0.227	0.00	1.00
Small Area Plans																				
Urban renewal	0.000	0.000	0.00	0.00	0.006	0.080	0.00	1.00	0.002	0.048	0.00	1.00	0.000	0.000	0.00	0.00	0.011	0.102	0.00	1.00
Urban development	0.277	0.452	0.00	1.00	0.000	0.000	0.00	0.00	0.019	0.135	0.00	1.00	0.000	0.000	0.00	0.00	0.004	0.063	0.00	1.00
BRT																				
Buffer 500-meter built trunk	0.957	0.204	0.00	1.00	0.682	0.467	0.00	1.00	0.348	0.477	0.00	1.00	0.453	0.499	0.00	1.00	0.298	0.457	0.00	1.00
Buffer 500-meter trunk under construction	0.128	0.337	0.00	1.00	0.057	0.233	0.00	1.00	0.030	0.171	0.00	1.00	0.000	0.000	0.00	0.00	0.124	0.330	0.00	1.00
Buffer 500-meter Carrera Séptima Corridor	0.532	0.504	0.00	1.00	0.497	0.502	0.00	1.00	0.561	0.497	0.00	1.00	0.449	0.498	0.00	1.00	0.175	0.380	0.00	1.00

Table 3. Descriptive statistics isochrone analysis year 2023 – PLMB

	Year 2023																			
	Treatment 1 (N=221)				Treatment 2 (N=649)				Treatment 3 (N=1,712)				Treatment 4 (N=770)				Control (N=18,990)			
Variable	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**
Dependent variables																				
Log. Price per sqmt	15.213	0.663	12.90	16.17	15.115	0.760	12.83	16.34	15.265	0.677	12.63	16.83	15.319	0.698	13.02	16.70	15.105	0.700	10.27	17.13
Log. Distance to PLMB viaduct	4.428	1.004	2.85	5.88	5.702	0.888	2.96	6.75	6.558	0.551	3.09	7.25	6.885	0.239	6.49	7.34	8.309	0.588	4.54	9.76
Log. Distance to CBD. 72	7.843	0.777	6.70	9.51	8.038	0.874	5.54	9.57	7.729	0.784	5.89	9.58	7.748	0.930	6.09	9.57	8.644	0.540	6.34	9.87
Log. Distance to nearest activity center	7.648	0.463	5.80	8.15	7.482	0.531	5.55	8.24	7.534	0.652	4.80	8.27	7.126	0.683	5.89	8.26	8.285	0.628	4.30	9.75
Socioeconomic level																				
One	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.019	0.00	1.00
Two	0.068	0.252	0.00	1.00	0.074	0.262	0.00	1.00	0.046	0.209	0.00	1.00	0.087	0.282	0.00	1.00	0.046	0.209	0.00	1.00
Three	0.557	0.498	0.00	1.00	0.561	0.497	0.00	1.00	0.232	0.422	0.00	1.00	0.208	0.406	0.00	1.00	0.158	0.364	0.00	1.00
Four	0.376	0.485	0.00	1.00	0.331	0.471	0.00	1.00	0.513	0.500	0.00	1.00	0.225	0.418	0.00	1.00	0.235	0.424	0.00	1.00
Five	0.000	0.000	0.00	0.00	0.015	0.123	0.00	1.00	0.131	0.337	0.00	1.00	0.340	0.474	0.00	1.00	0.256	0.436	0.00	1.00
Six	0.000	0.000	0.00	0.00	0.018	0.135	0.00	1.00	0.079	0.270	0.00	1.00	0.140	0.347	0.00	1.00	0.306	0.461	0.00	1.00
Bedrooms																				
One	0.520	0.501	0.00	1.00	0.431	0.496	0.00	1.00	0.397	0.489	0.00	1.00	0.290	0.454	0.00	1.00	0.192	0.394	0.00	1.00
Two	0.303	0.461	0.00	1.00	0.293	0.455	0.00	1.00	0.324	0.468	0.00	1.00	0.291	0.454	0.00	1.00	0.291	0.454	0.00	1.00
Three	0.172	0.378	0.00	1.00	0.270	0.444	0.00	1.00	0.265	0.441	0.00	1.00	0.403	0.491	0.00	1.00	0.488	0.500	0.00	1.00
Four	0.005	0.067	0.00	1.00	0.006	0.078	0.00	1.00	0.014	0.118	0.00	1.00	0.017	0.129	0.00	1.00	0.029	0.168	0.00	1.00
Bathrooms	1.462	0.567	1.00	3.00	1.627	0.706	1.00	5.00	1.984	0.860	0.00	6.00	2.342	1.108	1.00	7.00	2.407	0.969	0.00	8.00
Log. Population density	4.328	2.042	0.00	7.09	4.827	1.926	0.00	7.14	5.000	1.717	0.00	7.62	5.022	1.778	0.00	7.38	4.661	2.184	-3.73	7.50
Log. Distance to nearest park	4.671	0.636	2.54	5.82	4.409	1.086	-1.27	6.25	4.434	0.908	-0.45	5.92	3.584	1.616	-3.53	6.15	3.983	1.271	-6.81	6.39
Log. Distance to nearest equipment	3.676	0.678	0.59	5.30	3.898	0.962	-3.11	5.90	3.790	0.882	1.03	5.70	4.191	0.905	0.86	5.86	4.358	0.928	-1.67	7.16
Roads Index / Ratio	-1.526	0.353	-2.10	-0.44	-1.664	0.332	-2.48	-0.02	-1.744	0.383	-2.80	-0.80	-1.807	0.339	-2.68	-0.36	-1.960	0.458	-5.12	1.37
Crime																				
Log. Homicides	2.626	0.816	2.08	4.77	2.912	0.867	1.10	4.77	2.499	0.739	1.10	4.77	2.585	0.850	1.10	4.77	3.266	0.680	1.10	4.93
Log. Thefts	8.914	0.265	7.71	9.39	8.811	0.368	6.63	9.39	8.813	0.505	6.63	9.39	8.832	0.472	6.63	9.39	8.968	0.338	6.63	9.45

(Table continues on the next page)

	Year 2023																			
	Treatment 1 (N=221)				Treatment 2 (N=649)				Treatment 3 (N=1,712)				Treatment 4 (N=770)				Control (N=18,990)			
Variable	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**
Type of housing																				
Micro-apartments	0.054	0.227	0.00	1.00	0.032	0.177	0.00	1.00	0.020	0.140	0.00	1.00	0.025	0.155	0.00	1.00	0.002	0.047	0.00	1.00
Affordable housing	0.163	0.370	0.00	1.00	0.096	0.294	0.00	1.00	0.053	0.224	0.00	1.00	0.081	0.272	0.00	1.00	0.079	0.270	0.00	1.00
Market housing	0.783	0.413	0.00	1.00	0.872	0.334	0.00	1.00	0.927	0.260	0.00	1.00	0.895	0.307	0.00	1.00	0.918	0.274	0.00	1.00
Small Area Plans																				
Urban renewal	0.000	0.000	0.00	0.00	0.002	0.039	0.00	1.00	0.001	0.034	0.00	1.00	0.000	0.000	0.00	0.00	0.018	0.131	0.00	1.00
Urban development	0.122	0.328	0.00	1.00	0.002	0.039	0.00	1.00	0.018	0.133	0.00	1.00	0.000	0.000	0.00	0.00	0.006	0.078	0.00	1.00
BRT																				
Buffer 500-meter built trunk	0.964	0.187	0.00	1.00	0.710	0.454	0.00	1.00	0.502	0.500	0.00	1.00	0.548	0.498	0.00	1.00	0.289	0.453	0.00	1.00
Buffer 500-meter trunk under construction	0.036	0.187	0.00	1.00	0.037	0.189	0.00	1.00	0.009	0.093	0.00	1.00	0.023	0.151	0.00	1.00	0.123	0.329	0.00	1.00
Buffer 500-meter Carrera Séptima Corridor	0.579	0.495	0.00	1.00	0.342	0.475	0.00	1.00	0.457	0.498	0.00	1.00	0.204	0.403	0.00	1.00	0.149	0.357	0.00	1.00

Table 4 presents the results of the hedonic price models on the anticipation effects of the PLMB on the prices per square meter of real estate projects between 2007 and 2023 with 4 treatment zones: (i) projects within the isochrone of 5 minutes of the stations, (ii) 10-minute isochrons, (iii) 15-minute isochrons and (iv) 20-minute isochronous. In the base model, for the first isochron, positive effects are observed between 16.6% for 2017 and 13% for 2023, for the second isochron, positive effects of 4.2% are observed only for the year 2022, for the third isochron, effects are observed positive effects of 3.4% for 2022 and 3.7% for 2023, and for the fourth and last isochron, positive effects of 9.1% in 2021, 7.2% in 2022 and 8.3% in 2023 are observed. These anticipation effects are similar in the other three models. These findings suggest that proximity to future stations is being capitalized by the private sector, especially in the first areas of influence of future stations. Figure 3 shows how the effects begin to converge between 2021 and 2023, which suggests that the anticipation effects may be promoting a reconfiguration of the urban spatial structure, by becoming possible future nodes or areas of greater activity in the city.

Table 4. Hedonic price model of the anticipation effects of the future PLMB on real estate development prices between 2007 and 2023 in isochrone analysis (N=278,393).

	Base Model			**Model 2 (Partial Plans)**			**Model 3 (BRT buffer 500mts)**			**Model 4 (Partial Plans & BRT buffer 500mts)**		
	Dependent variable:			**Dependent variable:**			**Dependent variable:**			**Dependent variable:**		
	Ln. Price per square meter			**Ln. Price per square meter**			**Ln. Price per square meter**			**Ln. Price per square meter**		
Year												
2007	0.001		-0.009	0.000		-0.009	0.001		-0.009	0.000		-0.009
2008	0.135	***	-0.008	0.134	***	-0.008	0.135	***	-0.008	0.134	***	-0.008
2009	0.203	***	-0.008	0.203	***	-0.008	0.203	***	-0.008	0.203	***	-0.008
2010	0.268	***	-0.008	0.268	***	-0.008	0.269	***	-0.008	0.268	***	-0.008
2011	0.328	***	-0.008	0.327	***	-0.008	0.329	***	-0.008	0.327	***	-0.008
2012	0.385	***	-0.008	0.383	***	-0.008	0.385	***	-0.008	0.384	***	-0.008
2013	0.462	***	-0.008	0.460	***	-0.008	0.463	***	-0.008	0.461	***	-0.008
2014	0.516	***	-0.008	0.514	***	-0.008	0.517	***	-0.008	0.515	***	-0.008
2015	0.553	***	-0.008	0.550	***	-0.008	0.553	***	-0.008	0.551	***	-0.008
2016	0.649	***	-0.009	0.646	***	-0.009	0.650	***	-0.009	0.647	***	-0.009
2017	0.705	***	-0.010	0.701	***	-0.010	0.706	***	-0.010	0.702	***	-0.010
2018	0.745	***	-0.011	0.739	***	-0.011	0.746	***	-0.011	0.741	***	-0.011
2019	0.778	***	-0.012	0.772	***	-0.012	0.779	***	-0.012	0.774	***	-0.012
2020	0.787	***	-0.010	0.783	***	-0.010	0.788	***	-0.010	0.784	***	-0.010
2021	0.821	***	-0.011	0.815	***	-0.011	0.822	***	-0.011	0.817	***	-0.011
2022	0.858	***	-0.012	0.852	***	-0.012	0.859	***	-0.012	0.854	***	-0.012
2023	0.856	***	-0.011	0.850	***	-0.011	0.857	***	-0.011	0.852	***	-0.011

(Table continues on the next page)

	Base Model			Model 2 (Partial Plans)			Model 3 (BRT buffer 500mts)			Model 4 (Partial Plans & BRT buffer 500mts)		
	Dependent variable:			Dependent variable:			Dependent variable:			Dependent variable:		
	Ln. Price per square meter			Ln. Price per square meter			Ln. Price per square meter			Ln. Price per square meter		
Interaction isochrone 5min * year												
2006*isochrone 5min PLMB	-0.252	***	-0.041	-0.277	***	-0.042	-0.258	***	-0.041	-0.283	***	-0.043
2007*isochrone 5min PLMB	0.081		-0.072	0.039		-0.076	0.074		-0.072	0.032		-0.076
2008*isochrone 5min PLMB	-0.009		-0.059	-0.045		-0.059	-0.016		-0.059	-0.053		-0.059
2009*isochrone 5min PLMB	0.054		-0.041	0.014		-0.044	0.046		-0.041	0.006		-0.043
2010*isochrone 5min PLMB	-0.026		-0.075	-0.063		-0.076	-0.034		-0.075	-0.071		-0.076
2011*isochrone 5min PLMB	-0.065		-0.043	-0.102	**	-0.044	-0.072	*	-0.043	-0.109	**	-0.044
2012*isochrone 5min PLMB	-0.105	**	-0.041	-0.142	***	-0.043	-0.112	***	-0.041	-0.149	***	-0.043
2013*isochrone 5min PLMB	-0.324	***	-0.053	-0.353	***	-0.053	-0.330	***	-0.053	-0.360	***	-0.053
2014*isochrone 5min PLMB	-0.065	*	-0.040	-0.092	**	-0.041	-0.072	*	-0.040	-0.099	**	-0.041
2015*isochrone 5min PLMB	-0.224	***	-0.046	-0.252	***	-0.047	-0.232	***	-0.046	-0.259	***	-0.047
2016*isochrone 5min PLMB	0.051		-0.040	0.028		-0.041	0.044		-0.040	0.021		-0.041
2017*isochrone 5min PLMB	0.166	***	-0.038	0.144	***	-0.039	0.158	***	-0.038	0.137	***	-0.039
2018*isochrone 5min PLMB	0.157	***	-0.038	0.136	***	-0.039	0.149	***	-0.038	0.128	***	-0.039
2019*isochrone 5min PLMB	0.147	***	-0.038	0.126	***	-0.039	0.139	***	-0.038	0.118	***	-0.039
2020*isochrone 5min PLMB	0.112	***	-0.036	0.092	**	-0.037	0.104	***	-0.036	0.084	**	-0.037
2021*isochrone 5min PLMB	0.119	***	-0.035	0.101	***	-0.036	0.111	***	-0.035	0.093	***	-0.036
2022*isochrone 5min PLMB	0.136	***	-0.033	0.120	***	-0.034	0.128	***	-0.033	0.112	***	-0.034
2023*isochrone 5min PLMB	0.137	***	-0.033	0.120	***	-0.034	0.129	***	-0.033	0.113	***	-0.034

(Table continues on the next page)

	Base Model			Model 2 (Partial Plans)			Model 3 (BRT buffer 500mts)			Model 4 (Partial Plans & BRT buffer 500mts)		
	Dependent variable:			Dependent variable:			Dependent variable:			Dependent variable:		
	Ln. Price per square meter			Ln. Price per square meter			Ln. Price per square meter			Ln. Price per square meter		
Interaction isochrone 10min * year												
2006*isochrone 10min PLMB	-0.083	***	-0.021	-0.082	***	-0.021	-0.088	***	-0.021	-0.088	***	-0.021
2007*isochrone 10min PLMB	-0.111	***	-0.032	-0.109	***	-0.032	-0.116	***	-0.032	-0.115	***	-0.032
2008*isochrone 10min PLMB	-0.204	***	-0.029	-0.203	***	-0.029	-0.210	***	-0.029	-0.209	***	-0.029
2009*isochrone 10min PLMB	-0.159	***	-0.022	-0.158	***	-0.022	-0.165	***	-0.022	-0.164	***	-0.022
2010*isochrone 10min PLMB	-0.141	***	-0.024	-0.138	***	-0.024	-0.147	***	-0.024	-0.144	***	-0.024
2011*isochrone 10min PLMB	-0.177	***	-0.023	-0.176	***	-0.023	-0.183	***	-0.023	-0.182	***	-0.023
2012*isochrone 10min PLMB	-0.266	***	-0.026	-0.266	***	-0.026	-0.272	***	-0.026	-0.272	***	-0.026
2013*isochrone 10min PLMB	-0.167	***	-0.024	-0.166	***	-0.024	-0.173	***	-0.024	-0.172	***	-0.024
2014*isochrone 10min PLMB	-0.187	***	-0.024	-0.186	***	-0.024	-0.193	***	-0.024	-0.192	***	-0.024
2015*isochrone 10min PLMB	-0.151	***	-0.025	-0.150	***	-0.025	-0.157	***	-0.025	-0.156	***	-0.025
2016*isochrone 10min PLMB	-0.128	***	-0.026	-0.127	***	-0.026	-0.134	***	-0.026	-0.133	***	-0.026
2017*isochrone 10min PLMB	-0.081	***	-0.025	-0.083	***	-0.025	-0.087	***	-0.025	-0.089	***	-0.025
2018*isochrone 10min PLMB	-0.060	**	-0.025	-0.062	**	-0.025	-0.066	***	-0.025	-0.068	***	-0.025
2019*isochrone 10min PLMB	-0.020		-0.024	-0.022		-0.024	-0.026		-0.024	-0.027		-0.024
2020*isochrone 10min PLMB	-0.008		-0.024	-0.009		-0.024	-0.013		-0.024	-0.015		-0.024
2021*isochrone 10min PLMB	0.023		-0.023	0.023		-0.023	0.017		-0.023	0.017		-0.023
2022*isochrone 10min PLMB	0.042	*	-0.023	0.042	*	-0.023	0.036		-0.023	0.036		-0.023
2023*isochrone 10min PLMB	0.038		-0.023	0.038		-0.023	0.032		-0.023	0.032		-0.023

(Table continues on next page)

	Base Model			Model 2 (Partial Plans)			Model 3 (BRT buffer 500mts)			Model 4 (Partial Plans & BRT buffer 500mts)		
	Dependent variable: Ln. Price per square meter			Dependent variable: Ln. Price per square meter			Dependent variable: Ln. Price per square meter			Dependent variable: Ln. Price per square meter		
Interaction isochrone 15min * year												
2006*isochrone 15min PLMB	-0.150	***	-0.025	-0.153	***	-0.025	-0.154	***	-0.025	-0.156	***	-0.025
2007*isochrone 15min PLMB	-0.071	***	-0.020	-0.073	***	-0.020	-0.074	***	-0.020	-0.077	***	-0.020
2008*isochrone 15min PLMB	-0.165	***	-0.019	-0.167	***	-0.019	-0.168	***	-0.019	-0.170	***	-0.019
2009*isochrone 15min PLMB	-0.053	***	-0.016	-0.054	***	-0.016	-0.056	***	-0.016	-0.057	***	-0.016
2010*isochrone 15min PLMB	-0.037	**	-0.018	-0.036	**	-0.018	-0.040	**	-0.018	-0.040	**	-0.018
2011*isochrone 15min PLMB	-0.023		-0.015	-0.024		-0.015	-0.026	*	-0.015	-0.028	*	-0.015
2012*isochrone 15min PLMB	-0.082	***	-0.016	-0.084	***	-0.017	-0.085	***	-0.017	-0.088	***	-0.017
2013*isochrone 15min PLMB	-0.095	***	-0.016	-0.098	***	-0.016	-0.098	***	-0.016	-0.102	***	-0.016
2014*isochrone 15min PLMB	-0.090	***	-0.016	-0.094	***	-0.016	-0.094	***	-0.016	-0.098	***	-0.016
2015*isochrone 15min PLMB	-0.148	***	-0.017	-0.152	***	-0.017	-0.151	***	-0.017	-0.155	***	-0.017
2016*isochrone 15min PLMB	-0.057	***	-0.016	-0.061	***	-0.016	-0.062	***	-0.016	-0.065	***	-0.016
2017*isochrone 15min PLMB	-0.022		-0.016	-0.025		-0.016	-0.026	*	-0.016	-0.030	*	-0.016
2018*isochrone 15min PLMB	-0.010		-0.016	-0.014		-0.016	-0.014		-0.016	-0.018		-0.016
2019*isochrone 15min PLMB	0.024		-0.016	0.020		-0.016	0.020		-0.016	0.016		-0.016
2020*isochrone 15min PLMB	0.012		-0.016	0.008		-0.016	0.007		-0.016	0.003		-0.016
2021*isochrone 15min PLMB	0.017		-0.015	0.014		-0.015	0.012		-0.016	0.009		-0.016
2022*isochrone 15min PLMB	0.034	**	-0.016	0.031	**	-0.016	0.029	*	-0.016	0.027	*	-0.016
2023*isochrone 15min PLMB	0.037	**	-0.016	0.034	**	-0.016	0.032	**	-0.016	0.029	*	-0.016

(Table continues on the next page)

	Base Model			Model 2 (Partial Plans)			Model 3 (BRT buffer 500mts)			Model 4 (Partial Plans & BRT buffer 500mts)		
	Dependent variable:			Dependent variable:			Dependent variable:			Dependent variable:		
	Ln. Price per square meter			Ln. Price per square meter			Ln. Price per square meter			Ln. Price per square meter		
Interaction isochrone 20min * year												
2006*isochrone 20min PLMB	-0.314	***	-0.056	-0.313	***	-0.056	-0.319	***	-0.056	-0.317	***	-0.056
2007*isochrone 20min PLMB	0.099	***	-0.028	0.101	***	-0.028	0.094	***	-0.029	0.096	***	-0.028
2008*isochrone 20min PLMB	0.039		-0.026	0.040		-0.026	0.034		-0.026	0.036		-0.026
2009*isochrone 20min PLMB	0.069	***	-0.020	0.071	***	-0.020	0.064	***	-0.020	0.067	***	-0.020
2010*isochrone 20min PLMB	0.074	***	-0.021	0.078	***	-0.021	0.069	***	-0.021	0.074	***	-0.021
2011*isochrone 20min PLMB	0.031	*	-0.018	0.033	*	-0.018	0.027		-0.018	0.029		-0.018
2012*isochrone 20min PLMB	-0.021		-0.020	-0.019		-0.019	-0.025		-0.020	-0.022		-0.020
2013*isochrone 20min PLMB	-0.063	***	-0.019	-0.061	***	-0.019	-0.067	***	-0.019	-0.065	***	-0.019
2014*isochrone 20min PLMB	-0.044	**	-0.021	-0.043	**	-0.021	-0.048	**	-0.021	-0.046	**	-0.021
2015*isochrone 20min PLMB	-0.052	**	-0.022	-0.049	**	-0.022	-0.055	**	-0.022	-0.053	**	-0.022
2016*isochrone 20min PLMB	-0.039	*	-0.023	-0.037		-0.023	-0.043	*	-0.023	-0.040	*	-0.023
2017*isochrone 20min PLMB	-0.018		-0.023	-0.016		-0.023	-0.022		-0.023	-0.019		-0.023
2018*isochrone 20min PLMB	-0.003		-0.022	-0.001		-0.023	-0.007		-0.023	-0.004		-0.023
2019*isochrone 20min PLMB	0.016		-0.022	0.019		-0.022	0.012		-0.022	0.016		-0.022
2020*isochrone 20min PLMB	0.016		-0.022	0.018		-0.022	0.012		-0.022	0.015		-0.022
2021*isochrone 20min PLMB	0.091	***	-0.022	0.095	***	-0.022	0.087	***	-0.022	0.091	***	-0.022
2022*isochrone 20min PLMB	0.072	***	-0.021	0.076	***	-0.022	0.068	***	-0.021	0.073	***	-0.022
2023*isochrone 20min PLMB	0.083	***	-0.022	0.087	***	-0.022	0.079	***	-0.022	0.083	***	-0.022

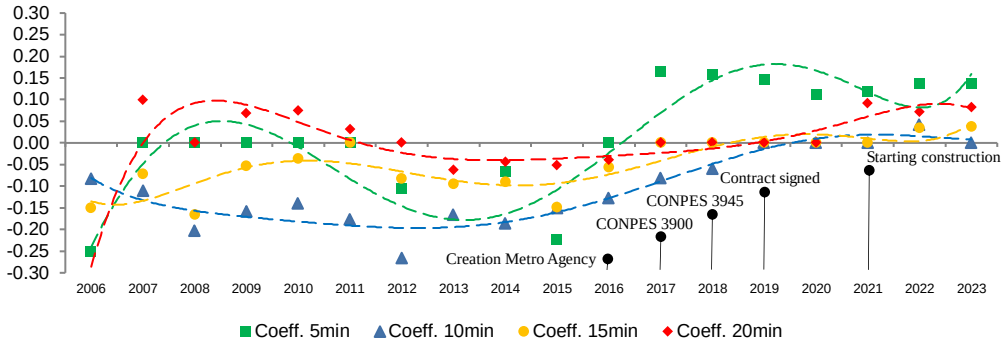
(Table continues on the next page)

	Base Model			Model 2 (Partial Plans)			Model 3 (BRT buffer 500mts)			Model 4 (Partial Plans & BRT buffer 500mts)		
	Dependent variable: Ln. Price per square meter			Dependent variable: Ln. Price per square meter			Dependent variable: Ln. Price per square meter			Dependent variable: Ln. Price per square meter		
Bedrooms												
1	0.833	***	-0.007	0.834	***	-0.007	0.833	***	-0.007	0.834	***	-0.007
2	0.563	***	-0.006	0.563	***	-0.006	0.563	***	-0.006	0.564	***	-0.006
3	0.338	***	-0.006	0.338	***	-0.006	0.338	***	-0.006	0.339	***	-0.006
Bathrooms	0.187	***	-0.002	0.186	***	-0.002	0.187	***	-0.002	0.186	***	-0.002
Housing type												
Market housing (reference)												
Micro-apartments	0.523	***	-0.010	0.524	***	-0.010	0.522	***	-0.010	0.523	***	-0.010
Affordable housing	-0.199	***	-0.005	-0.200	***	-0.005	-0.198	***	-0.005	-0.199	***	-0.005
Socioeconomic Level *(1 reference)*												
2	-0.886	***	-0.028	-0.889	***	-0.028	-0.885	***	-0.028	-0.888	***	-0.028
3	-0.419	***	-0.028	-0.423	***	-0.028	-0.420	***	-0.028	-0.423	***	-0.028
4	-0.239	***	-0.029	-0.245	***	-0.029	-0.240	***	-0.029	-0.245	***	-0.029
5	-0.125	***	-0.029	-0.128	***	-0.029	-0.128	***	-0.029	-0.131	***	-0.029
6	-0.028		-0.029	-0.031		-0.029	-0.026		-0.029	-0.029		-0.029
Neighborhood attributes												
Log. Population density	-0.006	***	0.000	-0.006	***	0.000	-0.006	***	0.000	-0.006	***	0.000
Log. Distance to nearest park	0.015	***	-0.001	0.015	***	-0.001	0.015	***	-0.001	0.015	***	-0.001
Log. Distance to nearest equipment	-0.013	***	-0.001	-0.013	***	-0.001	-0.013	***	-0.001	-0.013	***	-0.001
Roads Index	-0.018	***	-0.002	-0.017	***	-0.002	-0.018	***	-0.002	-0.016	***	-0.002

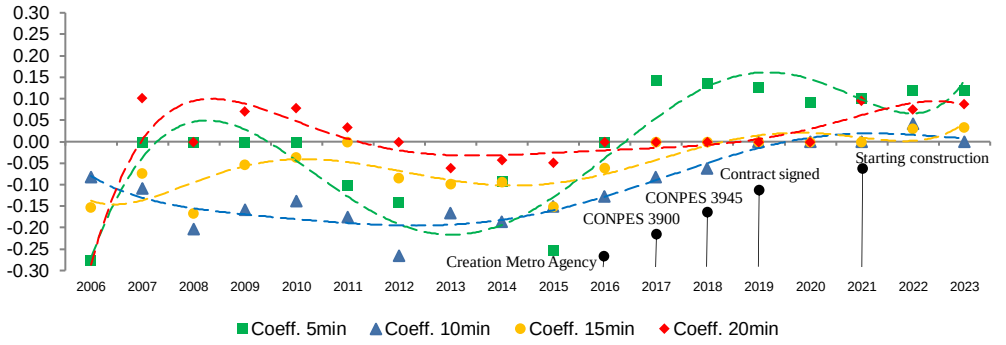
(Table continues on the next page)

	Base Model			Model 2 (Partial Plans)			Model 3 (BRT buffer 500mts)			Model 4 (Partial Plans & BRT buffer 500mts)		
	Dependent variable:			Dependent variable:			Dependent variable:			Dependent variable:		
	Ln. Price per square meter			Ln. Price per square meter			Ln. Price per square meter			Ln. Price per square meter		
Location												
Log. Distance to CBD.72	-0.038	***	-0.003	-0.039	***	-0.003	-0.039	***	-0.003	-0.040	***	-0.003
Log. Distance to nearest activity center	-0.049	***	-0.003	-0.046	***	-0.003	-0.050	***	-0.003	-0.047	***	-0.003
Log. Distance to PLMB viaduct	-0.020	***	-0.003	-0.020	***	-0.003	-0.019	***	-0.003	-0.019	***	-0.003
Crime												
Log. Homicides	-0.027	***	-0.002	-0.029	***	-0.002	-0.027	***	-0.002	-0.028	***	-0.002
Log. Thefts	-0.033	***	-0.004	-0.031	***	-0.004	-0.034	***	-0.004	-0.032	***	-0.004
BRT												
Buffer 500mts built trunk							0.012	***	-0.002	0.012	***	-0.002
Buffer 500mts trunk under construction							-0.019	***	-0.003	-0.017	***	-0.003
Buffer 500mts Carrera Séptima Corridor							0.003		-0.003	0.006	**	-0.003
Partial Plans												
Urban Renewal				0.064	***	-0.010				0.063	***	-0.010
Development				0.158	***	-0.012				0.157	***	-0.012
Constant	14.812	***	-0.049	14.792	***	-0.049	14.817	***	-0.049	14.793	***	-0.049
Observations	278,393			278,393			278,393			278,393		
R – Squared	0.473			0.474			0.473			0.474		
Robust standard errors in parentheses												
***p<0.01, **p<0.05, *p<0.1												

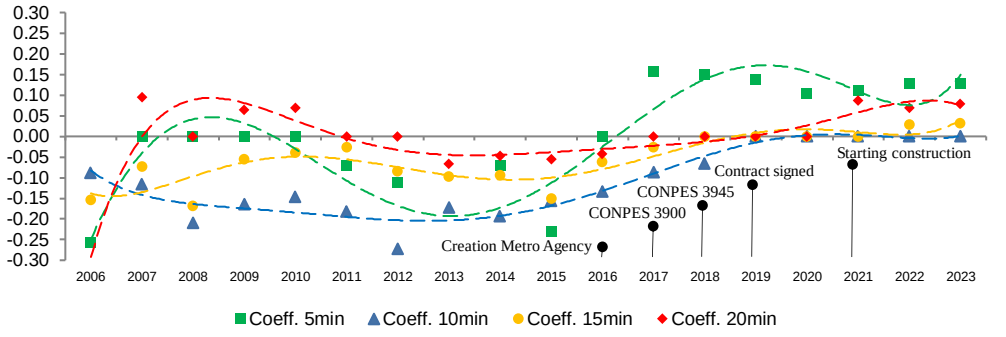
Base Model



Model 2 *(control with partial plans)*



Model 3 *(control with BRT buffer 500mts)*



Model 4 *(control with partial plans and BRT buffer 500mts)*

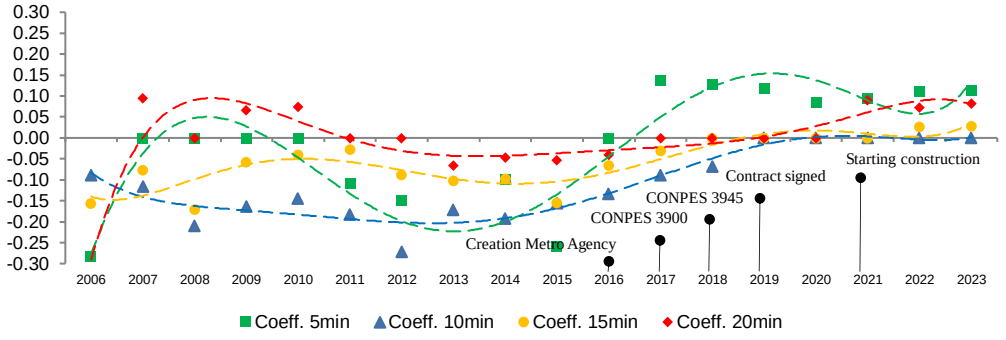


Figure 3. Effects of the PLMB on real estate development prices in Bogotá by Isochrone (2006-2023) *Sources: Statistical analysis on STATA (STATA, 2024)*

4.2 Second line of the metro project L2MB isochrone analysis (four treatment zones)

Table 5 presents the descriptive statistics of the real estate projects in the treatment area (isochronous) for the L2MB and in the control area (rest of the city) for the year we have as a baseline (2007), while Table 6 presents the descriptive statistics for the year 2023. The data corresponds to the information provided by the GI Real Estate Gallery with the registration of new projects in the city.

In the descriptive statistics for the year 2007 (Table 5) it is observed that the price per square meter variable (natural logarithm) in the treatment areas has slightly lower values than in the rest of the city (around 4.4%). Regarding socioeconomic levels, it is observed that in the first treatment zone, projects in stratum 3 predominate (100%), in the second treatment zone there is a greater presence of projects in stratum 4 (66.7%) and some in strata 3 and 2 (33.3%), in treatment zone 3 projects from strata 3 and 4 predominate (79.6%), and in the fourth treatment zone projects in stratum 3 predominate (53.4%), followed for stratum 4 and 2. In the control zone there are projects in all segments, except for stratum 1. In the number of rooms in the housing units, in the first treatment zone, projects with properties of 2 and 4 bedrooms, in the second treatment zone, projects with 3-bedroom properties predominate, in the third treatment zone, projects with 4-bedroom properties also predominate, followed by 3-bedroom units, in the fourth treatment zone, properties with 4 bedrooms predominate. 2 and 3 bedrooms. In the control area, 3-bedroom projects predominate, followed by 2- and 1-bedroom projects. In treatment zones 2, 3 and 4, slightly lower population densities are observed than those observed in the control zone. Greater proximity to parks and facilities is also observed in the housing projects located in the first treatment area. The crime data show similar values between the treatment and control zones, with slightly higher values for the first treatment zone. Regarding the typology of housing supply, a greater presence of affordable housing projects is observed in the treatment areas, while in the control area a greater concentration of market value housing units (Non-Social-Housing) projects is observed. A greater concentration of projects in partial development plans is observed in the control zones compared to the treatment zones, while in the third treatment zone a concentration of projects in partial urban renewal plans is observed.

In the descriptive statistics for the year 2023 (Table 6), an increase is observed in the price per square meter variable (natural logarithm) in relation to the year 2007, but the increase is greater in the projects in the treatment areas. Specifically, in zone 1 an increase of 14.2% was recorded, in zone 2 of 9.1%, in zone 3 of 7.3%, in zone 4 of 6.2% and in the control zone 5.9%. Regarding socioeconomic levels, an increase in real estate projects for strata 2 and 4 is observed in the first treatment zone, in the second treatment zone an increase is observed from 16.7% to 73.1% in stratum 3 projects, in the third treatment zone, an increase in projects is observed in stratum 4 from 36.4% to 38.5%, in the fourth treatment zone an increase in projects is observed in strata 2 and 4. In the control zone, a decrease in real estate projects for all segments. Regarding the number of bedrooms, an increase is observed in the number of projects with one bedroom in both the treatment and control areas. An increase in the number of projects with market value housing units (Non-Social-Housing) is observed in the first treatment area. Finally, an increase in projects in partial development plans is observed in the fourth treatment zone.

Table 5. Descriptive statistics isochrone analysis year 2007 – L2MB

	Year 2007																			
	Treatment 1 (N=2)				Treatment 2 (N=6)				Treatment 3 (N=88)				Treatment 4 (N=178)				Control (N=6,813)			
Variable	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**
Dependent variables																				
Log. Price per sqmt	13.251	0.197	13.11	13.39	13.767	0.874	12.00	14.24	13.769	0.794	12.06	14.95	13.665	0.443	12.04	14.63	14.293	0.619	10.27	16.03
Independent variables																				
Log. Distance to L2MB	5.300	0.000	5.30	5.30	6.136	0.855	4.60	6.66	5.520	1.196	1.68	6.90	6.361	0.718	0.84	7.15	8.157	0.650	5.12	9.65
Log. Distance to CBD. 72	9.482	0.000	9.48	9.48	8.337	0.694	7.89	9.50	8.977	0.420	7.80	9.42	8.957	0.511	7.68	9.45	8.488	0.704	5.94	9.80
Log. Distance to nearest activity center	9.383	0.000	9.38	9.38	8.255	0.673	7.83	9.40	8.851	0.412	7.82	9.32	8.838	0.489	7.19	9.34	8.148	0.707	4.30	9.59
Socioeconomic level																				
One	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00
Two	0.000	0.000	0.00	0.00	0.167	0.408	0.00	1.00	0.000	0.000	0.00	0.00	0.208	0.407	0.00	1.00	0.041	0.198	0.00	1.00
Three	1.000	0.000	1.00	1.00	0.167	0.408	0.00	1.00	0.432	0.498	0.00	1.00	0.534	0.500	0.00	1.00	0.123	0.328	0.00	1.00
Four	0.000	0.000	0.00	0.00	0.667	0.516	0.00	1.00	0.364	0.484	0.00	1.00	0.230	0.422	0.00	1.00	0.282	0.450	0.00	1.00
Five	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.102	0.305	0.00	1.00	0.022	0.149	0.00	1.00	0.232	0.422	0.00	1.00
Six	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.102	0.305	0.00	1.00	0.006	0.075	0.00	1.00	0.323	0.468	0.00	1.00
Bedrooms																				
One	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.034	0.183	0.00	1.00	0.067	0.251	0.00	1.00	0.109	0.312	0.00	1.00
Two	0.500	0.707	0.00	1.00	0.167	0.408	0.00	1.00	0.170	0.378	0.00	1.00	0.270	0.445	0.00	1.00	0.243	0.429	0.00	1.00
Three	0.000	0.000	0.00	0.00	0.667	0.516	0.00	1.00	0.750	0.435	0.00	1.00	0.596	0.492	0.00	1.00	0.589	0.492	0.00	1.00
Four	0.500	0.707	0.00	1.00	0.167	0.408	0.00	1.00	0.045	0.209	0.00	1.00	0.067	0.251	0.00	1.00	0.059	0.235	0.00	1.00
Bathrooms	1.500	0.707	1.00	2.00	1.833	0.408	1.00	2.00	2.273	0.968	1.00	4.00	1.669	0.692	1.00	4.00	2.546	0.960	1.00	6.00
Neighborhoods attributes																				
Log. Population density	0.000	0.000	0.00	0.00	4.010	3.126	0.00	6.48	4.580	2.950	0.00	7.33	4.505	2.771	0.00	7.35	4.840	2.142	0.00	7.62
Log. Distance to nearest park	4.324	0.000	4.32	4.32	3.665	0.936	2.60	4.57	3.864	1.075	0.74	5.29	3.744	1.695	-5.36	5.93	3.834	1.360	-6.81	5.92
Log. Distance to nearest equipment	4.987	0.000	4.99	4.99	4.264	0.849	3.31	5.54	4.690	0.652	2.74	5.34	4.403	0.755	2.05	5.64	4.364	0.913	-3.11	7.06
Roads Index / Ratio	-3.094	0.000	-3.09	-3.09	-2.072	0.518	-3.09	-1.60	-1.893	0.405	-2.57	-0.99	-1.869	0.673	-3.09	-0.24	-1.942	0.457	-4.73	1.37
Crime																				
Log. Homicides	4.585	0.000	4.59	4.59	3.973	0.442	3.69	4.59	4.502	0.205	3.69	4.59	4.430	0.303	3.69	4.59	3.881	0.750	0.69	5.40
Log. Thefts	7.385	0.000	7.39	7.39	6.554	0.524	6.22	7.39	7.193	0.288	6.22	7.39	7.106	0.390	6.22	7.39	7.102	0.433	4.99	7.39

(Table continues on next page)

	Year 2007																			
	Treatment 1 (N=2)				Treatment 2 (N=6)				Treatment 3 (N=88)				Treatment 4 (N=178)				Control (N=6,813)			
Variable	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**
Type of housing																				
Micro-apartments	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00
Affordable housing	1.000	0.000	1.00	1.00	0.167	0.408	0.00	1.00	0.193	0.397	0.00	1.00	0.213	0.411	0.00	1.00	0.047	0.212	0.00	1.00
Market housing	0.000	0.000	0.00	0.00	0.833	0.408	0.00	1.00	0.807	0.397	0.00	1.00	0.787	0.411	0.00	1.00	0.953	0.212	0.00	1.00
Small Area Plans																				
Urban renewal	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.011	0.107	0.00	1.00	0.000	0.000	0.00	0.00	0.010	0.099	0.00	1.00
Urban development	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.007	0.082	0.00	1.00
BRT																				
Buffer 500-meter built trunk	0.000	0.000	0.00	0.00	0.667	0.516	0.00	1.00	0.170	0.378	0.00	1.00	0.146	0.354	0.00	1.00	0.325	0.468	0.00	1.00
Buffer 500-meter trunk under construction	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.091	0.289	0.00	1.00	0.045	0.208	0.00	1.00	0.116	0.320	0.00	1.00
Buffer 500-meter Carrera Séptima Corridor	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.226	0.418	0.00	1.00

Table 6. Descriptive statistics isochrone analysis year 2023 – L2MB

	Year 2023																			
	Treatment 1 (N=31)				Treatment 2 (N=52)				Treatment 3 (N=327)				Treatment 4 (N=549)				Control (N=21,383)			
Variable	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**
Dependent variables																				
Log. Price per sqmt	15.138	0.840	13.11	15.99	15.020	0.679	13.79	16.05	14.783	0.623	13.06	15.74	14.513	0.818	12.88	16.03	15.147	0.691	10.27	17.13
Independent variables																				
Log. Distance to L2MB	4.400	0.847	2.38	5.47	5.655	1.102	3.53	6.70	5.991	1.069	1.68	6.90	6.363	0.637	0.84	7.36	8.198	0.648	2.93	9.87
Log. Distance to CBD. 72	7.738	1.224	6.70	9.49	8.419	0.616	7.84	9.50	8.760	0.438	7.80	9.42	8.867	0.449	7.68	9.46	8.506	0.670	5.54	9.87
Log. Distance to nearest activity center	7.864	1.027	7.10	9.39	8.316	0.597	7.72	9.40	8.626	0.441	7.82	9.32	8.739	0.427	7.19	9.35	8.136	0.700	4.30	9.75
Socioeconomic level																				
One	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.018	0.00	1.00
Two	0.258	0.445	0.00	1.00	0.154	0.364	0.00	1.00	0.138	0.345	0.00	1.00	0.239	0.427	0.00	1.00	0.041	0.199	0.00	1.00
Three	0.194	0.402	0.00	1.00	0.731	0.448	0.00	1.00	0.422	0.495	0.00	1.00	0.594	0.492	0.00	1.00	0.165	0.371	0.00	1.00
Four	0.548	0.506	0.00	1.00	0.115	0.323	0.00	1.00	0.385	0.487	0.00	1.00	0.137	0.344	0.00	1.00	0.261	0.439	0.00	1.00
Five	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.028	0.164	0.00	1.00	0.029	0.168	0.00	1.00	0.249	0.433	0.00	1.00
Six	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.028	0.164	0.00	1.00	0.002	0.043	0.00	1.00	0.283	0.451	0.00	1.00
Bedrooms																				
One	0.323	0.475	0.00	1.00	0.269	0.448	0.00	1.00	0.086	0.280	0.00	1.00	0.144	0.351	0.00	1.00	0.225	0.417	0.00	1.00
Two	0.323	0.475	0.00	1.00	0.288	0.457	0.00	1.00	0.242	0.429	0.00	1.00	0.352	0.478	0.00	1.00	0.293	0.455	0.00	1.00
Three	0.323	0.475	0.00	1.00	0.404	0.495	0.00	1.00	0.661	0.474	0.00	1.00	0.483	0.500	0.00	1.00	0.456	0.498	0.00	1.00
Four	0.032	0.180	0.00	1.00	0.038	0.194	0.00	1.00	0.012	0.110	0.00	1.00	0.022	0.146	0.00	1.00	0.027	0.162	0.00	1.00
Bathrooms	1.581	0.620	1.00	3.00	1.692	0.544	1.00	3.00	2.168	0.854	1.00	4.00	1.628	0.666	1.00	5.00	2.364	0.976	0.00	8.00
Neighborhoods attributes																				
Log. Population density	4.361	1.621	0.00	6.52	5.563	1.643	0.00	6.48	5.406	2.216	0.00	7.33	4.929	2.499	-3.73	7.35	4.683	2.121	-1.77	7.62
Log. Distance to nearest park	4.812	0.758	3.38	5.61	3.917	2.200	-4.10	5.35	3.939	0.981	0.74	5.59	4.008	1.300	-5.36	5.93	4.024	1.262	-6.81	6.39
Log. Distance to nearest equipment	4.366	0.590	3.55	5.34	4.353	0.943	1.33	5.54	4.584	0.716	2.07	5.76	4.352	0.776	2.05	6.06	4.282	0.946	-3.11	7.16
Roads Index / Ratio	-2.124	0.641	-3.09	-1.40	-1.983	0.417	-3.09	-1.60	-1.819	0.298	-2.98	-0.99	-1.918	0.605	-3.50	-0.24	-1.926	0.450	-5.12	1.37
Crime																				
Log. Homicides	2.839	0.832	2.08	4.03	3.335	0.531	2.83	4.03	3.778	0.327	2.83	4.03	3.767	0.369	2.83	4.03	3.142	0.741	1.10	4.93
Log. Thefts	9.035	0.322	8.59	9.45	8.965	0.394	8.59	9.45	9.295	0.238	8.59	9.45	9.283	0.268	8.59	9.45	8.932	0.360	6.63	9.45

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	Year 2023																			
	Treatment 1 (N=31)				Treatment 2 (N=52)				Treatment 3 (N=327)				Treatment 4 (N=549)				Control (N=21,383)			
Variable	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Mean**	**Std. Dev.**	**Min**	**Max**
Type of housing																				
Micro-apartments	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.002	0.043	0.00	1.00	0.006	0.077	0.00	1.00
Affordable housing	0.323	0.475	0.00	1.00	0.154	0.364	0.00	1.00	0.208	0.406	0.00	1.00	0.311	0.464	0.00	1.00	0.070	0.255	0.00	1.00
Market housing	0.677	0.475	0.00	1.00	0.846	0.364	0.00	1.00	0.792	0.406	0.00	1.00	0.687	0.464	0.00	1.00	0.924	0.265	0.00	1.00
Small Area Plans																				
Urban renewal	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.003	0.055	0.00	1.00	0.000	0.000	0.00	0.00	0.016	0.124	0.00	1.00
Urban development	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.047	0.213	0.00	1.00	0.007	0.083	0.00	1.00
BRT																				
Buffer 500-meter built trunk	0.613	0.495	0.00	1.00	0.519	0.505	0.00	1.00	0.223	0.417	0.00	1.00	0.281	0.450	0.00	1.00	0.335	0.472	0.00	1.00
Buffer 500-meter trunk under construction	0.097	0.301	0.00	1.00	0.000	0.000	0.00	0.00	0.294	0.456	0.00	1.00	0.046	0.209	0.00	1.00	0.107	0.309	0.00	1.00
Buffer 500-meter Carrera Séptima Corridor	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.000	0.000	0.00	0.00	0.193	0.395	0.00	1.00

Table 7 presents the results of the hedonic price models on the anticipation effects of the L2MB on the prices per square meter of real estate projects between 2007 and 2023 with 4 treatment zones: (i) projects within the isochrone of 5 minutes of the stations, (ii) 10-minute isochronous, (iii) 15-minute isochronous and (iv) 20-minute isochronous. In the base model, for the first isochron, positive effects are observed between 24.8% for 2016 and 20.1% for 2023, for the second isochron, positive effects are observed between 14% for 2013 and 17.3% for 2023, for the third isochron, positive effects of 7.4% are observed for 2008 and 12.4% for 2023, and for the fourth and last isochron, negative effects of -5.3% are observed in 2014 and -4.1% in 2018. These effects are similar. in the other three models. These findings suggest that it is still premature to identify anticipation effects, however, the variations suggest that the L2MB layout is in an area with opportunities for high-income developments, with the possibility of generating a mix of VIS projects. Figure 4 shows a high variation in the coefficients for the four treatment zones, with a trend towards convergence between 2021 and 2023 for projects in the first three isochrons. The variations in the coefficients between isochrons are explained by the different real estate dynamics that occur in the areas close to the L2MB layout.

It is relevant to clarify again that there are other variables that influence the price of new housing that are not explicitly addressed in this study. Additionally, demand plays a fundamental role in the creation of prices. It should be noted that according to a study by Camacol, location is the main motivation when buying a home, followed by accessibility, price and space design. Likewise, there are public policy factors that generate variations in prices, for example, in Colombia the changes made to the “Mi Casa Ya” subsidy program significantly influence the demand for VIS homes and, consequently, their prices. For example, the study conducted by (Rey Hernández, 2023) found that a 22.55% increase in subsidies per eligible household translates into a 13.51% increase in VIS housing sales. For the L2MB there are other determining factors in housing prices around the stations, specifically greater growth in real estate developments has been observed, in line with urban migration to these areas of the city.

Table 7. Hedonic price model of the anticipation effects of the future L2MB on real estate development prices between 2007 and 2023 in isochrone analysis (N=278,393)

	Base Model			**Model 2 Urban renewal partial plans**			**Model 3 BRT buffer 500 mts**			**Model 4 Urban renewal partial plans & BRT buffer 500 mts**		
	Dependent variable:			**Dependent variable:**			**Dependent variable:**			**Dependent variable:**		
	Ln. Price per square meter			**Ln. Price per square meter**			**Ln. Price per square meter**			**Ln. Price per square meter**		
Year												
2007	0.020	**	-0.009	0.020	**	-0.009	0.020	**	-0.009	0.020	**	-0.009
2008	0.143	***	-0.008	0.142	***	-0.008	0.143	***	-0.008	0.142	***	-0.008
2009	0.221	***	-0.008	0.221	***	-0.008	0.222	***	-0.008	0.221	***	-0.008
2010	0.278	***	-0.008	0.277	***	-0.008	0.276	***	-0.008	0.276	***	-0.008
2011	0.340	***	-0.008	0.338	***	-0.008	0.337	***	-0.008	0.335	***	-0.008
2012	0.390	***	-0.008	0.388	***	-0.008	0.387	***	-0.008	0.385	***	-0.008
2013	0.466	***	-0.008	0.463	***	-0.008	0.462	***	-0.008	0.459	***	-0.008
2014	0.521	***	-0.008	0.518	***	-0.008	0.516	***	-0.008	0.513	***	-0.008
2015	0.553	***	-0.008	0.549	***	-0.008	0.548	***	-0.008	0.545	***	-0.008
2016	0.654	***	-0.008	0.649	***	-0.008	0.647	***	-0.008	0.643	***	-0.008
2017	0.706	***	-0.010	0.699	***	-0.010	0.695	***	-0.010	0.689	***	-0.010
2018	0.743	***	-0.011	0.735	***	-0.011	0.730	***	-0.011	0.723	***	-0.011
2019	0.778	***	-0.012	0.769	***	-0.012	0.763	***	-0.012	0.756	***	-0.012
2020	0.793	***	-0.010	0.786	***	-0.010	0.782	***	-0.010	0.776	***	-0.010
2021	0.827	***	-0.011	0.820	***	-0.011	0.815	***	-0.011	0.808	***	-0.011
2022	0.864	***	-0.012	0.855	***	-0.012	0.850	***	-0.012	0.842	***	-0.012
2023	0.868	***	-0.011	0.860	***	-0.011	0.855	***	-0.011	0.848	***	-0.011

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	Base Model			Model 2 Urban renewal partial plans			Model 3 BRT buffer 500 mts			Model 4 Urban renewal partial plans & BRT buffer 500 mts		
	Dependent variable:			Dependent variable:			Dependent variable:			Dependent variable:		
	Ln. Price per square meter			Ln. Price per square meter			Ln. Price per square meter			Ln. Price per square meter		
Interaction isochrone 5min + year												
2006*isochrone 5min SLMB	0.227	***	-0.069	0.235	***	-0.070	0.247	***	-0.071	0.254	***	-0.071
2007*isochrone 5min SLMB	0.271	***	-0.081	0.278	***	-0.082	0.292	***	-0.082	0.298	***	-0.083
2008*isochrone 5min SLMB	0.073		-0.067	0.072		-0.068	0.092		-0.068	0.090		-0.069
2009*isochrone 5min SLMB	0.041		-0.066	0.040		-0.067	0.059		-0.066	0.057		-0.067
2010*isochrone 5min SLMB	-0.152	*	-0.091	-0.149	*	-0.090	-0.132		-0.091	-0.130		-0.091
2011*isochrone 5min SLMB	0.200	***	-0.078	0.205	***	-0.078	0.220	***	-0.078	0.223	***	-0.079
2012*isochrone 5min SLMB	0.188	**	-0.087	0.193	**	-0.087	0.207	**	-0.087	0.210	**	-0.088
2013*isochrone 5min SLMB	0.070		-0.104	0.074		-0.104	0.088		-0.105	0.091		-0.105
2014*isochrone 5min SLMB	0.099		-0.082	0.103		-0.083	0.117		-0.083	0.121		-0.083
2015*isochrone 5min SLMB	0.054		-0.081	0.059		-0.081	0.073		-0.081	0.076		-0.082
2016*isochrone 5min SLMB	0.248	***	-0.075	0.253	***	-0.075	0.259	***	-0.074	0.264	***	-0.075
2017*isochrone 5min SLMB	0.200	***	-0.074	0.206	***	-0.075	0.211	***	-0.074	0.216	***	-0.074
2018*isochrone 5min SLMB	0.171	**	-0.076	0.177	**	-0.076	0.183	**	-0.075	0.188	**	-0.075
2019*isochrone 5min SLMB	0.235	***	-0.076	0.241	***	-0.076	0.248	***	-0.075	0.254	***	-0.076
2020*isochrone 5min SLMB	0.256	***	-0.076	0.262	***	-0.077	0.269	***	-0.076	0.274	***	-0.076
2021*isochrone 5min SLMB	0.236	***	-0.076	0.242	***	-0.077	0.249	***	-0.076	0.255	***	-0.076
2022*isochrone 5min SLMB	0.216	***	-0.076	0.222	***	-0.077	0.229	***	-0.076	0.234	***	-0.076
2023*isochrone 5min SLMB	0.201	***	-0.076	0.208	***	-0.076	0.214	***	-0.076	0.220	***	-0.076

(Table continues on next page)

	Base Model			Model 2 Urban renewal partial plans			Model 3 BRT buffer 500 mts			Model 4 Urban renewal partial plans & BRT buffer 500 mts		
	Dependent variable:			Dependent variable:			Dependent variable:			Dependent variable:		
	Ln. Price per square meter			Ln. Price per square meter			Ln. Price per square meter			Ln. Price per square meter		
Interaction isochrone 10min + year												
2006*isochrone 10min SLMB	0.319	***	-0.041	0.325	***	-0.041	0.337	***	-0.041	0.341	***	-0.041
2007*isochrone 10min SLMB	0.238	***	-0.053	0.243	***	-0.053	0.256	***	-0.053	0.260	***	-0.053
2008*isochrone 10min SLMB	0.141	***	-0.042	0.146	***	-0.042	0.160	***	-0.042	0.163	***	-0.042
2009*isochrone 10min SLMB	0.008		-0.048	0.012		-0.048	0.024		-0.049	0.027		-0.049
2010*isochrone 10min SLMB	0.100	***	-0.036	0.104	***	-0.036	0.116	***	-0.036	0.119	***	-0.036
2011*isochrone 10min SLMB	0.053		-0.035	0.058	*	-0.035	0.070	**	-0.035	0.074	**	-0.035
2012*isochrone 10min SLMB	0.023		-0.047	0.028		-0.046	0.039		-0.047	0.043		-0.047
2013*isochrone 10min SLMB	0.140	***	-0.039	0.145	***	-0.039	0.156	***	-0.039	0.159	***	-0.039
2014*isochrone 10min SLMB	0.085	**	-0.038	0.090	**	-0.038	0.101	***	-0.038	0.104	***	-0.038
2015*isochrone 10min SLMB	0.159	***	-0.039	0.164	***	-0.039	0.173	***	-0.039	0.177	***	-0.039
2016*isochrone 10min SLMB	0.120	***	-0.037	0.127	***	-0.037	0.134	***	-0.037	0.141	***	-0.037
2017*isochrone 10min SLMB	0.138	***	-0.038	0.145	***	-0.038	0.152	***	-0.038	0.159	***	-0.038
2018*isochrone 10min SLMB	0.187	***	-0.037	0.194	***	-0.037	0.200	***	-0.037	0.206	***	-0.037
2019*isochrone 10min SLMB	0.169	***	-0.037	0.177	***	-0.037	0.182	***	-0.037	0.189	***	-0.037
2020*isochrone 10min SLMB	0.162	***	-0.037	0.169	***	-0.037	0.175	***	-0.037	0.181	***	-0.037
2021*isochrone 10min SLMB	0.167	***	-0.036	0.175	***	-0.036	0.179	***	-0.035	0.186	***	-0.035
2022*isochrone 10min SLMB	0.172	***	-0.035	0.180	***	-0.035	0.185	***	-0.035	0.192	***	-0.035
2023*isochrone 10min SLMB	0.173	***	-0.036	0.181	***	-0.036	0.185	***	-0.036	0.193	***	-0.036

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	Base Model			Model 2 Urban renewal partial plans			Model 3 BRT buffer 500 mts			Model 4 Urban renewal partial plans & BRT buffer 500 mts		
	Dependent variable: Ln. Price per square meter			Dependent variable: Ln. Price per square meter			Dependent variable: Ln. Price per square meter			Dependent variable: Ln. Price per square meter		
Interaction isochrone 15min + year												
2006*isochrone 15min SLMB	0.084	**	-0.035	0.088	**	-0.035	0.095	***	-0.035	0.098	***	-0.035
2007*isochrone 15min SLMB	-0.067		-0.051	-0.062		-0.051	-0.056		-0.051	-0.052		-0.051
2008*isochrone 15min SLMB	0.074	**	-0.032	0.079	**	-0.032	0.084	***	-0.032	0.089	***	-0.032
2009*isochrone 15min SLMB	0.149	***	-0.029	0.154	***	-0.029	0.161	***	-0.029	0.166	***	-0.030
2010*isochrone 15min SLMB	0.071	**	-0.035	0.076	**	-0.035	0.084	**	-0.035	0.087	**	-0.035
2011*isochrone 15min SLMB	0.167	***	-0.026	0.173	***	-0.026	0.183	***	-0.026	0.188	***	-0.026
2012*isochrone 15min SLMB	0.219	***	-0.026	0.224	***	-0.026	0.233	***	-0.026	0.237	***	-0.026
2013*isochrone 15min SLMB	0.166	***	-0.026	0.171	***	-0.026	0.180	***	-0.026	0.184	***	-0.027
2014*isochrone 15min SLMB	0.136	***	-0.026	0.142	***	-0.026	0.151	***	-0.026	0.156	***	-0.026
2015*isochrone 15min SLMB	0.123	***	-0.030	0.129	***	-0.030	0.139	***	-0.030	0.144	***	-0.030
2016*isochrone 15min SLMB	0.168	***	-0.026	0.175	***	-0.026	0.182	***	-0.026	0.188	***	-0.026
2017*isochrone 15min SLMB	0.181	***	-0.026	0.188	***	-0.026	0.196	***	-0.026	0.201	***	-0.026
2018*isochrone 15min SLMB	0.178	***	-0.026	0.184	***	-0.026	0.191	***	-0.026	0.196	***	-0.026
2019*isochrone 15min SLMB	0.168	***	-0.026	0.175	***	-0.026	0.181	***	-0.026	0.187	***	-0.026
2020*isochrone 15min SLMB	0.164	***	-0.026	0.171	***	-0.026	0.177	***	-0.026	0.182	***	-0.026
2021*isochrone 15min SLMB	0.131	***	-0.026	0.137	***	-0.026	0.144	***	-0.026	0.149	***	-0.026
2022*isochrone 15min SLMB	0.119	***	-0.026	0.125	***	-0.026	0.132	***	-0.026	0.137	***	-0.026
2023*isochrone 15min SLMB	0.124	***	-0.026	0.128	***	-0.026	0.136	***	-0.026	0.139	***	-0.026

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	Base Model			Model 2 Urban renewal partial plans			Model 3 BRT buffer 500 mts			Model 4 Urban renewal partial plans & BRT buffer 500 mts		
	Dependent variable: Ln. Price per square meter			Dependent variable: Ln. Price per square meter			Dependent variable: Ln. Price per square meter			Dependent variable: Ln. Price per square meter		
Interaction isochrone 20min + year												
2006*isochrone 20min SLMB	-0.097	***	-0.036	-0.094	***	-0.036	-0.094	***	-0.036	-0.091	**	-0.036
2007*isochrone 20min SLMB	0.047	*	-0.024	0.050	**	-0.024	0.049	**	-0.024	0.053	**	-0.024
2008*isochrone 20min SLMB	-0.052	**	-0.023	-0.049	**	-0.023	-0.051	**	-0.023	-0.048	**	-0.023
2009*isochrone 20min SLMB	-0.067	***	-0.020	-0.064	***	-0.020	-0.066	***	-0.020	-0.063	***	-0.020
2010*isochrone 20min SLMB	0.006		-0.020	0.011		-0.020	0.008		-0.019	0.012		-0.019
2011*isochrone 20min SLMB	-0.085	***	-0.020	-0.081	***	-0.020	-0.083	***	-0.020	-0.080	***	-0.020
2012*isochrone 20min SLMB	-0.047	**	-0.022	-0.043	**	-0.022	-0.046	**	-0.022	-0.042	*	-0.022
2013*isochrone 20min SLMB	-0.119	***	-0.022	-0.116	***	-0.022	-0.118	***	-0.022	-0.114	***	-0.022
2014*isochrone 20min SLMB	-0.053	**	-0.023	-0.049	**	-0.023	-0.052	**	-0.023	-0.049	**	-0.023
2015*isochrone 20min SLMB	-0.038		-0.024	-0.036		-0.024	-0.038		-0.024	-0.035		-0.024
2016*isochrone 20min SLMB	-0.023		-0.024	-0.025		-0.024	-0.023		-0.024	-0.025		-0.024
2017*isochrone 20min SLMB	-0.032		-0.025	-0.034		-0.024	-0.033		-0.025	-0.034		-0.024
2018*isochrone 20min SLMB	-0.041	*	-0.025	-0.042	*	-0.024	-0.041	*	-0.024	-0.042	*	-0.024
2019*isochrone 20min SLMB	-0.034		-0.025	-0.037		-0.024	-0.035		-0.025	-0.038		-0.024
2020*isochrone 20min SLMB	-0.030		-0.025	-0.034		-0.024	-0.031		-0.024	-0.034		-0.024
2021*isochrone 20min SLMB	0.007		-0.024	0.004		-0.024	0.005		-0.024	0.003		-0.024
2022*isochrone 20min SLMB	-0.014		-0.024	-0.016		-0.024	-0.015		-0.024	-0.017		-0.024
2023*isochrone 20min SLMB	-0.013		-0.025	-0.015		-0.024	-0.015		-0.025	-0.017		-0.024

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	Base Model			Model 2 Urban renewal partial plans			Model 3 BRT buffer 500 mts			Model 4 Urban renewal partial plans & BRT buffer 500 mts		
	Dependent variable: Ln. Price per square meter			Dependent variable: Ln. Price per square meter			Dependent variable: Ln. Price per square meter			Dependent variable: Ln. Price per square meter		
Bedrooms												
1	0.824	***	-0.007	0.824	***	-0.007	0.823	***	-0.007	0.823	***	-0.007
2	0.555	***	-0.006	0.556	***	-0.006	0.554	***	-0.006	0.554	***	-0.006
3	0.333	***	-0.006	0.334	***	-0.006	0.333	***	-0.006	0.333	***	-0.006
Bathrooms	0.185	***	-0.002	0.184	***	-0.002	0.186	***	-0.002	0.185	***	-0.002
Housing type												
Market housing (reference)												
Micro-apartments	0.564	***	-0.010	0.563	***	-0.010	0.556	***	-0.010	0.555	***	-0.010
Affordable housing	-0.196	***	-0.005	-0.197	***	-0.005	-0.193	***	-0.005	-0.194	***	-0.005
Socioeconomic Level *(1 reference)*												
2	-0.842	***	-0.029	-0.845	***	-0.029	-0.840	***	-0.029	-0.843	***	-0.029
3	-0.372	***	-0.029	-0.375	***	-0.029	-0.373	***	-0.029	-0.376	***	-0.029
4	-0.210	***	-0.029	-0.215	***	-0.029	-0.213	***	-0.029	-0.217	***	-0.029
5	-0.100	***	-0.029	-0.102	***	-0.029	-0.107	***	-0.029	-0.108	***	-0.029
6	-0.005		-0.029	-0.006		-0.029	-0.004		-0.029	-0.005		-0.029
Neighborhood attributes												
Log. Population density	-0.007	***	0.000	-0.006	***	0.000	-0.007	***	0.000	-0.006	***	0.000
Log. Distance to nearest park	0.013	***	-0.001	0.013	***	-0.001	0.013	***	-0.001	0.013	***	-0.001
Log. Distance to nearest equipment	-0.010	***	-0.001	-0.010	***	-0.001	-0.010	***	-0.001	-0.010	***	-0.001
Roads Index	-0.020	***	-0.002	-0.018	***	-0.002	-0.021	***	-0.002	-0.020	***	-0.002

(Table continues on next page)

	Base Model			Model 2 Urban renewal partial plans			Model 3 BRT buffer 500 mts			Model 4 Urban renewal partial plans & BRT buffer 500 mts		
	Dependent variable:			Dependent variable:			Dependent variable:			Dependent variable:		
	Ln. Price per square meter			Ln. Price per square meter			Ln. Price per square meter			Ln. Price per square meter		
Location												
Log. Distance to CBD.72	-0.111	***	-0.004	-0.115	***	-0.004	-0.125	***	-0.004	-0.128	***	-0.004
Log. Distance to nearest activity center	-0.051	***	-0.002	-0.047	***	-0.003	-0.044	***	-0.003	-0.039	***	-0.003
Log. Distance to L2MB	0.064	***	-0.003	0.067	***	-0.003	0.072	***	-0.003	0.074	***	-0.003
Crime												
Log. Homicides	-0.021	***	-0.002	-0.023	***	-0.002	-0.023	***	-0.002	-0.024	***	-0.002
Log. Thefts	-0.021	***	-0.004	-0.018	***	-0.004	-0.015	***	-0.004	-0.012	***	-0.004
BRT												
Buffer 500mts built trunk							0.020	***	-0.002	0.019	***	-0.002
Buffer 500mts trunk under construction							-0.022	***	-0.003	-0.020	***	-0.003
Buffer 500mts Carrera Séptima Corridor							-0.019	***	-0.003	-0.018	***	-0.003
Small Area Plans												
Urban Renewal				0.079	***	-0.010				0.076	***	-0.010
Development				0.177	***	-0.012				0.172	***	-0.012
Constant	14.607	***	-0.046	14.567	***	-0.046	14.562	***	-0.047	14.523	***	-0.047
Observations	278,393			278,393			278,393			278,393		
R – Squared	0.473			0.474			0.474			0.474		

Robust standard errors in parentheses
***p<0.01, **p<0.05, *p<0.1

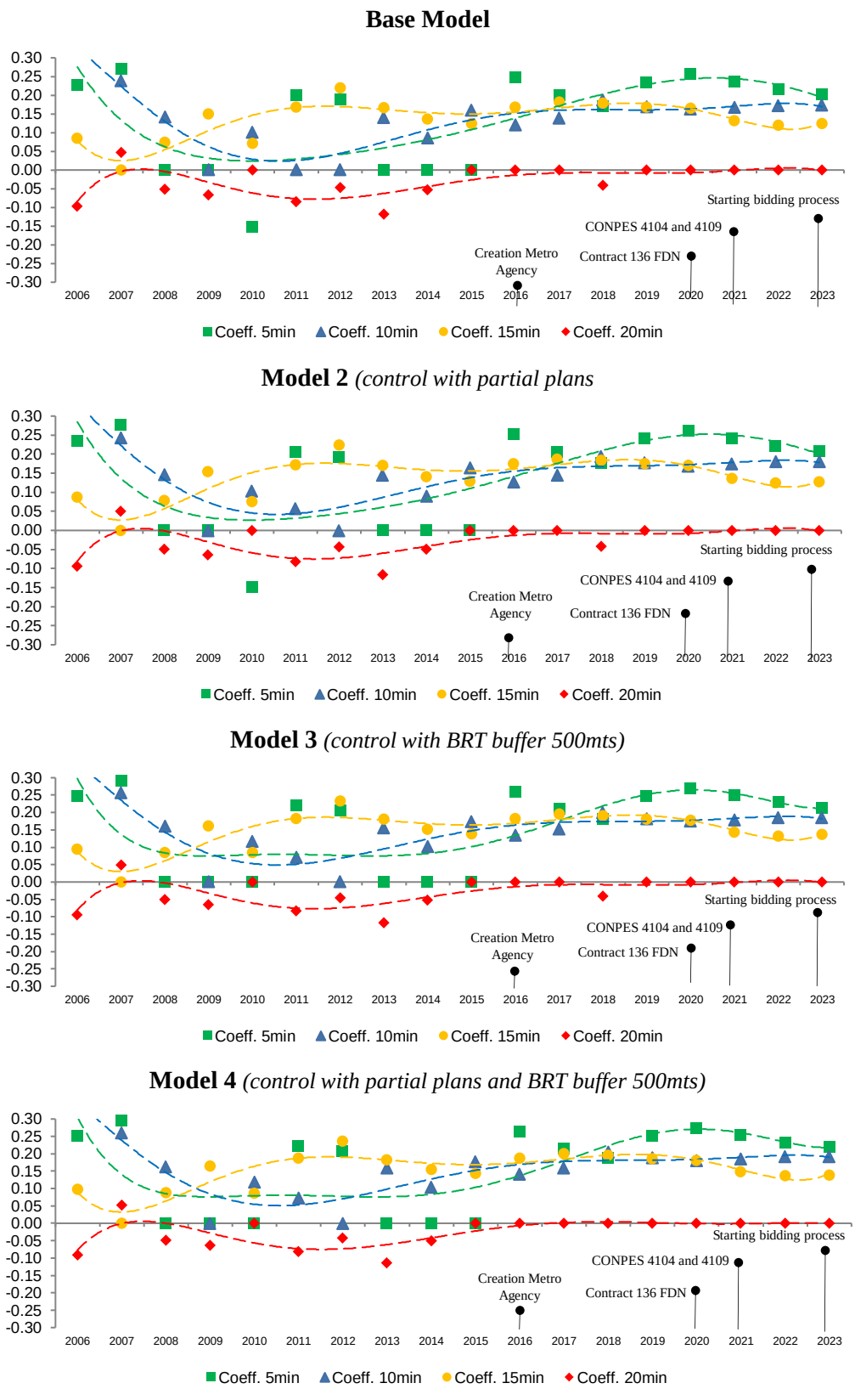

Figure 4. Effects of the L2MB on real estate development prices per square meter in Bogotá by Isochrone (2006-2023) *Sources: Analysis on (STATA, 2024)*

4.3 Spatial data analysis (cluster and kernel density)

We developed spatial data analysis using ArcGIS tools based on the difference between the predicted and observed values estimated in the statistical analysis for the average prices per m2 of the new housing supply (ESRI, 2024b). We conducted a cluster analysis identifying individual projects that share similar values with their neighboring projects (Figure 5). This cluster may contain differences between the predicted value and the observed value that are high (red on the map), low (blue on the map), or simply not significant as they do not form a cluster (gray on the map). We conducted a kernel density analysis of the new housing projects statistical analysis results (Figure 5). The analysis confirms the high-income cone on the eastern edge of the city, which coincides with the urban spatial structure identified in the city's mobility surveys (2015 and 2019), where high-income areas present the highest concentration of formal employment in the city and consequently the greatest travel attraction. We found that the lowest prices of the real estate market housing units are mostly located at urban peripheries. This confirms the monocentric spatial structure of the city. We also confirmed the anticipation effects of the PLMB, while there are emerging markets along the L2MB.

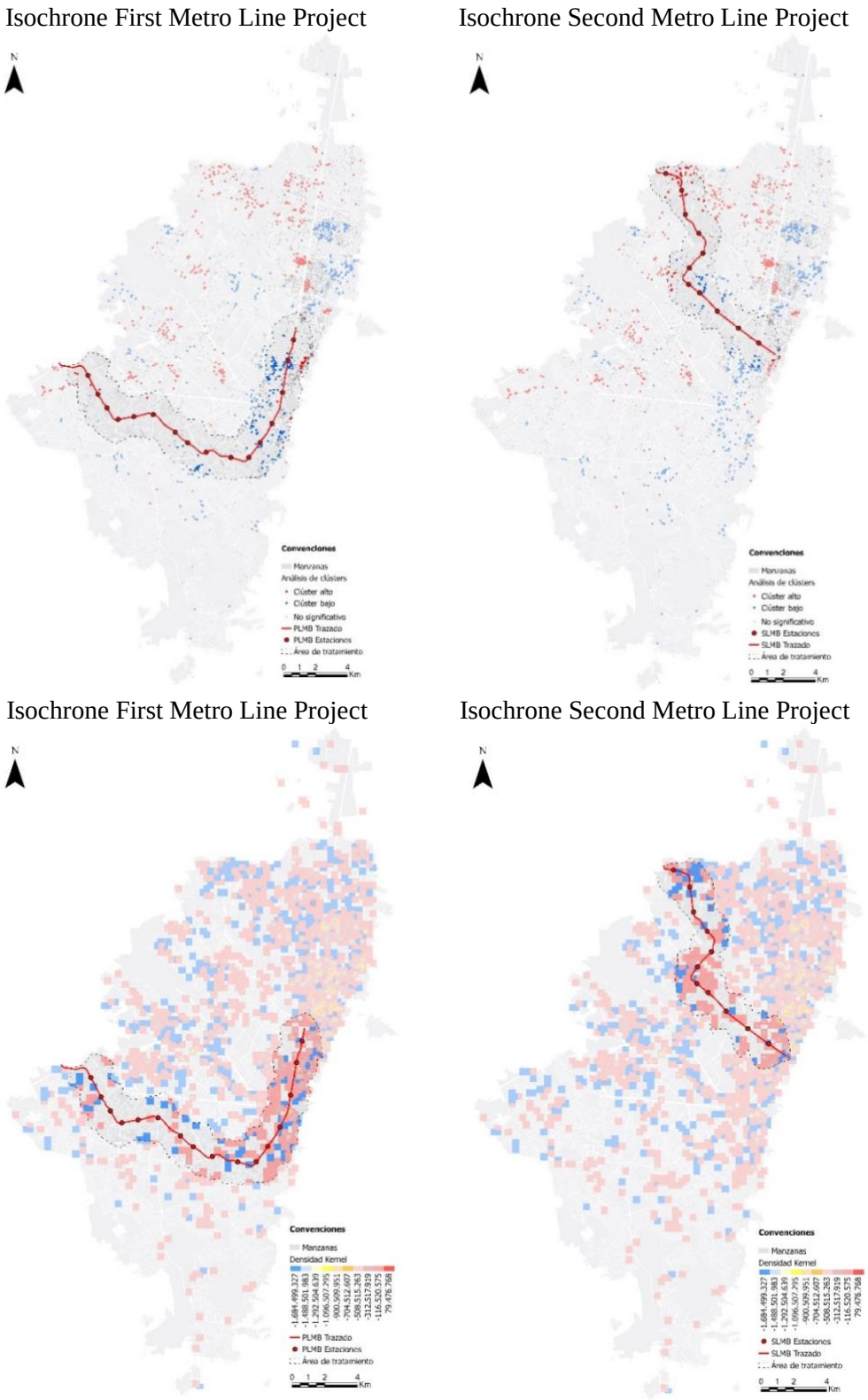

Figure 5. Cluster analysis of the difference between the predicted and observed values for the prices per m2 built of the new housing supply in the PLMB and L2MB
Sources: Spatial analysis on Arc-GIS (ESRI, 2024a) based on the statistical analysis developed in STATA (STATA, 2024)

5 Discussion

The analysis provides evidence on the anticipation effects of the PLMB and L2MB projects between 2007 and 2023. These findings suggest that the real estate market is having a reaction in relation to the announcements about the metro project, so it is important to continue conducting further analyzes on the effects of the project on the urban spatial structure of Bogotá. It should be noted that the findings are consistent with previous research (Cárdenas et al., 2023), however, the premiums identified in this document for new real estate development projects around PLMB stations are between 3.5% and 4.8%, which are lower than the findings on changes in property sales prices (dwelling units 10.5% and 6.5% for apartment units). Although our research estimates are showing lower ranges, we recommend continuing observing and analyzing changes in the real estate market for new development projects as the PLMB moves forward with the construction process. The research findings in this article are similar to Rodríguez and Targa's estimates for the first phase of the BRT system (6.8% and 9.3% for the sales prices of properties located in areas served by the first phase of the BRT system (Rodriguez & Targa, 2004).

The research results in this article also show the significant increase in micro apartments in the influence of the future metro project. Within the area of influence of the future metro project, we observe an increase of more than 5% of micro apartment projects between 2007 and 2023. This action of the real estate market suggests that developers are finding in this segment a product that corresponds to the dynamics expected around the influence area of the future rail transit system. Micro apartments include other types of facilities such as gyms and parking areas that could be a challenge for the expected modal change that the local government expects for those who will be the residents within the area of influence of the metro project. The generation of micro apartments in the treatment area and the negative effects on the generation of new affordable housing constitute a planning challenge considering recent findings on the difficulties of promoting more socially diverse environments within the area of influence of mass transit projects in Latin America and the Caribbean (Vergel-Tovar, 2023). This topic requires further investigation in terms of analyzing the travel behavior problems of current and future residents within the project's catchment area. Another interesting dynamic observed in the analysis is related to the lower diversity observed in the socioeconomic levels of real estate development projects, which suggests that the market could shift towards socioeconomic levels two and three in the treatment area.

Although this paper focuses on real estate development projects and prices, the research findings are consistent with previous research in terms of the ability of mass transportation systems in Bogotá to attract development and new projects (Rodriguez et al., 2016; Vergel-Tovar & Rodriguez, 2022). This suggests that the metro system could strengthen the attractiveness of mass transit systems for developers. The findings of this study also confirm the concentration of residential developments in areas served by Bogotá's BRT network (Bocarejo et al., 2013), highlighting the importance of the accessibility benefits generated by the BRT system when developers seek development opportunities within the urban spatial structure. However, as shown in figure 6, the metro project is attracting high-density mixed-use developments that include a three stories commercial platform at the same elevation of the viaduct of the first line of the metro project. On top of the commercial platform, residential towers emerge consolidating an urban form that might continue in the urban redevelopment process of the city if there is not an application of land-use planning and management instruments that may promote the generation of new public spaces, road space, active mobility infrastructure and an

integration with the new mass transit infrastructure of the first metro line of the metro project in Bogota.

Figure 6. New developments on Caracas Avenue in front of the future elevated infrastructure of the First Line of the Metro Project of Bogota. *Sources: Fieldwork visits in 2024*

The research findings regarding urban regulations suggest a challenge. Analysis of the data shows that urban renewal partial plans have positive effects on the prices of real estate development projects and therefore the areas designated for urban renewal measures are certainly becoming nodes where further developments could take place with densities to absorb higher land values. Considering the guidelines established in the Territorial Planning Plan, the local government can find some incentives by promoting some urban management tools such as inclusionary housing measures (Calavita & Mallach, 2010; Santoro, 2019) that could anticipate possible negative effects on affordable housing projects. Furthermore, urban renewal partial plans have been the subject of controversy in Bogotá due to equity concerns on the part of residents (Pinilla & Arteaga, 2021), therefore, policies that aim for more inclusive measures could be promoted as part of the incentives necessary to attract private developers with multiple types of housing in the areas that will be served by the metro project. This is certainly part of the current discussions in Latin America about equity in relation to transportation projects (Vecchio et al, 2020).

Our findings regarding the PLMB suggest that there is potential for a value capture mechanism. Considering that developers are already taking advantage of the proximity to the future metro line; the local government could determine some regulations for future developments based on their location in relation to future metro stations. This would allow the local government to participate in the capitalization of the accessibility benefit that the project offers through various mechanisms, including mechanisms such as the issuance of construction licenses, incentives for higher floor area ratio regulations or the transfer of development rights TDR. In addition, based on current regulations on the promotion of urban renewal dynamics close to the metro project, the local government could determine value capture mechanisms linked to greater buildability for future

developments close to the metro project stations. We recommend continuing with further studies that analyze potential changes around metro stations based on the analysis of data on land use and development dynamics within the legal framework defined by the Territorial Planning Plan and its regulation through planning and management figures that define the regulation in the areas of influence of the PLMB and the L2MB such as Strategic Actions (*Actuaciones Estratégicas* in Spanish), Multimodal Integration Areas – (*Áreas de Integración Multimodal* AIM in Spanish) and Urban Renewal Projects for Sustainable Mobility (*Proyectos de Renovación Urbana para la Movilidad Sostenible* PRUMS in Spanish). Our findings on the L2MB suggest that it is premature to identify the effects of the announcement of the new metro line on real estate development projects in terms of prices. We consider it important to continue carrying out this type of analysis to determine whether the L2MB project will have effects on real estate development projects once the tender is awarded. Considering that this is an underground line, it is important to note that the analysis must incorporate the distances to the stations as a control variable.

The present study has some limitations. First, the databases provided by GI included some key attributes for real estate development projects, but since the data are mainly collected from the sales offices of developer agencies, other attributes included in the hedonic pricing models in the literature, such as the floor location for each housing unit, the provision of parking within each development project and its association with each housing units, and other architecture characteristics of the housing units were not fully available. Furthermore, some variables related to environmental aspects related to pollution and air quality were not included in the analysis due to a lack of information at the local level. The data analysis includes urban regulation data covering several blocks and therefore the analysis may not capture changes in urban regulations at the parcel level. While the citywide database of real estate development projects was accessed, the data analysis has limitations regarding market dynamics at the regional scale, where projects being developed outside of Bogotá are a factor for the developer's decision. Another limitation of our study consists of the effects of the COVID-19 pandemic on the real estate market. In the year 2020, the real estate market slowed down due to the increments in construction costs during the pandemic. We addressed this limitation by extending our analysis until 2023 so that the changes in the trend are observed three years after the pandemic.

6 Conclusion

The study of the effects of the future first line of the Bogotá metro constitutes an important area of research considering that this large infrastructure project will have impacts on the urban spatial structure, this research shows some of the anticipation effects on the real estate market. This work provides evidence of the positive effects on prices of real estate development projects due to the announcement of the first line of the metro project. Indeed, the analysis shows that the project milestones in terms of political decisions of the national and local governments regarding the metro have already generated responses from the private sector in the real estate market. The findings of the present paper provide a set of conclusions and recommendations for policymakers, planners, practitioners, developers, and local communities.

The results of the research confirm that developers are already responding to the announcements and progress of the first line of the Bogotá metro project. The data analysis shows that real estate development projects are already capturing some of the expected accessibility benefits that this rail-based public transport project will generate in the city. Given that the real estate market is having a positive reaction towards the first

metro line project, it would be appropriate to define policy measures from the local government that could guide these responses by generating incentives that promote more compact urban forms in the areas served by the future stations, including opportunities to improve the urban environment by promoting high-quality public spaces for pedestrians and active mobility.

Likewise, we recommend studying the regulation of value capture mechanisms in three-time frames. In the short term, we consider that the local government could capture a percentage of the capitalization in real estate projects with a charge at the time of approval of the construction licenses of the projects within the isochrones by the findings of this study. In the medium term, we recommend that the EMB lead real estate operations within the first isochrone where the value capture mechanisms allow financing the urban development of the immediate surroundings of the future stations, incorporating mechanisms such as greater buildability in exchange for the generation of high-quality public space for active mobility. In the long term, we recommend that the EMB identify two TOD pilot projects, one to be carried out in the PLMB and the other in the L2MB. Pilot projects could incorporate management and financing instruments that incorporate value capture mechanisms to finance urban development in the surroundings of both stations by applying management and financing instruments that attract private sector investment by incorporating cross-subsidies to guarantee the generation of the social housing supply.

Another research finding of this work is related to the contrasts in housing typology that are occurring, or not, within the area of influence of the future PLMB. The real estate market is generating micro apartments within the area of influence of the future project, with small housing units that mostly focus on promoting mixed and multi-facility developments. However, this type of development is linked to rental markets with increases in the parking areas offered to tenants. This implies a challenge or promotion of transport-oriented development results within the area of influence of the future metro project. Although there is an increase in the supply of social housing in some of the sectors of the area of influence of the Metro project, this supply is not homogeneous and in many cases is linked to the supply of micro-apartments. From an equity perspective, this is another challenge given that low-income groups, who are users of public transport, will have difficulty accessing land and housing in the areas that will be served in the future by the metro project. Thus, it is important to define incentives linked to inclusive housing measures that can help attract private developers with this type of housing within the area of influence of the future PLMB.

Finally, we recommend continuing with the statistical and spatial analyses of the effects that the Bogotá Metro project may have on the urban spatial structure of the city based on the findings of this study. New studies should include additional characteristics of real estate development projects such as the number of floors, parking facilities and changes to public facilities that may occur over time in the study areas. The EMB's Land Occupation and Value Observatory (Observatorio de Ocupación y Valor del Suelo OOVS in Spanish) has the tools to carry out this type of analysis, which would allow the identification of TOD pilot projects. These types of pilot projects have been carried out in Brazil (Hobbs et al., 2021) and Perú (BID, 2023; JICA, 2022) under an inter-institutional support scheme, and we consider that this type of exercise could be carried out in the case of the Bogotá Metro project. With the results of the statistical analysis, it is possible to define public policies for the pilot projects so that new activity nodes can be consolidated in the surroundings of the future stations, defining changes in the densities of the built area about the distance to the future stations, as well as the definition of land uses in terms of proximity to the Metro project infrastructure. We believe that the Bogotá Metro Company (EMB) could be the promoter and developer of real estate TOD pilot projects

so that value capture mechanisms can be explored through the rents of new land developments as well as those associated with changes in land use. Moreover, we recommend the development of long-term post-construction studies looking at the effects before and after of the Metro project of Bogotá. These new studies could include longitudinal data analysis by looking at the changes in the development projects over time with the beginning of commercial operations of the first line of the Metro project, which is expected to start operations in 2028.

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Author contribution

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