The Impact of Bus Rapid Transit System on Land Prices in Mexico City

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Lincoln Institute of Land Policy
Working Paper

Lincoln Institute Product Code: WP13DV1

Abstract

This paper estimates the effect of the Bus Rapid Transit (BRT) system of Mexico City on residential land prices in the formal real estate market. Specifically, we estimate the effects of Line 1 (on Insurgentes Ave.) and Line 2 (on Axis 4 South) of the Metrobus, which is the name of the BRT in the Mexico City. A quasi-experimental approach is used, with the roadways mentioned as the treatment group and a control group compring the southern section of Insurgentes Avenue (where the Metrobus was not initiallty built) and Axis 6 South (which is a road that runs parallel to Line 2). The strategy used to ensure that the treatment group can be compared with the control group, and to isolate possible effects of ongoing infrastructure works, was to estimate the effects by area on different sections of the BRT. The main findings are that the north and south end segments of Insurgentes Avenue are comparable and allow for an unbiased estimation. Line 1 produced an increase of approximately 15 percent in land prices, while the estimates for Line 2 showed no evidence that land prices were affected by the BRT infrastructure investment. This last result may be associated with the time period used for the assessment of effect, which is the entire construction period plus 5 months after the service was inaugurated. Possibly this is a too short a period to measure impact.

Keywords: BRT, land prices, urban transit, Mexico City public transportation, infrastructure investment impact on land prices.

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Acknowledgements

I wish to thank the Lincoln Institute of Land Policy for funding this research, and the Secretary of Finance of the Federal District for providing the data used in the empirical analysis. The support provided by Raúl Lemus, from the Computer Service Center of El Colegio de Mexico was essential to obtain georreferenced data and generate the maps. The comments received during the research seminar organized by the Lincoln Institute of Land Policy, and in particular from Anna Sant'Anna and Onésimo Flores, who reviewed the first draft of this paper, were important in producing this final version.

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1. Introduction

The development of mass transit infrastructure based on Bus Rapid Transit (BRT) systems is viewed with excitement by planners and experts on the subject. Some of the main advantages of this transit system are the flexibility of its physical implementation, its cost effectiveness when compared to other alternatives—such as trains or subways—and the ability to improve access, mobility and quality of life for its users (Levinson, Zimmerman et al. 2003).

The goal of this paper is to make a contribution to the empirical literature about the effect of this particular transit system on the value of land and at the same time, to generate additional evidence of the effect of transportation infrastructure on the value of land in the context of developing countries. We estimate the effects of Lines 1 and 2 of Metrobus on residential land values in the formal real estate market, within an area of influence of 500 meters from the BRT corridor.

The BRT transit system is growing rapidly, both in developing (especially in Latin America) and developed countries (EMBARQ, 2011; Levinson, Zimmerman et al. 2003), and Mexico has implemented this system in the cities of León (Guanajuato) in 2003, Mexico City in 2005, and Ecatepec (State of México) in 2010. In Mexico City, the Corridor System of Confined Public Transport (*Sistema de Corredores de Transporte Público Confinados*), Metrobus, is one of the most important public investments in public transit and road infrastructure, started in 2005 and still expanding. Three bus corridors have been completed to date, and a fourth is under construction, for a total of 67 km, plus another 27 km crossing the historic center of the city, which will be available soon.

In Mexico, as in other countries with an expanding BRT system, it is important to understand the changes in real estate development that can be produced by such investments, in order to anticipate their benefits and fiscal impact. Economic theory predicts that improvements in mass transit systems not only reduce transportation costs and improve accessibility, but also reflect these advantages, in whole or in part, on land prices. In the case of traditional mass transit systems, such as the train or the subway, there are numerous studies in developed countries as for example, Agostini and Palmucci (2008). For BRT systems, there is not yet a great deal of empirical evidence about their effect on the real estate markets.

The empirical evidence on the Colombian BRT "TransMilenio" (Rodríguez and Targa, 2004), shows that it had a positive effect on land prices, but because the study uses a cross-sectional analysis, it is not possible to know if the BRT stations were simply located in high value areas, or if the value was generated by the BRT itself. Rodriguez and Mojica (2008) also estimate changes in land prices in Bogotá after the extension of the Transmilenio, comparing periods before and after the extension. The authors find mixed results: a positive effect on land prices near existing BRT stations, and no effect in areas near the new stations. In Seoul, South Korea (Cervero and

Kang, 2001), there was a positive effect on land prices, and this effect was greater for nonresidential land.

In Mexico, a study conducted by Flores (2011) found that the effects of the BRT announcement in Ecatepec, State of Mexico, depended on the quality of the homes. For Mexico City there are no studies to date on the impact of the Metrobus on land prices.
Unlike the studies mentioned above, the data used for the present analysis are not home prices, but land prices. This information was provided by the Department of Finance of the Federal District, and is obtained from the commercial assessments required for all sales transactions in the formal real estate market. The assessments are believed to reflect true market prices, as the Department regulates and monitors the performance of the land assessors. The database used for the analysis was complemented with demographic and statistical information from the National Institute of Statistics and Geography (*Instituto Nacional de Estadística y Geografía*, INEGI).

The methodology for analysis is a quasi-experimental approach, which estimates the difference-in-difference of two treatment variables, Lines 1 and 2 of the Metrobus, and two control variables, during the period before and after the introduction of each of the BRT lines. The difference-in-difference estimators render unbiased estimations, as they control for both observable and unobservable variables not explicitly included in the regressions and show the same trends across groups. The BRT corridors were divided into sections to allow for estimating the separate effects by area, as the land use along the corridors is not homogeneous. Also, in the case of Line 2, this segmentation was used to explore if the announcement of the Line 12 of the subway system and the beginning of its construction contaminated the control group.

The main findings are that the northern section of Metrobus Line 1 increased land values by approximately a 14.6 to 15.8 percent within 500 meters of the BRT corridor. There was no empirical evidence that Metrobus Line 2 affected land values. However, this latter finding may be related to the length of the period of observation, i.e. to our choice of the "before" and "after" periods. The period "after" starts with the announcement of the project, encompas its construction, but only covers five months after the Line started operatring. It is possible that the period of operation of this BRT lines was too short to produce meansurable effets on land values.

We also found another interesting result that requires a separate study. Apparently, the announcement and the beginning of construction of Metro Line 12 had no long range effect (at more than 500 meters) on the land prices of the control group which runs parallel to the path of this transit infrastructure. Moreover, the price for residential land located between 0 and 500 meters from a Metrobus station declined. This finding matches the results obtained by Velandia and Sanora (2011), in their study on the effects of zoning on land prices in Mexico City. These results seem mixed, but suggest that in Mexico City investments in public transit infrastructure such as the metro are not capitalized on land values.

This paper is organized as follows. The next section 2 reviews the literature; section 3 describes the characteristics of the Metrobus system in Mexico City, focusing on the BRT corridors object this study; section 4 describes the database and the variables used in the analysis; section 5 presents the methodology and the econometric model used, and section 6 concludes.

2. Review of Literature

Only recently has the BRT been implemented widely as a cost effective alternative for reducing transportation costs and urban traffic congestion and it use has expanded worldwide. It is possibly for this reason why there are so few empirical studies on the effect of these systems on land prices and land development.

Rodríguez and Targa (2004) estimate a spatial hedonic equation to calculate the magnitude of the effect of two main corridors of the Transmilenio on land prices in Bogotá. In their analysis the authors use an empirical specification that corrects for the spatial correlation between observations, and use as dependent variable the rental price of properties in a 1.5 kilometer strip on each side of the BRT line. They find that access to Transmilenio stations is capitalized on land values. For every 5 more minutes of (walking) distance to a BRT station, the rental price of a property is reduced by 6.8 to 9.3 percent. However, as the study used cross-sectional data, it is not possible to know for sure if the Transmilenio produced an increase in land values, or if the stations were located there precisely because land prices were high.

The study by Rodriguez and Mojica (2008), also for Bogota, uses data before and after the expansion of the Transmilenio, together with a control group, to explore if land prices changed due to the BRT. In this case, the authors use different estimation specifications, with mixed results. On the one side, they find an appreciation of between 15 and 20 percent in the asking price of the properties near Transmilenio stations built prior to the route extensions. This appreciation starts appearing one year after the start of operation of the Transmilenio extension. On the other side, there is no evidence that asking prices changed in the area served by the system extension where previously there were no BRT station. The authors explain these findings by arguing that perhaps there is no uniformity in the effects of the Transmilenio because the impact may vary with land use, whether commercial or residential for instance. It is also possible the land appreciation occurred before the system was formally announced, or that capitalization on land values becomes apparent only after a three year period. Finally, the authors mention that the findings may have been influenced by the economic recession affecting the country at the time of the data collection, and the effects of that might have been different depending on the neighborhood.

Cervero and Kang (2011) study the impact of the BRT on land prices and land use in Seoul, South Korea. Their findings highlight the importance of introducing regulated zoning areas before the implementation of the BRT: Land prices increased 10 percent for residential properties within 300 meters of the BRT stations, and more than 25 percent for commercial and nonresidential properties within 150 meters.

In Mexico, Flores (2011) studied possible anticipated effects on land prices of the announcement of the BRT in the city of Ecatepec, State of Mexico—a large, densely urbanized municipality in the northeastern fringe of the Mexico City metropolitan area. He estimated a hedonic model of difference-in-difference of home selling prices in Ecatepec, selecting a control group and designating as treatment group the observations within 1 kilometer of the planned BRT corridor. The results depend on the quality of the homes. Flores finds a negative effect of the

announcement of BRT construction on high quality homes, and a positive effect on low quality homes.

Building upon these prior studies, this paper estimates the effect of Lines 1 and 2 of the Mexico City BRT on residential land values in the formal real estate market, within an area of influence of 500 meters. We want to understand the effect of investments in BRT systems on accessibility, and how improved accesibility translates into land value, allowing for greater development and a better use of the land.

The data for this analysis differ from that of the studies mentioned above. We had access to the land prices of properties sold between 2003 and 2009, thanks to the commercial assessments performed by the Secretary of Finance of the Federal District. The methodology used in the analysis is a quasi-experimental approach, which estimates the difference-in-difference for two treatment variables, Metrobus' Lines 1 and 2, and two control variables.

This methodology eliminates biases due to observable and non observable variables that are not included as controls and have the same trends between groups, and it also eliminates fixed individual effects. In the case of the Metrobus in Insurgentes Avenue (Line 1), the empirical identification strategy consideres the effects for two segments of Line 1, to account for the fact that the control group is more similar to the northern segment of Insurgentes Avenue than the central segment, that is a business center. In the case of Axis 4 South—our second treatment group—we also partition the corridor in two segments to eliminate any possible interaction of the effects of the BRT with the construction of Line 12 of the subway system, which runs parallel to one segment of the control group, and whose announcement and start of construction were approved during the BRT "after" period considered in the study of Axis 4.

3. The Metrobus System in Mexico City

The approval of the Metrobus Insurgentes corridor was officially announced in October of 2004. This would be the first BRT line in the city (Government of the Federal District, 2004). The idea of a new public mass transit system first appeared in the government agenda in 2002, at the same time as the program to improve air quality. The air quality program, jointly implemented by the city and the State of Mexico, identified motor vehicle transportation as one of the main contaminants. Metrobus was seen as a viable alternative to gradually replace the medium capacity, privately owned, public transit system, composed of a fleet of buses, microbuses, and minivans serving the city.

The plan for the BRT was developed initially by the Integrated Transportation and Roads Program (*Programa Integral de Transporte y Vialidad*) which considered the implementation of five confined corridors during 2001–2006 (Government of the Federal District, 2002), and an additional 33 corridors to be built by 2020 (Kete, et. al. 2005). The basic design of the physical infrastructure of the system has direct effects on the environment, the users and the city population as a whole.

The operation of BRT system is regulated and controlled to satisfy the changes in service demand during the day; its physical infrastructure predetermines the number and location of stations (both terminals and stations along the path) to allow passengers to enter and exit the bus rapidly. The service is provided by articulated and bi-articulated buses. Its direct impact on environment quality is evident: the BRT produces very low contaminating emissions (100,000 metric tons fewer CO_2 emissions into the atmosphere per year) and lower noise contamination, as it eliminates the overlap of bus and microbus routes. Another environmental benefit is the recovery of green and recreational areas that took place in conjunction with the construction of the BRT corridors.

The actual service provided by the BRT aimes to serve the same transportation needs of the users but offering higher quality and greater accessibility, resulting in a 50 percent saving in travel time (Negrete, 2008). From a theoretical point of view, we can expect this improvement in quality and accessibility to be captalized, either in whole or in part, on the land values near the BRT stations. The assumption here is that the benefits provided by the BRT stimulate and promote development and better land uses within its area of influence, translating its greater accessibility into the price of land.

New Role of the Public Sector

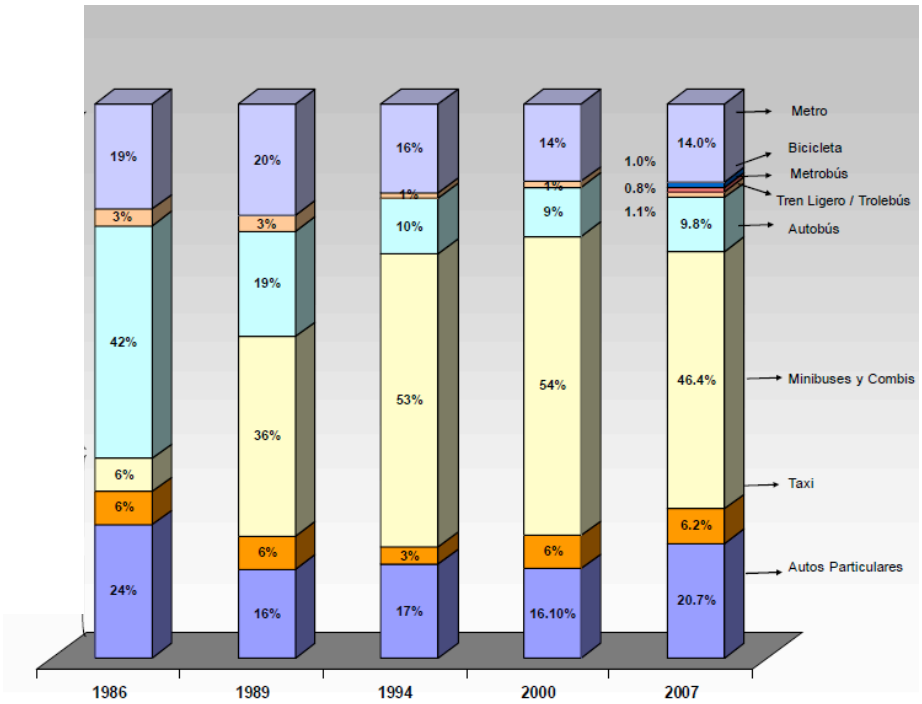
Besides innovations in infrastructure and physical organization of the transit system that came about with the BRT in Mexico City, the system also introduced another novel element as to the way the public sector participates in the transit system. Traditionally, the public sector owns and directly operates high-capacity mass transit systems using carriers that emit fewer contaminants into the air compared to the private fleet. These systems comprise: the Bus-Metro Transportation System (*Sistema de Transporte Colectivo-Metro*); the Electric Transport Service (*Servicio de Transportes Eléctricos*), a light-rail and trolleybus service; and the Passenger Transport Network of the Federal District (*Red de Transporte de Pasajeros*) with a diesel bus fleet that introduced natural gas buses on two routes in June of 2011. As a departure from this ownership-management practice, the BRT was designed to operate with public sector financing and regulations but sharing sevice operation with the private sector.

Several Federal Government agencies participated in the planning, execution, and regulation of the BRT system. The Metrobus, as the BRT is known in Mexico City, is also the name of the decentralized public agency created to plan the expansion of the system. It regulates system operations, monitors and supervises operational standards, and also controls BRT fares. Additionally, the Department of Transportation and Highway Administration is responsible to approve the corridors and authorize and subcontract service operation with private sector firms or by forming public-private partnerships.

Thus, the BRT introduced new trends in the public mass transit systems and in the role of the private sector in public transportation in Mexico City. Its impact is felt throughout the metropolitan area compring 58 municipalities in the State of Mexico and one municipality in the State of Hidalgo. Graph 1 shows the evolution of the different modes of transportation from 1986 to 2007 in the Metropolitan Area of the Mexico Valley (*Zona Metropolitana del Valle de México*, or ZMVM). Public transportation (subway, light rail, trolleybus and RTP) accounted for

64 percent of all trips in 1986, but only 24 percent in 2000; while the share of medium capacity systems (microbuses and minivans) increased from 6 to 54 percent in the same 16-year period, gradually replacing high capacity buses, which offered less frequent service at lower costs for their owners.

Graph 1. Estimated Transportation Modal Split in the Federal District and the Mexico City Metropolitan Area, 1986–2007



Source: Government of the Federal District (2007), based on data from the Integrated Transportation and Road Program for 1986–2000 and on the Origin-Destination Survey (INEGI) for 2007.

In this context, the ultimate aim of the BRT system is to replace the privately-operated medium-capacity fleet with a bi-articulated high-capacity bus service that involves public and private sector participation. In graph 1 one can observe that the Metrobus Line 1 on Insurgentes Avenue accounted for 0.8 percent of the 22 million trips taken in the ZMVM in 2007, or the equivalent to 2 percent (261,000) of the daily trips in the Federal District (Government of the Federal District, 2008a). In the same year, 2007, the share of the other modes of transportation operated by the public sector remained constant, while the share of trips by private microbuses and minivans declined by almost 8 percent in the Federal District.

Financial Resources of the System

The financing of the BRT is also innovative compared to prior practice in the city. In the first place, the service fare is determined by the Head of Government of the Federal District to cover the operating costs plus a profit margin for the service operators. As in other modes of public transportation owned by the public sector, there is a single fare for the BRT, independently of the

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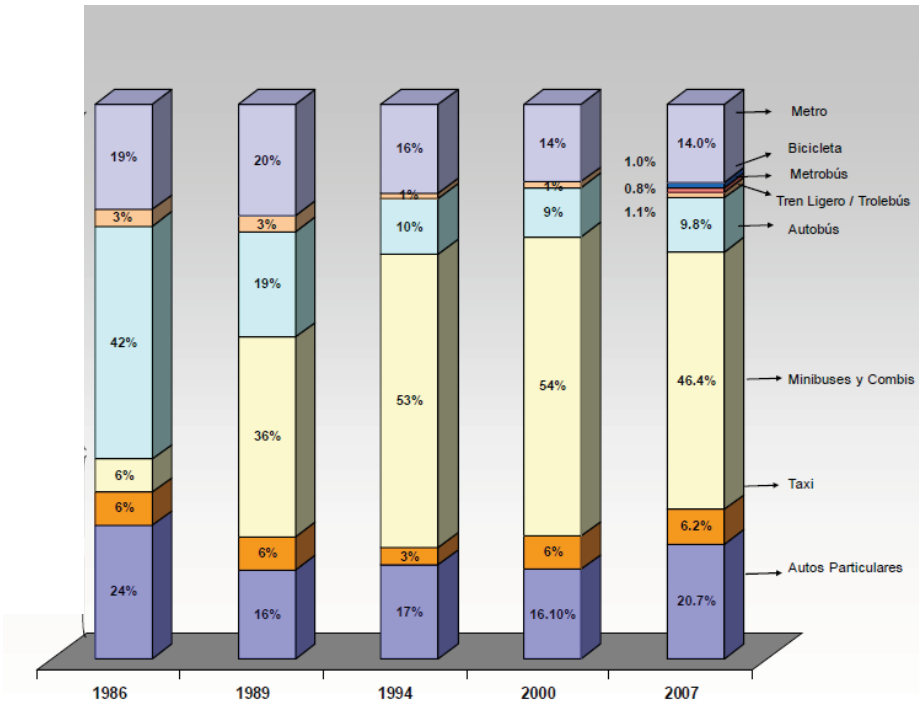

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distance traveled.[1] This is different than the fares charged by private buses, microbuses, and minivans serving the area now covered by Metrobus. These fares vary according to the distance traveled throughout Mexico City.

Second, the user pays 5 Mexican pesos for the Metrobus, and this fare covers all costs including toll fee and access control, services associated with the corridor, and operation of the decentralized Metrobus agency plus a profit margin for the private operators. This means that the system is not subsidized by the government as in other mass transit systems owned by the public sector. Rather, it provides for cross-subsidies among users. Those who travel shorter distances subsidize those who travel farther. Public resources clearly have a role in financing the construction of the infrastructure and modifying the roads for the BRT system. These resources subsidize the development of the transportation infrastructure of the city.[2]

Insurgentes Corridor (Line 1)

The choice of location for the Metrobus corridors was based on the demand for service and on the basic urban integration features of the corridors. The Insurgentes avenue corridor (Line 1), inaugurated in 2005, runs from Indios Verdes Avenue in the north to Copilco Avenue in the south. The choice of this corridor was predicated on many factors including high political visibility, physical and institutional ease of implementation, high service demand and high potential to improve air quality (Kete, et. al. 2005).

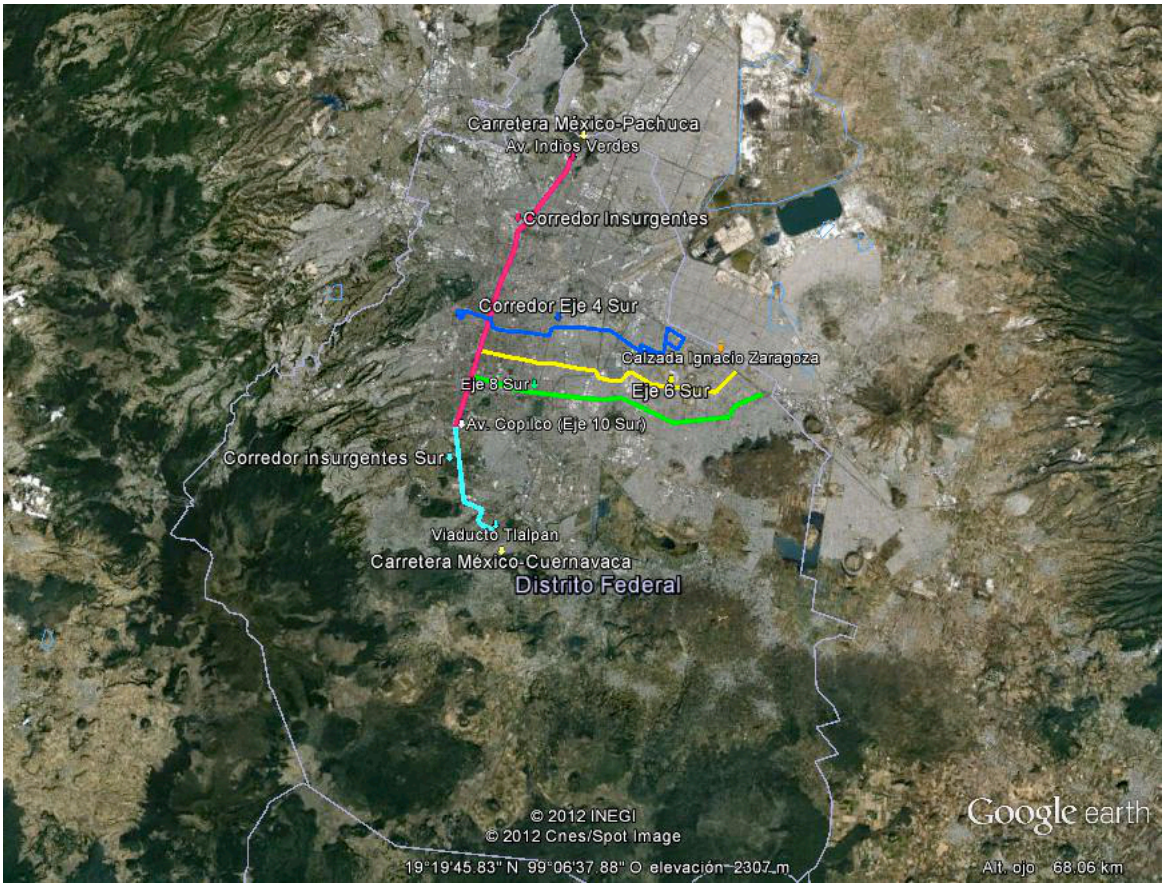
Insurgentes avenue, from its northern end (intersection with Indios Verdes Ave.) to its southern tip (where it intersects with the Tlalpan Viaduct) has an approximate length of 30 km, and represents approximately 10 percent of the main arteries in the city. The lane widths in this avenue allow vehicle circulation in 6 to 8 lanes in both directions. This main road has a unique and strategic location in Mexico City, as it crosses the city, connects to the north with the Mexico-Pachuca federal highway, in the State of Mexico and to the south with the Mexico-Cuernavaca federal highway, in the State of Morelos (see graph 2). Besides its strategic location and connection with two trunk highways, Insurgentes avenue is also important for its daily traffic circulation. In 2004, an estimated 6,400 cars circulated in each direction on Insurgentes per hour, moving about 250 thousand passengers daily, with a vehicular stock of 350 public transportation units (Government of the Federal District, 2004).

The planning and development study for the implementation of the Insurgentes Corridor (Line 1) had as scope the entire length of the avenue (Salazar and Lezama, 2008), from Indios Verdes to the Tlalpan Viaduct. However, the segment of Line 1 initially build, as announced in March 2004, covered just the first 19.4 Km (12 miles) of Insurgentes avenue, from the Indios Verdes Terminal to the intersection with Axis 10 South (red line in graph 2, labeled “Insurgentes Corridor”).

[1] Transfers between the Insurgentes Corridor (Line 1) and Metrobus Line 2 can be made at the intersecting stations between the lines (Nápoles and Nuevo León). In order to transfer from Line 1 to Line 3, passengers have to exit the system and reenter in Etiopia station. In this case, the system recognizes one ticket per electronic card used to get on Line 2, and the user does not have to pay again.

[2] The fare proceeds are collected by automated devices and transferred to a central trust that manages the resources of the corridor.

Graph 2. Map of the Metrobus Lines: Insurgentes Corridor (Insurgentes and Insurgentes South sections), Axis 4 South and Axis 8 South Corridor



Source: Image from Google Earth.

The reason for building the Metrobus in only one section of Insurgentes Avenue was mainly political, and guided by the availability of financial resources. The first stage was inaugurated in 2005 in a hurry so as to take place before the end of the term of the Head of the Federal District Government. There was also a lot of resistance to extending Line 1 further to the south, especially from microbus owners who filed legal suits (injunctions) to continue operating in the event the Department of Transportation and Highway Administration revoked their licenses. Another reason supporting the the start of the project in the north was a greater supply and demand of mass transit in that segment of Insurgentes, as the area connects with the suburban municipalities of greater Mexico City, while the southern area does not extend beyond the limits of the Federal District.

After a period of uncertainty as to the extension of BRT of Line 1 to the south, feasibility studies were contracted in 2007 to evaluate the construction of the Metrobus "Confined Corridor Insurgentes South." This study determined that the 8.23 Km (5.11 miles) of Insurgentes avenue between Copilco and the Tlalpan Viaduct had the right combination of passenger demand; need

to reduce contaminating emissions; and road and transportation infrastructure to justify extending Line 1 that way (Government of the Federal District, 2008a).

Despite the differences in length and size of the demand between these two corridors in Insurgentes avenue, they are comparable in terms of their location in the city and area of influence, which is mainly commercial. In contrast, the central segment of Insurgentes has a greater density of businesses, offices and restaurants, and lower resident population densities compared with the northern and southern segments of the avenue. With respect to the resident population, the upper socioeconomic levels are concentrated in the central section of the city. As we advance toward the both the north and the south periphery of the city, we find a combination of middle, middle-low and low-income residential areas (Schteingart, 2008), which are also areas of greater population density along the corridor (see map A1).

Axis 4 South Corridor (Line 2)

Line 2 of the Metrobus, also known as the Axis 4 South Corridor, is 20 km (13 miles) long and was inaugurated on December 16, 2008 (blue line in graph 2). The location of Axis 4 South was selected for its geographic position, connecting large housing areas on the eastern part of the city, and the high demand for mass transit along this segment of Insurgentes.[3] Axis 6 South (yellow route, graph 2), parallel to Axis 4, was another corridor considered for the construction of Line 2 (Government of the Federal District, 2008). The decisions to build Metrobus Axis 4 South and the Line 12 of the subway were announced almost simultaneously. The decision to build the extension of the Metrobus on Axis 4 South (rather than Axis 6) had to do with the fact that part of Metro Line 12 runs between Axis 7 and Axis 8 South (see map A3).[4]

4. Data

The data to estimate the effect on the price of land of the confined BRT corridors on Insurgentes and Axis 4 South was obtained from several sources. The price of land per square meter (m^2) was provided by the Department of Finance of the Federal District, for the period from January 2003 to June 2005, and from January 2006 to May 2009. These data was generated from records of commercial assessment used to calculate the tax on real estate acquisitions (*Impuesto sobre Adquisiciones Inmobiliarias*, or ISAI) levied on each property bought and sold in the formal real estate market in those years. The basis for the tax is the highest amount of the value recorded in the city cadastre, the value of the transaction, and the commercial assessment made within six months of the date of the property transaction.

The main worry when using information from commercial assessments performed for tax purposes is the incentive to underestimate the price of the property in order to reduce the taxable amount. There is no empirical evidence of the existence and/or magnitude underreporting for the

[3] Although the official notice of approval of the mass transit BRT corridor on Axis 4 South was published on June 23, 2008, the start of construction was announced in September 2007 and the corridor became operational December 16, 2008.

[4] The environmental impact report on Line 12 of the subway system was published in June 2008; and construction started in September of that same year.

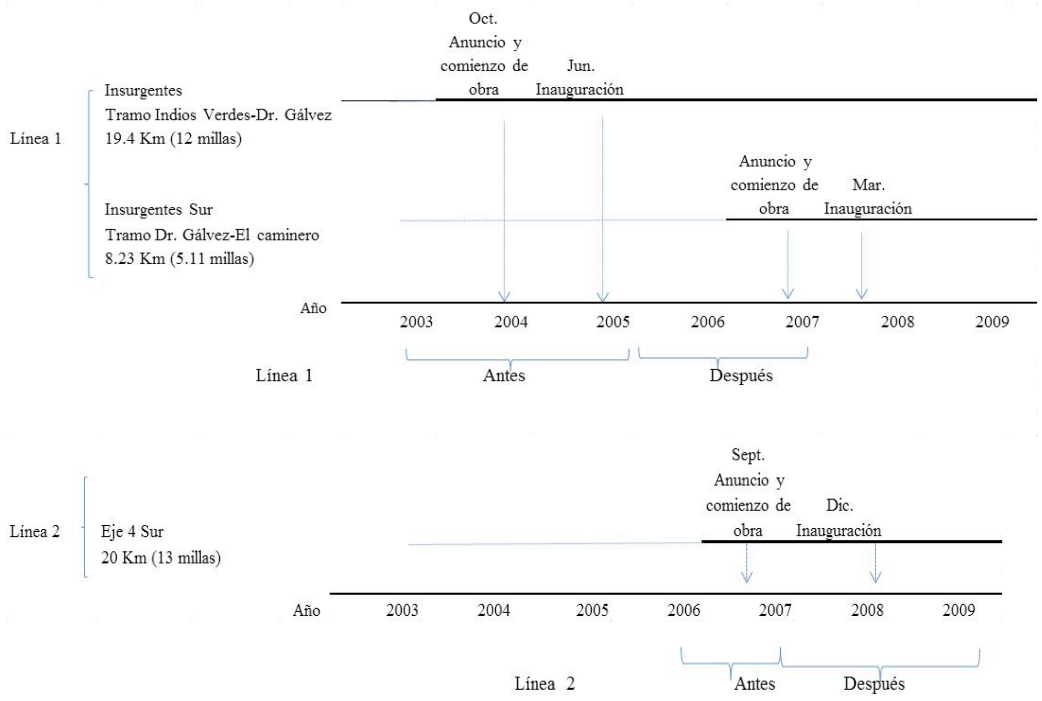
Federal District, and in any case, if underreporting is generalized to the entire city, then its effect on land prices is neutral for the purpose of this study. On the other side, we can consider the price of land as reported in this commercial assessment as reflecting market prices. That is because these assessments for the ISAI tax are carried out by commercial assessors certified by the Department of Finance, an agency that is responsible for monitoring and disciplining the assessors.

The analysis reported in this paper refers specifically to residential land transactions in the formal real estate market. The sample of observations used are prices for land parcels transacted in the formal market during the period of study, and located in the area of influence of the BRT—i.e. from 0 to 500 m from the Metrobus corridors.[5] The parcel observation was placed in the centroid of the region-block geographic area, and because it was not aggregated, we can have several observations in the same region-block. The unit of analysis is the region-block, and the database is composed of repeated cross sections, given that the probability of observing land prices/m^2 for the same real estate property in two periods that are close in time is low.

The observations were grouped in two periods—before and after the construction of the Metrobus Lines—as illustrated in chart 1. As the Insurgentes Corridor was inaugurated in June of 2005, the period 2003–2005 (June) was taken as "before" the intervention. The information from 2006 and 2007 was considered as belonging to the period "after" the intervention.

[5] We took samples along the BRT corridors instead of just close to the Metrobus stations because the stations are very close to each other, with a 600 meter distance between them. If we drew an area with a radius of 500 surrounding each station we would end up with overlapping areas. Line 1 has 30 km, 3 terminals, and 44 intermediary stations; Line 2 has two terminals and 34 stations in its 20 km trajectory.

Chart 1. Construction Period of Metrobus Lines 1 and 2



For the Metrobus Axis 4 South confined corridor, whose construction was announced in September of 2007, the period "before" was 2006 and 2007, and the period "after" was from 2008 to May of 2009. These periods were chosen because the number of observations available in the sample (actual formal real estate transactions) for the 5 months following the inauguration of the corridor was small. It follows that the treatment effect (if any) reflects primarily the land price changes that occurred during the period of construction, more so than the effect of the actual operation of this BRT corridor.

As the empirical analysis is implemented with a quasi-experimental approach, the challenge is to make the land parcels in the region-block geographic areas comparable between the control group and the treatment groups, so that the effect of comparing the average change in land prices per m^2 between periods and between groups is the result of the implementation of the BRT system.

The difference-in-difference (i.e. differences in time periods and differences between the control and treatment groups) eliminates the effect of observable and nonobservable variables that have the same time trend. To account for factors that affect land price and are not homogeneously distributed in the control and treatment groups, we introduce variables that account for urban and socioeconomic characteristics as controls. To control for urban characteristics we spatially located every subway station, commercial center, hospital and school, and created a dummy variable with a value of 1 if the land parcel is within a 500 meter radius of a subway station, 500 meters from a commercial area, 500 meters from a hospital or 200 meters from a school (or university). The information about urban characteristics was obtained from the database "Spatial Analysis Laboratory" of El Colegio de Mexico.

The information on socioeconomic characteristics was obtained from the National Institute of Statistics and Geography Information (INEGI). For observations prior to 2005, these variables are measured by geostatistical unit (*ageb*) of the General Census of Population and Housing for the year 2000. For 2005 and later, the corresponding values reflect information from the National Tally of Population and Housing of 2005.[6] The variables selected to control for socioeconomic characteristics are population and housing density, the age distribution of the population (percentage of people 18 years and older, and percentage of people 60 years and older), and educational level (percentage of the population 15 years and older with post-basic education). In addition, we used a marginalization variable, to characterize each *ageb* into five marginalization categories (very high, high, medium, low and very low). This classification was created by the National Population Council (*Consejo Nacional de Población*, or CONAPO) using principal component analysis to measure several marginalization indicators, such as degree of overcrowding, availability of basic services in the home (drinking water, drainage, electricity), size of the dwelling unit, and the residents' income level.[7]

To account for the effect of land use zoning on land prices, we included a categorical variable. Specifically, this categorical variable reflects a land use regulation called "Bando2" in effect from 2000 to 2006. This regulation divided the entire city in three zones. The zone corresponding to the Delegations located in the central city introduced higher FAR for home construction in order to increase population density. The zone comprising the southern and western delegations was subjected to growth control measures that limited new housing development. And the zone corresponding to the north and east side of the city was left unregulated. As Insurgentes Avenue (Line 1) crosses the city from north to south, and Line 2 crosses from east to center-west, the observations in our data sample are located in areas with different land use regulations.

Given that the central area of the Insurgentes corridor (Line 1) comprised high level of commercial, service and restaurant activities not found in the north and south segments (Schteingart, 2008), we included a dummy variable to identify the central segment to capture the effect of this type of activities on the price of land for residential use. The central segment of Axis 4 South (and its control group Axis 6 South) we also considered separately from the central and the eastern segments, because there is a close parallelism between Axis 6 South and a section of the Metro Line 12 (see map A3).

[6] The geostatistical unit (*área geoestadística básica*, or *ageb*) is the basic geographic reference used by INEGI. The information collected and generated by this Institute, is available to the public and comprises socioeconomic variables at this maximum level of diasggregation. One *ageb* may have one or more region-blocks.

[7] The variables included in the marginalization indicator are: Percentage of illiterate population 15 years or older, percentage of population 15 years or older that did not complete a primary education, percentage of home dwellers without sewer or sanitary services, percentage of home dwellers without electricity, percentage of home dwellers without piped water, percentage of homes with some level of overcrowding, percentage of homes with dirt floor, percentage of locales with fewer than 5,000 inhabitants, percentage of the population with incomes of up to 2 minimum salaries. We obtained this marginalization indicator data for the year 2000 from the 2000 General Census of Population and Housing. For 2005, the indicator was calculated based on the II Tally of Population and Housing of 2005, and the National Survey of Occupation and Employment 2005 (fourth quarter), given that the Tally did not collect income information.

Finally, we calculated the distance from each observation to the BRT corridor for the treatment groups, and the distance to the streets for the control groups, in order to capture nonlinear effects.

Descriptive Statistics

Graph 3 shows the behavior of median land prices between 2003 and 2007. The prices (in constant 2002 Mexican pesos) in the treatment area are higher than the prices in the control area during the entire period, showing a rising trend, interrupted by a descent between 2004 and 2005 (a period which coincides with the construction of the Metrobus station and the modification of the streets). Between 2005 and 2006 land prices increase again. The control group shows the opposite behavior for the period prior to 2005, when a decline in land prices ocurrs between 2003 and 2004; followed by a sharp price increase between 2004 and 2005, and by price stabilization after the inauguration of the Insurgentes Corridor (Indios Verdes-Copilco segment).[8]

Tables 1 and 4 describe the main characteristics of the data used to estimate the effects of the intervention on the Insurgentes (Line 1) and Axis 4 South (Line 2) corridors. Columns (1) to (4) show the difference between the treatment and control group for the variables included in the analysis demonstrating the degree of homogeneity beteween the groups in the period prior to the BRT inauguration. The averages, standard deviations and differences betwee the group variables are also shown in these tables. Column (4) shows the t-test of the difference, indicating if the variable is or is not homogeneously distributed between treatment and control groups. Because there can be more than one observation in the same region-block, the t-test estimate is corrected by correlation in this geographic area.[9]

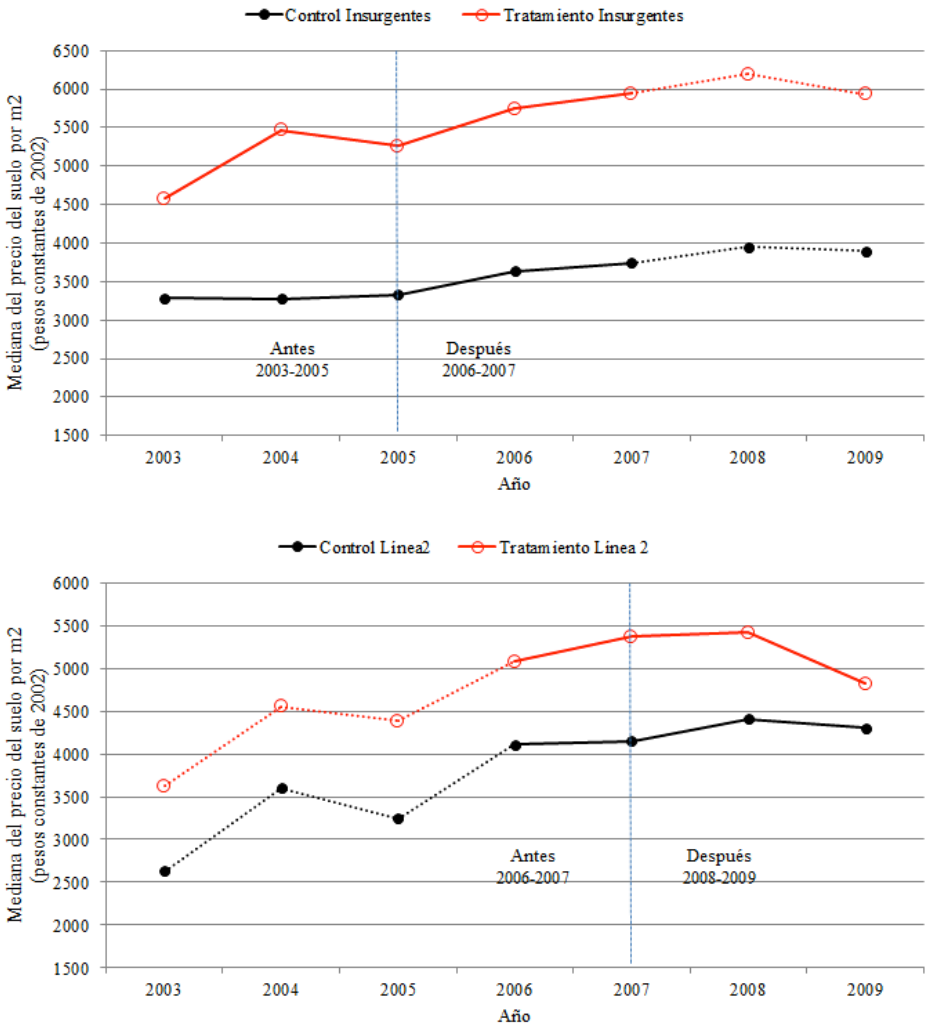
For the Insurgentes corridor, table 1, column 4 shows a difference in the price of land between the treatment and the control group (t = 1.67, table 1, column (4)), with a statistical significance of 90 percent, in the period prior to the inauguration of Metrobus Line 1. The covariants indicate that before 2005 these groups had differed housing density, demographic structure, marginalization levels and access to the city subway system. The significance and sign of the covariant differences confirm these disparities between the control and treatment groups. The treatment group has a larger number of occupied houses per km^2 (912 more housing units), a greater percentage of population 18 years or older (0.04 percent more), and a larger senior population (0.06 percent more) than the control group. Also, the treatment area has a lower level of marginalization: 89 percent of the observations in the treatment group have a very low level of marginalization, 10 percent a low level, and 0.1 percent a medium level. In contrast, in the control group marginalization levels are very low (58 percent), low (28 percent) and medium (14

[8] We used as synonyms for the Insurgentes treatment group the following expression: Metrobus Insurgentes corridor, Line 1 (Indios Verdes Ave.-Copilco Ave), Insurgentes Avenue tramo Av. Indios Verdes-Av Copilco. We named the Insurgentes control group as Insurgentes south corridor or Insurgentes Avenue Copilco Ave.-Tlalpan Viaduct.

[9] The t-test was calculated taking regressions of the variable of interest against a dummy variable which is equal to 1 if the variable is in the treatment group and 0 if it is in the control group. The regression was corrected by correlation in the following geographic areas: region-block, *ageb* and value area. This last unit was provided by the Department of Finance of the Federal District to designate geographic areas that have a homogeneous value. The significance of the variables does not change with the different measurements. The results obtained in the region-block are reported as a cluster unit, because these present the most conservative results.

percent). We also find differences in access to the subway system between the two groups. In the control group there is no observation within the area of influence of the Metro (500 meters), which is not true for the treatment group. Finally, the murder rate, introduced as a quality of life indicator, is statistically different and greater in the treatment area. These unbalanced covariants are included in the analysis to control for biases due to observed differences.

Graph 3. Prices of Land per m2 around Metrobus Line 1 (Insurgentes) and Line 2 (Axis 4 South) Periods "Before" and "After"



Nota: Los datos son la mediana de los precios del suelo habitacional en un rango de 0 a 500 metros los corredores y ejes viales.
Fuente: Elaboración propia. Secretaria de Finanzas Públicas del Distrito Federal

Regarding differences in sample size, note that the number of observations for the control group in the Insurgentes (Line 1) is much smaller than that for the treatment group. This fact, besides being associated with the different lengths of the Insurgentes Avenue segments considered part of the control and treatment groups, also shows that the residential real estate market along Insurgentes avenue has different dynamics, which could trend differently in time, and therefore could affect the price of land.

For the Axis 4 South corridor (Line 2) and its control group in t=0, the land price trend can be seen in the second part of graph 3. The dotted lines represent years for which we have information, but are not used in the analysis. In table 4 shows no significant difference (t= –0.49) between the two groups in the price of land; but the density variables are not balanced between groups, and Axis 4 South has more population and houses per km^2 than Axis 6 South. We also find that the observations located at 0 and 500 meters of Axis 4 South have better access to the subway system and schools, while those surrounding Axis 4 South have a higher murder rate per year in the period prior to the inauguration of the BRT Line 2. The the samples for the two groups in this corridor are similar in size and show similar real estate market dynamics.

5. Methodology for the Empirical Estimation

We used a quasi-experimental approach, with the region-block as the geographic unit of analysis, in order to determine if the BRT corridors had an effect on the price of land and estimate the magnitude of such effect. There are two treatment groups and two control groups, and the effects of each treatment are estimated separately. On one side are the observations of the treatment group for the Metrobus Insurgentes corridor (Line 1); observations for the corresponding control group are in the area of influence of the Insurgentes south corridor (the southern expansion was inaugurated in March 2008, see Chart 1). On the other side are the observations of the treatment group in the area of influence of Metrobus Axis 4 south (Line 2) and the corresponding control group which comprises observations of the area of influence of Axis 6 South.

In all cases, the area of influence of the BRT was defined as from 0 to 500 meters to each side of the corridors, along their entire length. 500 meters was also the distance used by other studies of the impact of the BRT on land prices. The diagnostic studies for the design of the BRT corridors in Mexico considered a band of 500 meter along both sides of the corridors, which is the distance that a person would normally be willing to walk from the point he leaves the public transportation system to his/her destination.

We selected the control groups aimed at the best comparator to the treatment groups. As mentioned earlier, the selection of the BRT corridors was not random, but rather took into account the volume of demand for public transportation, the geographic location and strategic connectivity to the city, the physical conditions to reserve a lane for exclusive use, and the political relevance of the route. In the selection of the control group for Line 1 of the Metrobus, we took advantage that the southern segment was not yet built in the period from 2005 to 2007, and and therefore could be an appropriate control group for Line 1. This is so, even though transportation demand was changing at the time all along Insurgentes avenue. This analysis does not take into account differences in passenger demand between the control and the treatment groups. However, these differences may affect the results of the analysis, as the Metrobus was introduced with the idea of replacing existing transportation services that satisfied the existing demand. Demand estimates calculated in 2004 for Line 1 registered 250 thousand trips per day, while the actual demand in 2007 was 260 thousand daily trips. As the passenger demand was not affected before and after the BRT in the period of this analysis, we considered that the demand effects that may influence the price of land also remain constant, at least in the short period

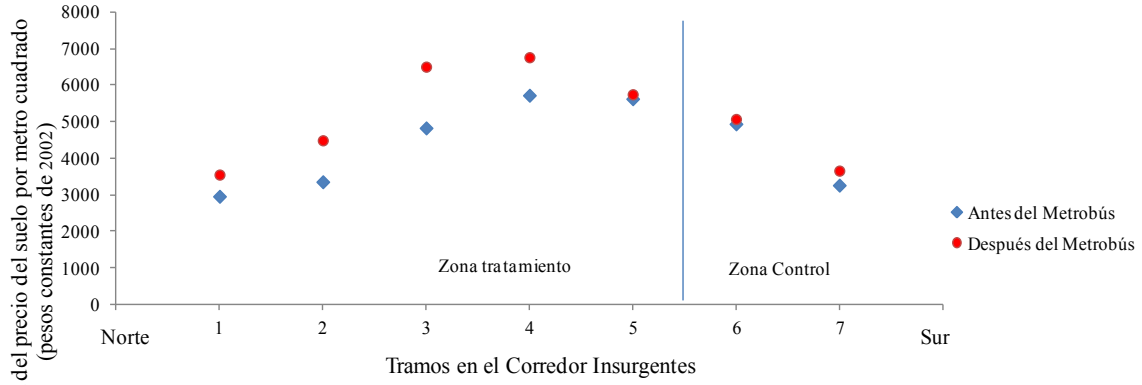
covered by this study.[10] This counterfactual allows us to control for nonobservable variables associated with the unique and important strategic location of Insurgentes avenue, while controlling for the observable differences in land parcels. The difference-in-difference captures the effect of observable and nonobservable variables that exhibit the same trends over time in the control and treatment groups.

While the control groups are considered good counterfactuals of the treatment groups, there is an important element associated with the creation of expectations, which can generate non-observable biases in the estimation of the BRT effect on the price of land. While it is true that the initial plans were to develop the entire Insurgentes avenue corridor (assuming that Line 1 would run throughout Insurgentes from north to south), there was a period of great uncertainty over the construction of the southern corridor of Insurgentes due to opposition from affected stakeholders (mainly the private microbus). Thus, it is reasonable to think that there were no expectations formed with respect to the construction of the Insurgentes South segment that would affected the price of land the before actual construction of the BRT Line 2.

Recognizing that the prevalent land use and level of marginalization are not homogeneous along the Insurgentes corridor, we subdivided the corridor into seven segments, as illustrated in graph 4 (see maps A1 and A2). Segments 6 and 7 correspond to the control group. The treatment group comprises segments 1 and 2 in the northern part of Insurgentes avenue and segments 3 to 5 in the central area of Insurgentes. Graph 4 shows the median land prices in each segment before and after the inauguration of the Metrobus Line 1. One can see that the highest land prices per m^2—both before and after the BRT—are located in the central area (segments 3 to 5), which is a business center between the avenues Reforma and Copilco. The residential control and treatment areas (segments 6 and 7 in the south end, and 1 and 2 in the north end, respectively) have more similar land prices. The price gradient is lower as we move toward the limits of the city. It is important to note that the prices before and after the BRT are practically the same in the control group, while in the treatment group prices after the inauguration of the Metrobus are higher in all the segments, and, in particular, in segments 3 and 4, as mentioned above.

[10] While Metrobus Line 1 is continuous along Insurgentes avenue, the pace of the articulated buses changes along the corridor to account for the variations in demand during the day in different areas. For example, if we divide Line 1 into 3 segments: (i) Insurgentes Indios Verdes-Glorieta, a medium demand segment; (ii) Insurgentes Glorieta-Doctor Gálvez, a high demand segment; and (iii) Doctor Gálvez-Caminero, a low demand segment, there is a group of articulated buses going through medium demand segments every 8 minutes, through high demand segments every 4 minutes and through low demand segments every 12 minutes.

Graph 4. Median Land Prices between 0 and 500 Meters of the Corridor in Different Sections of the Metrobus Line 1



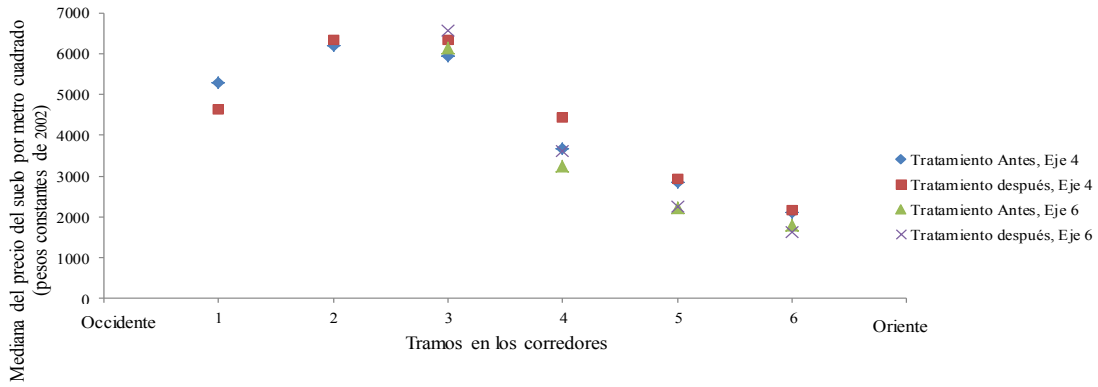
Tramos en el corredor insurgentes
Zona de Tratamiento: tramos 1 a 5
1. Indios Verdes-Avenida de los 100mts
2.Avenida de los 100mts-Reforma
3.Reforma- Viaducto Miguel Alemán
4. Viaducto Miguel Alemán-Río Mixcoac
5. Río Mixcoac-Av. Copilco

Tramos zona de control: tramos 6 y 7
6. Av. Copilco-Perfiférico Sur
7. Periférico Sur- Viaducto Tlalpan

If we study the differences along the Insurgentes corridor, we can try to gauge the impact of the BRT in the different areas. We estimated separately the effects in the northern area and the central area—even though we have included controls to account for the differences in the groups we compared—because there may be hidden biases generated by differences in nonobservable variables. Making comparisons between observations as homogeneous as possible can help us reduce these biases.

Graph 5 shows the pricing dynamic around the Metrobus Line 2 and its control group. We can see that the prices before and after the introduction of the BRT are very similar for both axes along the corridor. Section 3 corresponds to the area of Axis 6 that is parallel to the subway Line 12. The construction of this subway line started in December of 2008 (see map A3). The new subway line apparently has not affected the prices in the control group, as seen in the graph. However, because section 3 and sections 4–6 are different with respect to socioeconomic level, and distance to the city center and to Insurgentes Avenue, which is an important commercial area, we have made separate estimates for these two areas (map A1).

Graph 5. Median Land Prices between 0 and 500 Meters to the Corridor in Different Sections of the Metrobus Line 2 and Its Control Group



Tramos, vialidades que cortan los ejes 4 y 6 sur
1. Constituyentes-Patriotismo
2. Patriotismo-Insurgentes
3. Insurgentes-Calzada de Tlalpan
4. Calzada de Talpan-Rio Churubusco
5. Río Churubusco-Anillo Periférico
6. Anillo Periférico-Calzada Igancio Zaragoza

Empirical Specification

Given that observations were made before and after the inauguration of the Insurgentes corridor and the Axis 4 south corridor, we can estimate a difference-in-difference equation as an econometric specification, which allows us to identify the effect of each BRT line on the price of land. The equation we estimate is:

$$p_{it} = \alpha + \delta t + \gamma D_i + \tau t D_{ti} + \beta X_{it} + \mu_{it} \quad t = 0,1 \qquad (1)$$

The result variable, p_{it}, is the price of land per square meter in each period *t*, with *i*=1, 2,…n, for the Insurgentes corridor, and *i*=1, 2,…m for the Axis 4 south corridor (the equations for these two corridors are estimated separately with the same methodology). The dummy variable for time, t =1 indicates the period of time after treatment, and *t*=0 otherwise. D_i is the dummy variable that indicates the treatment group. It has a value of 1 if the observation belongs to the treatment group and 0 otherwise. The interaction $t * D_i$ identifies if an observation, i.e. a parcel of land, is in the treatment group after the inauguration of the BRT. Vector X_i allows for heterogeneity between observations that are unbalanced between groups, but stay fixed in time. Finally, μ_i is the idiosyncratic error.

The difference-in-difference indicator is $\hat{\tau} = (\bar{p}_{T,1} - \bar{p}_{T,0}) - (\bar{p}_{C,1} - \bar{p}_{C,0})$. The DD indicator identifies the effect after treatment, where the T subindex indicates treatment, and C indicates control, the numbers 1 and 2 identify correspond to the period before and after the inauguration of the BRT, respectively, and the bar above the result variable indicates the average value. The estimate $\hat{\tau}$ of difference-in-difference is the average effect of the introduction of a Metrobus line.

The coefficient(s) of the observable covariants between groups would disappear in cases where the value of $x \in X$ does not change from one period to the other. The DD indicator also allows for bias corrections for non observed covariants which maintain the same trend between periods; the possible bias in the second period (after treatment) if we were not to control for the permanent difference in the price of land between the control and treatment groups would also be eliminated. In sum, the difference-in-difference identifies the effect of the treatment and the effect of the time trend, as it eliminates the changes that affect all observations, treated and not treated, equally.

6. Main Results

The results of the estimate of the difference-in-difference equation for repeated sections, as specified in equation (1), are presented in table 2 for Insurgentes and table 5 for Axis 4. [11] The estimated coefficient [432.72 (table 2, column (1)] is the *Effect of the Insurgentes BRT Corridor* on the price of land if the treatment and control groups were directly comparable. In this case, the difference between the control group prices before and after the inauguration of the BRT would also be positive (720 pesos) and significantly different than zero; and the prices of the treatment group for the period "before" would be 862 pesos higher that the control group prices.

Table 2, column (2) shows that when we include the variables that account for the differences in land attributes across groups, such as the specific regulations (zoning), the social and demographic characteristics of the population, and the location factors (such as the distance to the corridor, closeness to a subway station, hospital, or school), the calculated *Effect of the Insurgentes BRT Corridor* increases (to 823 pesos) when compared with the one estimated in column (1). Also, the difference in price between the treatment and control groups in the period "before" is significant (807 pesos) and stays at practically the same level as in the case when controls are not included (862 pesos). In addition, the coefficient of the *period* variable is not significant, indicating that the prices in the control group for the period before and after the treatment are not significantly different.

The estimation in table 2, column (3) controls for unbalanced covariants between the treatment and control groups, as in column (2), but also includes the dummy variable *Business Center Area*, which has a value of 1 for the observations in the area of influence of the section Reforma Ave.-Copilco Ave. of the Insurgentes Metrobus. This variable is positive and significant, and its inclusion changes the significance and magnitude of the treatment estimators. When we eliminate the influence of higher prices of land in the *Business Center* section of Insurgentes, the column (3) coefficients are telling us that the prices of land before the Metrobus in the treatment and control groups were not statistically different (nonsignificant coefficient of the *control treatment group*); it also tells us that the prices of the control group before and after the

[11] The coefficients shown in tables 1 and 4 were calculated using the geographic unit region-block as a cluster, to correct for the correlation between groups of observations. The regressions were also corrected using the following geographic units as clusters: *ageb*, colony (neighborhood), zip code and value area (see definition of aged in footnote 6 and of value are in footnotes 9). The coefficients remain significant regardless of the cluster used; we present the region-block cluster because it renders the most conservative statistics.

Metrobus Insurgentes corridor show a positive and significant difference (603 pesos), and that the effect of the BRT on the prices of land is positive and significant (381 pesos) although its magnitude is less than 50 percent of the effect estimated in column (2).

Given the great change in the impact of Metrobus Insurgentes when we include the variable that identifies the central section of the corridor, we estimate separately the effects of the treatment on the residential areas, called here the northern area which corresponds to sections 1 and 2 of Insurgentes Ave. In graph 4 (Indios Verdes Ave.-Reforma Ave., see maps A1 and A2) and on the central area, using the same control group.

Table 3 shows the average land prices per periods and treatment groups. The last column (5) shows the t test, which indicates that the difference in prices between the two zones is statistically significant, and that the central section of the corridor has higher prices, as also seen in graph 4. With this segmentation of the corridor we have a smaller difference in the size of the groups compared, in particular in the northern area, before the advent of the Metrobus: 342 observations in the control group and 669 in the treatment group. The difference in real estate dynamics of these areas is maintained. The central section shows the strongest dynamics, both before and after treatment; while the control group has the lowest dynamics, and the northern section shows intermediate dynamics. As the real estate dynamics per area have the same time trend, the factors that affect the price of land associated with this dynamic also show the same trend, and therefore the difference-in-difference methodology employed eliminates the effect of the variables (observable or not) that have the same time trend before and after the treatment.

The control variables used in this analysis are distributed more homogeneously in the northern area and the control group (table 1, columns 5–8). The northern area is more densely populated and has more housing units than the control area, and also had greater access to the subway before the advent of the Metrobus. The level of marginalization is equally distributed between these areas, and so is the population educational level indicator, the share of people over 18 years old, and the number of schools. The availability of hospitals is higher in the control area, and the murder rate is higher in the northern area of Insurgentes. The similarities and differences between the central area and the control group are described in columns (9) through (12) in table 1, including the level of significance of the t-test.

In table 2, the regressions shown in columns (4) and (6) only include the variables that identify the period, treatment and effect of Metrobus Insurgentes corridor (difference-in-difference indicator) as if the observations between the groups were homogeneously distributed and comparable. The coefficient of the *period* variable is still the same as the one estimated in column (1), since the control group does not change. In the northern area, we can see that land prices (on average, 885 pesos) are significantly lower than the prices in the control group (column (4), table 2), and there is no evidence that the Metrobus changed the land prices in the area (nonsignificant coefficient of the variable *Effect of the Insurgentes BRT Corridor*).

When we control for the variables that affect the price of land and are not balanced between groups (column (5), table 2), we see that the prices in the control group before and after the Metrobus are not different; a result similar to that illustrated in graph 4. However, the difference in land prices before the inauguration of the Metrobus between both groups increases in absolute

terms (to 2,096 pesos). Note that the control group still has higher prices than the northern area. We see that the Metrobus in the northern area has a positive effect, with 85 percent significance, and an average price increase 671 pesos.

The empirical specification of column (6) (table 2) includes all the controls considered in this study (balanced and unbalanced), and if we compare these coefficients with the ones estimated in specification (5), we find that the land prices in the control group differ in 1,736 pesos between the "before" and "after" periods. We also find that the significance of the *Effect of the Insurgentes BRT Corridor* is 95 percent and its magnitude is maintained at approximately the same level (723 pesos) an increase of 15.8 percent (table 6). These effects are similar to the 6.8 percent and 9.3 percent increase found by Rodríguez and Targa (2004); and to the 10 percent increase found by Cervero and Kang (2011).

The estimates for the *central business area* of the Insurgentes corridor appear in columns (7) to (9) in table 2, which show that the prices of the control group after the advent of the Metrobus were higher than in the previous period. They also show that land prices in the central section of Insurgentes Ave. were higher than in the treatment group (positive and significant coefficients) before the advent of the BRT. The *Effect of the Insurgentes BRT Corridor* is positive and significant in specification (8), which only includes the period, group and difference-in-difference indicators; and in specification (9), which also includes the unbalanced variables between groups. The coefficients of the effect estimated by these two specifications are very similar (483 and 463, respectively). However, when we include the balanced covariants between groups as explanatory variables, column (9), table 2, the effect of the BRT on the price of land disappears. This change may be indicating the presence of other variables, observable or not, affect the result variable and are not controlled in the estimate for this part of the Insurgentes corridor. We acknowledge therefore that the central section of Insurgentes cannot be compared with the treatment area selected with the controls we have available.

Table 5 presents the results of the difference-in-difference estimates for Metrobus Line 2. As noted above, this effect corresponds to the capitalization of the land markets in the period after the announcement and 5 months after the inauguration of Line 2. So it covers mainly the construction period of the BRT. The empirical specifications in columns (1) – (3) show the average effect on the entire Line 2 corridor, while the specifications in columns (4) – (6) show the effect of the central section of the corridor (between Insurgentes Ave. and Rio Churubusco) and the last three columns (7) – (9) estimate the effect of the Metrobus in the eastern area.

The main result of this analysis is that none of the specifications show an effect produced by Metrobus Line 2. These results are similar to those of Rodriguez and Mojica (2004) for the Transmilenio in Bogotá, where land price appreciation one year after the inauguration of the BRT was not found. Table 3a shows the prices before and after the announcement of Line 2, per areas. We can see that the price of land in the area around Axis 4 is significantly different from the price of land in the treatment group for the eastern area before and after the Metrobus (t=1.94 in column (9), table 1, and t= 2.40 in the last row, table 3a). We also find that the prices of the central area were different from those in the eastern area before and after the Metrobus (t=5.07 and t=5.87, respectively). However, the estimates in columns (7)–(9) do not show any effect

when controlled by the balanced and/or unbalanced covariants [columns (8) and (9)] or when we consider that the control and treatment groups are homogeneously distributed [column (7)].

If we now look at the homogeneous results in the estimates for the eastern area of Axis 4 South and the central area, which is parallel and close to one section of the new subway Line 12, and considering that the price of land in the control and treatment groups was not statistically different before the advent of Metrobus Line 2 (t=–0.32 in table 3a and nonsignificant coefficients in the variable *Difference treatment-control*) nor after (t=–0.96 in table 3a), we can conclude that the announcement and start of construction of the Line 12 of the subway was not reflected in the prices of land in Axis 6 South during the study period.

For the BRT Line 2, we did not find an effect on the central area (the area of greater economic activity) nor in the eastern area (more residential, with less socioeconomic diversity), but, as found by Flores (2011), in the medium and long range this greater accessibility may be reflected in the prices of land. This is what we found in the north corridor of Metrobus Insurgentes, where two years after its inauguration a positive and strong effect on land prices was observed, as measured by different specifications.

Table 6 shows the estimated effects of the Insurgentes BRT (table 2) as a percentage of the average land price in each area in the period after the introduction of Metrobus Line 1. We can see an average effect of about 14.6 percent and 15.8 percent in an area 0 to 500 m from the corridor. This effect was calculated for the northern area and for the entire corridor using unbalanced controls between the control and treatment group (table 6, columns (5) and (2), respectively).

Other Control Variables

One interesting result is that, for BRT Insurgentes we do not find a significant relationship with respect to distance from corridor. This finding may be related to the way the distances were calculated; each observation was placed in the centroid of the block, and therefore all observations in the same region-block have the same distance to the BRT. In contrast, in BRT Axis 4 south, the distance from the corridor is significant and is positively related to the price of land (table 5) while the square of the distance is negative. In other words, for each meter of distance between the BRT and the parcel of land, the price increases, but this increase is lower each time and at some point it becomes zero and then negative.

The variable that identifies the effect of regulation (zoning), *Land Regulation: Redensification,* is significant and positive in the estimates for both BRT corridors, confirming the impact of the zoning code (Bando2) that increased housing and population densities has positively affected the prices of land (Velandia and Sanora 2011).

One important finding is that the influence of the subway stations is negative and significant for estimate (8) of the BRT Insurgentes (table 2). The same is true for the estimates in columns (2), (3), (5) and (6) for Axis 4 South. These findings contradict the empirical and theoretical literature about the land value capture of the accessibility associated with mass transit systems, such as train or subway (Cervero and Susanto, 1999; Charlermpong, 2007), even prior to the

operation of the system (Agostini and Palmucci, 2008). Velandia and Sanora (2011) also found a negative relationship between the price of land for residential use and the proximity to subway stations in the Mexican Federal District, where regressions estimating the effect of zoning on the land prices showed a negative and significant relationship between distance (being within 500 meters of a subway station) and a reduction in land prices.

7. Discussion and Conclusions

The main finding is that Metrobus Line 1 has a positive effect on land price, estimated between 14.6 percent and 15.8 percent in the northern section of the corridor (Indios Verdes Ave.-Reforma Ave.) within a period of two years after its inauguration. For BRT Line 2, we found no evidence to support the hypothesis of land value capture of the greater accessibility provided by the BRT in a period encompassing the announcement of the project, 1 year and 3 months after start of construction, and 5 months after the inauguration.

The positive effects of the Mexico City BRT in the northern section of Line 1 cannot be extended to the central part of the corridor, where an important business center is lcoated. The reason is that our control group for Insurgentes Line 1 is not sufficiently similar to the treatment group to establish unbiased comparative estimates. In this case, the estimates could follow the results of Cervero and Kang (2011), who found greater capitalization of nonresidential land use, as opposed to residential land. Another limitation of the study lies in the fact that it was not possible to analyze the effects of the BRT according to the quality or type of housing, as we had access to the prices of land, but not the total commercial assessments of the real estate properties bought and sold.

While we could not find any evidence of capitalization in land price of the investment in transportation infrastructure for Line 2 of the BRT in the time period considered, we cannot conclude that this lack of evidence will be extended to later periods. The positive effect of Metrobus Insurgentes was estimated in a two year period after its inauguration. Also, the empirical evidence for the Bogota BRT indicates that the capitalization on land prices does not occur immediately after the inauguration of a new transit system (Rodriguez and Mojica, 2008). In addition, the evidence in Mexico (Flores, 2011) shows that the announcement of the BRT does not always have a positive effect on land prices, but one cannot assert that it will be stable over time.

Other results show that the densification zoning regulation had a positive impact on the price of land. But we find no effect of the announcement and start of construction of the subway line 12 on land prices. We also find a negative relationship between land price and the distance to a subway station, even though in an earlier study such relationship was positive (Velandia and Sanora, 2011). The issue merits a separate study, given its importance in the theoretical and empirical literature associated with the subway systems in developing countries.

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Tables

Tabla 1. Corredor Insurgentes. Balance de variable de resultado y covariantes entre grupos de control y tratamiento, en el perido prevo al Metrobús.

	Todo el corredor (Indios Verdes-Av. Copilco)				Zona habitacional (Av. Indios Verdes-Av. Reforma)				Zona centro de negocios (Av. Reforma-Av. Copilco)			
	Tratamiento (1)	Control (2)	Diferencia (3)=(1)-(2)	Estadístico t (4)	Tratamiento (5)	Control (6)	Diferencia (7)=(5)-(6)	Estadístico t (8)	Tratamiento (9)	Control (10)	Diferencia (11)=(9)-(10)	Estadístico t (12)
n	2,373	342			669	342			1,704	342		
Precio suelo/m2	5197	4334	862.7	1.67	3449	4334.1	-885.08	-1.91	5883	4334	1548.9	3.60
	(1942.99)	(2093.85)	(515.85)		(1247.22)	(2093.85)	(463.82)		(1725.38)	(2093.85)	(430.05)	
Densidad Población	13063	11784	1278.7	0.79	17639	11784	5855	2.23	11266	11784	-518	-0.36
	(6721.106)	(3807.16)	(2001.76)		(9220.71)	(3807.16)	(2630.35)		(4255.80)	(3807.16)	(1438.42)	
Densidad viviendas	4277	3365	912	1.66	5137	3365	1772	1.99	3939	3365	574	1.09
	(2136.94)	(1253.72)	(549.23)		(3008.70)	(1253.72)	(891.41)		(1550.76)	(1253.72)	(525.65)	
%Población de 18 años y más	0.76	0.72	0.04	3.41	0.72	0.72	0.00	0.11	0.77	0.72	0.05	4.99
	(0.033)	(0.03)	(0.011)		(0.03)	(0.03)	(0.01)		(0.02)	(0.033)	(0.00)	
%Población de 60 años y más	0.19	0.13	0.06	5.29	0.17	0.13	0.04	3.16	0.20	0.13	0.06	5.80
	(0.032)	(0.027)	(0.011)		(0.02)	(0.027)	(0.01)		(0.02)	(0.027)	(0.01)	
Indicador nivel educativo	0.84	0.84	0.00	0.2	0.81	0.84	-0.03	-1.27	0.86	0.84	0.02	0.89
Grado de Marginacion medio	0.01	0.14	-0.13	-1.55	0.02	0.14	-0.12	-1.31	0.00	0.14	-0.14	-1.63
	(0.08)	(0.35)	(0.09)		(0.15)	(0.35)	(0.09)		(0.00)	(0.35)	(0.09)	
Grado de Marginacion bajo	0.10	0.28	-0.18	-1.6	0.27	0.28	-0.01	-0.07	0.03	0.28	-0.25	-2.22
	(0.30)	(0.45)	(0.11)		(0.45)	(0.45)	(0.15)		(0.18)	(0.45)	(0.11)	
Grado de Marginacion muy bajo	0.89	0.58	0.31	1.81	0.70	0.58	0.13	0.62	0.97	0.58	0.39	2.26
	(0.31)	(0.49)	(0.17)		(0.46)	(0.49)	(0.20)		(0.18)	(0.49)	(0.17)	
Metro	0.31	0.00	0.31	4.34	0.48	0.00	0.48	4.33	0.24	0.00	0.24	2.78
	(0.46)	(0.00)	(.07)		(0.50)	(0.00)	(0.11)		(0.42)	(0.08)	(0.00)	
Hospitales	0.56	0.67	-0.11	-0.65	0.28	0.67	-0.39	-2.33	0.67	0.67	0.00	0.01
	(0.50)	(0.47)	(0.17)		(0.44)	(0.47)	(0.17)		(0.47)	(0.47)	(0.18)	
Escuelas	0.99	0.94	0.05	1.01	1.00	0.94	0.06	1.11	0.99	0.94	0.05	0.96
	(0.07)	(0.23)	(0.05)		(0.00)	(0.23)	(0.05)		(0.08)	(0.23)	(0.05)	
Indice de homicidios	16.96	6.78	10.18	17.31	16.68	6.78	9.90	11.89	17.07	6.78	10.29	14.10
	(1.25)	(3.81)	(0.59)		(2.64)	(3.81)	(0.83)		(4.17)	(3.81)	(0.72)	

Se presentan las desviaciones estándar en paréntesis. Los t estadísticos se obtuvieron de regresar cada variable con una dummy de grupo (1, tratamiento; 0, control) corrigiendo por correlación entre la unidad geográfica *región-manzana* .

El grupo de tratamiento lo conforman las observaciones ubicadas entre 0 y 500 metros del Corredor Insurgentes del Metrobús desde el cruce con la Av. Indios Verdes hasta el cruce con la Av. Copilco. El grupo de control corresponde a las observaciones ubicadas entre 0 y 500 metros de la Avenida Insurgentes desde el cruce con la Av. Copilco hasta su cruce con el Viaducto Tlalpan. Los años 2003, 2004 y 2005 conforman el periodo antes del tratamiento, los años 2006 y 2007 son el periodo después del Metrobús Corredor Insurgentes

La fuente de datos para la variable precio de suelo/m2 fue obtenido de la Secretaría de Finanzas del Distrito Federal En el preriodo previo se tiene datos de 2003-2005, en el periodo "después" se tienen datos de 2006 y 2007. La fuente de datos de los covariantes es el INEGI, para el periodo "antes" se tomó como referencia el Censo de 2000 y para "después" el Conteo de Población 2005.

%porcentaje de población posbásica se define como el porcentaje de población de 15 años y más que tiene como máxima escolaridad algún grado aprobado en la educación preparatorio o superior.

El grado de marginación fue calculado por el Consejo Nacional de Población (CONAPO) para cada unidad geográfica ageb utilizando el tamaño de la localidad, educación e ingresos de su población, calidad de las viviendas y disponibilidad de servicios públicos. Se determinaron cinco categorías de marginación en el Distrito Federal, muy alto, alto, medio, bajo y muy bajo; en la muestra de este estudio no encontramos agebs con marginación muy alta o alta.

Tabla 2. Efectos del Metrobús en los precios del suelo en la Avenida Insurgentes (Indios Verdes-Av. Copilco). Buffer 500m

	Corredor completo (Indios Verdes-Av. Copilco)			Insurgentes norte: zona habitacional (Av. Indios Verdes-Av. Reforma)			Insurgentes centro: zona centro de negocios (Av. Reforma-Av. Copilco)		
Variable dependiente precio del suelo por m2	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Periodo (t=0 antes)	720.28***	336.44	603.77***	720.28***	329.77	1,736.65***	720.28***	576.23***	2,068.90***
	(213.68)	(237.21)	(242.38)	(213.92)	(318.17)	(361.92)	(213.77)	(269.69)	(333.67)
Grupo tratamiento y control	862.71***	807.50**	-734.53	-885.08***	-2,096.92***	-1,623.84**	1,548.90***	1,588.59***	2,386.03***
(0=control, 1=tratamiento)	(332.05)	(486.83)	(524.97)	(335.98)	(1,063.65)	(937.48)	(329.28)	(654.12)	(369.68)
Efecto del BRT Corredor Insurgentes	432.72**	823.50***	381.49**	412.80	671.25*	723.89***	483.31**	466.99**	-219.16
	(248.26)	(240.91)	(231.32)	(301.16)	(430.46)	(365.57)	(251.94)	(256.76)	(271.50)
Regulación de suelo: redensificación		2,845.52***	1,376.02***		1,455.02***	990.25***		1,524.22***	1,229.87***
		(229.73)	(255.85)		(456.49)	(453.94)		(359.48)	(334.84)
Regulación de suelo: restricción		2,739.53***	373.58		0.00	0.00		0.00	0.00
		(327.46)	(409.20)		(0.00)	(0.00)		(0.00)	(0.00)
Tamaño del terreno		-0.27*	-0.29**		-0.32*	-0.34**		-0.33*	-0.26*
		(0.17)	(0.16)		(0.22)	(0.18)		(0.20)	(0.17)
Metro		-96.51	-102.98		-47.78	116.13		-281.89*	-39.17
		(165.09)	(151.63)		(194.02)	(154.66)		(189.86)	(196.83)
Hospitales					1.75	525.48***			184.66
					(2.65)	(181.46)			(223.00)
Escuelas					-2.33	-2,791.66***			-1,921.69***
					(4.62)	(659.80)			(940.17)
Distancia a la Avenida Insurgentes		0.34	-0.39			-0.24		-0.41	1.29
		(1.60)	(1.51)			(1.99)		(1.78)	(1.42)
Distancia a la Avenida Insurgentes al		-1.34	-0.00		5,954.43	2.12		-0.50	-2.39
cuadrado		(2.66)	(2.60)		(5,710.10)	(3.15)		(3.07)	(2.34)
%Población con 18 años y más		3,145.77*	-905.43		793.23	-4,453.15*		338.98	-2,448.19
		(2,015.43)	(2,152.11)		(750.18)	(2,952.14)		(2,368.29)	(2,343.46)
%Población con 60 años y más		5,848.33*	1,712.10			-6,879.91***		1,041.37	-6,838.78***
		(3,635.50)	(3,789.93)			(2,602.89)		(4,860.46)	(3,197.76)
Grado de marginación medio		1,119.73*	397.08		57.55	1,255.30***		453.19	1,121.06**
		(724.39)	(724.07)		(117.06)	(616.66)		(823.86)	(669.96)
Grado de marginación muy bajo		551.73**	175.09			565.19***		-216.33	-781.76***
		(298.63)	(263.20)			(283.91)		(394.55)	(367.09)
Tasa de homicidios		-15.52	-73.38***		470.02***	121.44		-125.07***	-100.36***
		(34.19)	(32.13)		(208.90)	(114.57)		(24.55)	(24.87)
Zona centro de negocios			2,129.15***		-0.02				
(0=habitacional, 1=centro de negocios)			(247.62)		(0.02)				
Densidad poblacional						-0.03**			-0.06***
						(0.01)			(0.02)
%Población con educación posbásica						6,068.31***			9,901.85***
						(1,995.74)			(1,992.49)
Constante	4,334.15***	-1,685.76	4,944.00***	4,334.15***	2,847.54***	4,593.43***	4,334.15***	5,155.00***	2,062.13
	(322.22)	(1,529.06)	(1,671.23)	(322.58)	(1,242.81)	(1,880.47)	(322.35)	(1,677.38)	(2,158.03)
Observaciones	6658	6658	6658	2454	2454	2454	4947	4947	4947
R-Cuadrado	0.07	0.19	0.25	0.06	0.12	0.20	0.13	0.15	0.19

Errores estándar robustos en paréntesis. *** p<0.05, ** p<0.1, * p<0.15

La variable dependiente precio de suelo, tamaño del terreno, área de valor y ubicación geográfica fueron obtenidas de la Secretaría de Finanzas del Distrito Federal. Las variables demográficas utilizadas como controles fueron tomadas del INEGI y CONAPO. Los valores de los controles para el periodo anterior a 2005 corresponden a datos del Censo de General de Población y Vivienda del año 2000, los valores posteriores a 2005 fueron tomados del Conteo de Población y Vivienda 2005.

El grupo de tratamiento lo conforman las observaciones ubicadas entre 0 y 500 metros del Corredor Insurgentes del Metrobús desde el cruce con la Av. Indios Verdes hasta el cruce con la Av. Copilco. El grupo de control corresponde a las observaciones ubicadas entre 0 y 500 metros de la Avenida Insurgentes desde el cruce con la Av. Copilco hasta su cruce con el Viaducto Tlalpan. Los años 2003, 2004 y 2005 conforman el periodo antes del tratamiento, los años 2006 y 2007 son el periodo después del Metrobús Corredor Insurgentes

Las estimaciones fueron corregidas por intercorrelación con clusters utilizando la unidad geográfica región-manzana. Se utilizaron también como clusters las unidades geográficas: ageb, área de valor, código postal y colonia (barrio) pero no se encontraron cambios en la significancia de los coeficientes.

%porcentaje de población posbásica se define como el porcentaje de población de 15 años y más que tiene como máxima escolaridad algún grado aprobado en la educación preparatorio o superior. La categoría omitda en la variable de regulación del suelo es "no regulados"

Tabla 3. Precios promedio del suelo por zona. Metrobús Insurgentes

	Control	Tratamiento			Diferencia entre zonas	t estadístico
		Todo el corredor	Zona norte	Zona Centro		
		(1)	(2)	(3)	(4)=(3)-(2)	(5)
Periodo antes	4334	5197	3449	5883	2434	21.09
Desviación estándar	(1942.99)	(2093.85)	(1247.22)	(1725.38)		
N	342	2373	669	1,704		
Periodo despues	5054	6350	4582	7087	2504	10.07
Desviación estándar	(2296.27)	(2830.544)	(2797.48)	(2499.34)		
N	401	3,542	1,042	2,500		

Tabla 3a. Precios promedio del suelo por zona. Metrobús Línea 2

	Todo el corredor		Zona centro		Zona oriente		Diferencia entre zonas	t estadístico
	Control	Tratamiento	Control	Tratamiento	Control	Tratamiento		
		(1)		(2)		(3)	(4)=(3)-(2)	
Periodo antes	5577	5465	6426.0	6370	2965	3924	2446	5.07
Desviación estándar	(2389.90)	(2500.53)	(2040.49)	(2095.25)	(1196.36)	(2378.75)	(515.50)	
N	1,781	2,124	1,344	1,338	786	437		
Periodo despues	5924	5871	6753	6553	3042	4062	2491	5.87
Desviación estándar	(2525.68)	(2756.88)	(2134.66)	(2067.56)	(1421.92)	(3244.87)	(424.14)	
N	1097	1,592	852	784	245	398		
Diferencia Control y tratamiento. Después	-54		-200		1020			
t estadístico	-0.24		-0.96		2.40			

Tabla 4. Línea 2 del Metrobús (Eje 4). Balance de variable de resultado y covariantes entre grupos de control y tratamiento, en el perido prevo al Metrobús.

	Todo el corredor				Insurgentes Rio Churubusco				Rio Churubusco-Calzada Igancio Zaragoza			
	Tratamiento (1)	Control (2)	Diferencia (3)=(1)-(2)	Estadístico t (4)	Tratamiento (5)	Control (6)	Diferencia (7)=(5)-(6)	Estadístico t (8)	Tratamiento (9)	Control (10)	Diferencia (11)=(9)-(10)	Estadístico t (12)
n	2,124	1,781			1,338	1,344			437	786		
Precio suelo/m2	5465	5577	-111.8	-0.49	6370	6426.0	-55.84	-0.32	3924	2965	959.22	1.94
	(2500.53)	(2389.90)	(229.69)		(2095.25)	(2040.49)	-173.81		(2378.75)	(1196.36)	(495.71)	
Densidad Población	16523	15210	1312.8	2.51	15214	14218	997	1.57	18751	18264		0.58
	(4360.89)	(4902.99)	(522.48)		(2387.385)	(3951.90)	(636.70)		(5816.70)	(6136.15)	(840.83)	
Densidad viviendas	5365	4854	511	3.49	5383	4850	533	2.92	5334	4865	468.23	2.25
	(1012.73)	(1284.31)	(146.13)		(734.3794)	(1135.18)	(891.41)		(1361.50)	(1662.66)	(207.73)	
%Población de 18 años y más	0.75	0.75	0.00	0.36	0.75	0.76	-0.01	-1.27	0.74	0.69	0.05	6.08
	(0.05)	(0.04)	(0.006)		(0.07)	(0.03)	(0.01)		(0.04)	(0.04)	(0.01)	
%Población de 60 años y más	0.19	0.20	-0.01	-3.34	0.20	0.21	-0.01	-3.03	0.17	0.17	0.00	-0.07
	(0.02)	(0.04)	(0.002)		(0.01)	(0.02)	(0.00)		(0.06)	(0.03)	(0.01)	
Indicador nivel educativo	0.69	0.70	-0.01	-0.86	0.76	0.76	0.01	0.63	0.57	0.53	0.03	2.06
	(0.13)	(0.13)	(0.01)		(0.05)	(0.07)	(0.01)		(0.13)	(0.12)	(0.02)	
Grado de Marginacion medio	0.04	0.05	-0.01	-0.34	0.00	0.00	0.00		0.11	0.20	-0.08	-1.50
	(0.20)	(0.22)	(0.01)						(0.32)	(0.40)	(0.06)	
Grado de Marginacion bajo	0.13	0.15	-0.02	-0.63	0.00	0.04	-0.04	-1.93	0.36	0.49	-0.13	-1.81
	(0.34)	(0.36)	(0.03)		(0.00)	(0.20)	(0.21)		(0.48)	(0.50)	(0.07)	
Grado de Marginacion muy bajo	0.82	0.79	0.04	1.01	1.00	0.96	0.04	1.93	0.53	0.27	0.26	3.42
	(0.38)	(0.41)	(0.04)		(0.00)	(0.20)	(0.21)		(0.50)	(0.44)	(0.08)	
Metro	0.37	0.27	0.10	1.62	0.33	0.28	0.05	0.62	0.45	0.25	0.20	2.41
	(0.48)	(0.44)	(.06)		(0.47)	(0.45)	(0.07)		(0.43)	(0.50)	(0.08)	
Hospitales	0.76	0.75	0.01	0.20	0.92	0.90	0.03	0.64	0.47	0.28	0.19	2.47
	(0.46)	(0.44)	(0.05)		(0.27)	(0.30)	(0.04)		(0.50)	(0.45)	(0.08)	
Escuelas	1.00	0.99	0.01	1.57	1.00	0.99	0.01	1.00	1.00	0.99	0.01	1.66
	(0.00)	(0.08)	(0.004)		(0.00)	(0.23)	(0.05)		(0.00)	(0.11)	(0.01)	
Indice de homicidios	15.57	16.34	-0.77	-1.86	18.14	18.39	-0.25	-3.12	11.19	10.03	1.17	1.23
	(4.91)	(4.03)	(0.41)		(0.98)	(0.49)	(0.07)		(5.76)	(3.55)	(0.95)	

Se presentan las desviaciones estándar en paréntesis. Los t estadísticos se obtuvieron de regresar cada variable con una dummy de grupo (1, tratamiento; 0, control) corrigiendo por correlación entre la unidad geográfica *región-manzana* .

La variable dependiente precio de suelo, tamaño del terreno, área de valor y ubicación geográfica fueron obtenidas de la Secretaría de Finanzas del Distrito Federal. Las variables demográficas utilizadas como controles fueron tomadas del INEGI y CONAPO. Los valores de los controles no varían en los periodos antes y después, y fueron tomados del Conteo de Población y Vivienda 2005.

La fuente de datos para la variable precio de suelo/m2 fue obtenido de la Secretaría de Finanzas del Distrito Federal En el preriodo previo se tiene datos de 2003-2005, en el periodo "después" se tienen datos de 2006 y 2007. La fuente de datos de los covariantes es el INEGI, para el periodo "antes" se tomó como referencia el Censo de 2000 y para "después" el Conteo de Población 2005.

El grupo de tratamiento lo conforman las observaciones ubicadas entre 0 y 500 metros del Corredor Eje 4 Sur, Metrobús Línea 2, desde el cruce con la Av. Insurgentes hasta el cruce con la Av. Iganacio Zaragoza. El grupo de control corresponde a las observaciones ubicadas entre 0 y 500 metros del Eje 6 Sur desde el cruce con la Avenida Insurgentes hasta la Calzada Ignacio Zaragoza. Los años 2006 y 2007 conforman el periodo antes del tratamiento, los años 2007 y 2008 son el periodo después del Metrobús Corredor Eje 4 (Línea 2)

El grado de marginación fue calculado por el Consejo Nacional de Población (CONAPO) para cada unidad geográfica ageb utilizando el tamaño de la localidad, educación e ingresos de su población, calidad de las viviendas y disponibilidad de servicios públicos. Se determinaron cinco categorías de marginación en el Distrito Federal, muy alto, alto, medio, bajo y muy bajo; en la muestra de este estudio no encontramos agebs con marginación muy alta o alta.

Tabla 5. Efectos del anuncio y construcción del Metrobús en los precios del suelo del Eje 4 Sur. Buffer 500m

	Corredor completo			Eje 4 Sur desde Insurgentes-Rio churubusco			Rio Churubusco-Calzada Igancio Zaragoza		
Variable dependiente precio del suelo por m2	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Periodo (t=0 antes)	347.76***	217.35***	215.71***	327.23***	220.96**	221.26**	77.68	58.84	56.21
	(165.45)	(108.42)	(106.16)	(142.55)	(131.62)	(132.58)	(155.65)	(97.22)	(101.61)
Diferencia tratamiento y control	-111.80	77.08	-4.63	-55.84	66.24	-89.37	959.22**	-6.58	-135.66
(0=control, 1=tratamiento)	(229.70)	(162.81)	(148.79)	(173.82)	(169.98)	(169.52)	(495.79)	(188.92)	(222.52)
Efecto del Metrobús (doble diferencia)	-98.26	-60.27	-72.62	-144.08	-127.48	-136.11	60.31	144.81	138.45
	(254.87)	(180.09)	(175.90)	(221.36)	(194.49)	(192.21)	(389.87)	(295.88)	(300.10)
Regulación de suelo: redensificación		3,290.12***	2,285.92***					1,742.19***	2,095.30*
		(789.56)	(1,042.72)					(255.25)	(1,360.26)
Regulación de suelo: restricción		-297.75	-570.79**					-230.41**	-194.92
		(308.36)	(322.97)					(122.75)	(491.23)
Tamaño del terreno		-0.96***	-1.01***		-1.04***	-1.08***		-0.93***	-0.99***
		(0.26)	(0.25)		(0.28)	(0.27)		(0.47)	(0.49)
Metro		-639.55***	-473.97***		-811.85***	-680.48***		199.22	186.52
		(163.09)	(117.52)		(145.88)	(143.24)		(203.37)	(201.30)
Hospitales			78.57			198.45		-214.37	-178.70
			(110.63)			(164.67)		(163.14)	(152.69)
Escuelas		417.02	231.24		-552.29***	-444.19***		373.04	605.66
		(725.98)	(605.98)		(185.77)	(174.91)		(582.89)	(641.04)
Distancia al Eje		1.17	2.29*		-2.21	-0.93		6.15***	5.97***
		(1.53)	(1.52)		(1.63)	(1.66)		(2.52)	(2.42)
Distancia al Eje al cuadrado		-1.77	-3.79*		3.60	1.25		-10.60***	-10.13***
		(2.76)	(2.63)		(2.99)	(2.96)		(4.41)	(4.17)
%Población con 18 años y más			-732.18			-3,294.99***		6,542.39*	7,936.15**
			(1,556.36)			(1,329.22)		(3,975.08)	(4,580.80)
%Población con 60 años y más		3,081.54**	-3,345.88*		-1,071.69	-6,301.40*			-3,244.01
		(1,751.46)	(2,284.73)		(4,204.48)	(4,265.65)			(2,822.54)
Grado de marginación medio			268.88*			0.00		219.88	147.19
			(174.63)			(0.00)		(194.56)	(193.71)
Grado de marginación muy bajo			11.24			424.24		475.23	553.89
			(278.57)			(468.71)		(423.51)	(454.16)
Tasa de homicidios		-5.01	33.49		-8.82	63.39			-34.85
		(61.82)	(64.06)		(62.01)	(72.85)			(103.10)
Densidad poblacional		-0.06***	-0.04***		-0.13***	-0.08***			-0.01
		(0.01)	(0.01)		(0.02)	(0.02)			(0.01)
dviv								-0.01	
								(0.04)	
%Población con educación posbásica			4,550.85***			5,613.03***		955.95	946.03
			(1,218.07)			(1,557.58)		(1,904.21)	(1,889.66)
Zona (0=centro, 1=oriente)			-219.20						
			(436.85)						
Constante	5,576.66***	3,217.45***	1,841.81**	6,425.95***	9,874.00***	6,392.23***	2,964.65***	-3,081.57	-3,255.83
	(141.68)	(878.95)	(1,058.10)	(123.75)	(1,417.84)	(1,898.44)	(101.99)	(2,243.26)	(2,346.88)
Observaciones	6184	6184	6184	4318	4318	4318	1866	1866	1866
R-Cuadrado	0.00	0.38	0.40	0.00	0.08	0.10	0.04	0.38	0.38

Errores estándar robustos en paréntesis. *** p<0.05, ** p<0.1, * p<0.15

La variable dependiente precio de suelo, tamaño del terreno, área de valor y ubicación geográfica fueron obtenidas de la Secretaría de Finanzas del Distrito Federal. Las variables demográficas utilizadas como controles fueron tomadas del INEGI y CONAPO. Los valores de los controles no varían en los periodos antes y después, y fueron tomados del Conteo de Población y Vivienda 2005.

El grupo de tratamiento lo conforman las observaciones ubicadas entre 0 y 500 metros del Corredor Eje 4 Sur, Metrobús Línea 2, desde el cruce con la Av. Insurgentes hasta el cruce con la Av. Iganacio Zaragoza. El grupo de control corresponde a las observaciones ubicadas entre 0 y 500 metros del Eje 6 Sur desde el cruce con la Avenida Insurgentes hasta la Calzada Ignacio Zaragoza. Los años 2006 y 2007 conforman el periodo antes del tratamiento, los años 2007 y 2008 son el periodo después del Metrobús Corredor Eje 4 (Línea 2)

Las estimaciones fueron corregidas por intercorrelación con clusters utilizando la unidad geográfica región-manzana. Se utilizaron también como clusters las unidades geográficas: ageb, área de valor, código postal y colonia (barrio) pero no se encontraron cambios en la significancia de los coeficientes.

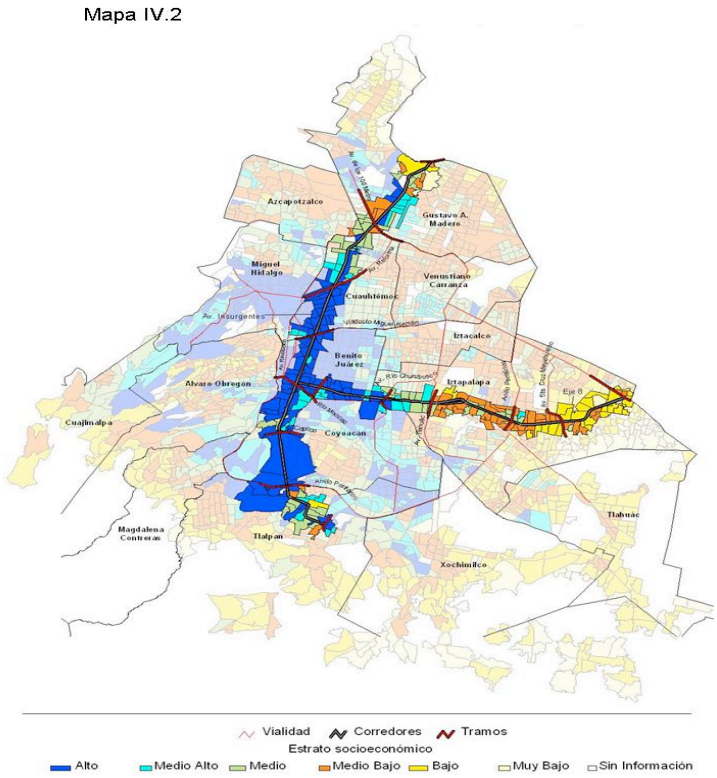
%porcentaje de población posbásica se define como el porcentaje de población de 15 años y más que tiene como máxima escolaridad algún grado aprobado en la educación preparatorio o superior

Tabla 6. Efectos promedio del Metrobús Insurgentes

	Toda la muestra			Zona norte			Zona Centro		
Efecto del BRT corredor Insurgentes	432.72**	823.50***	381.49**	412.80	671.25*	723.89***	483.31**	466.99**	-219.16
Precio promedio del suelo "después"	6350	6350	6350	4582	4582	4582	7087	7087	7087
%	6.81	12.97	6.01	9.01	14.65	15.80	6.82	6.59	-3.09

Maps

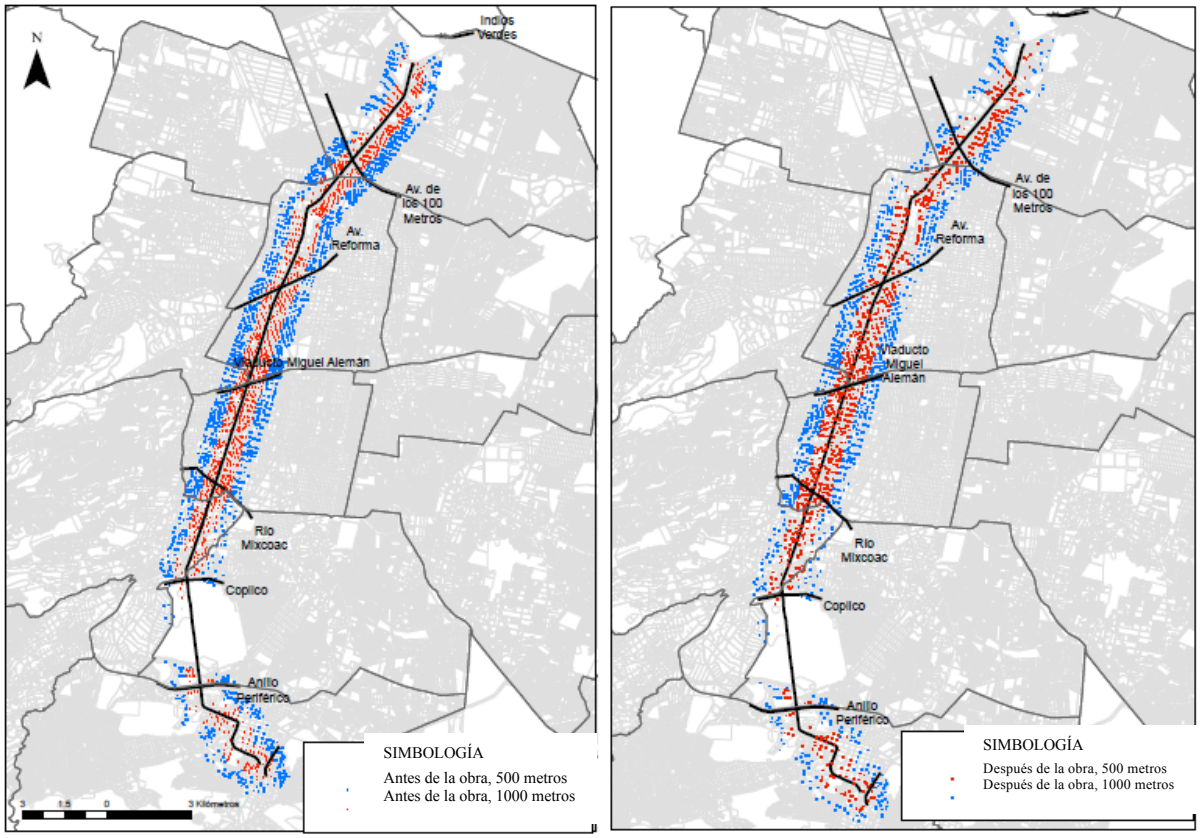
Map A1. Geo-Spatial Differentiation per Ageb in the Federal District—Data from the 2000 Census



Note: Highlighted colors along Insurgentes Avenue and Axis 8 South

Source: (Schteingart, 2008).

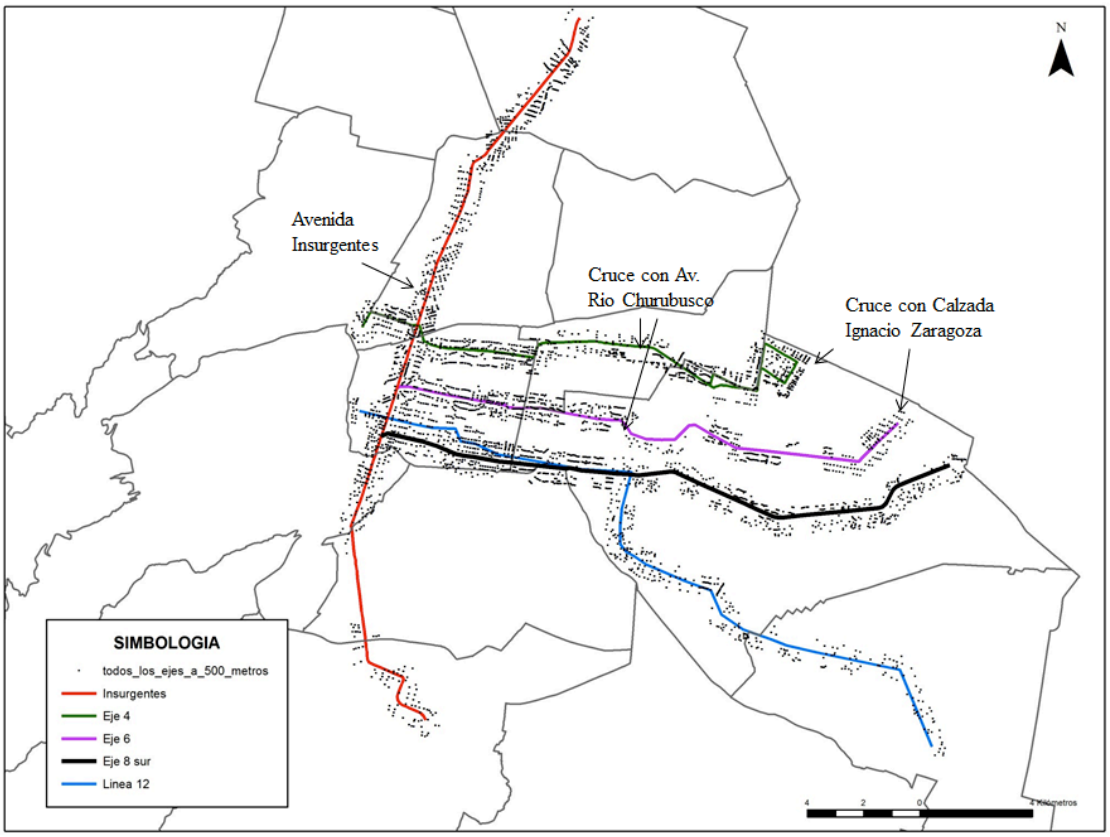
Map A2. Federal District. Sample Distribution in the Insurgentes Corridor (Metrobus Line 1) Before and After Construction of the Metrobus



Source: Drawn by the authors with data from the Department of Finance

Note: The observations around Insurgentes Ave. are for the 2003–2005 period on the left panel map, and for 2006–2007 on the right panel map.

Map A3. Federal District. Sample Distribution in the Insurgentes Corridor (Line 1 of the Metrobus) and Axis 4 (Line 2 of the Metrobus)

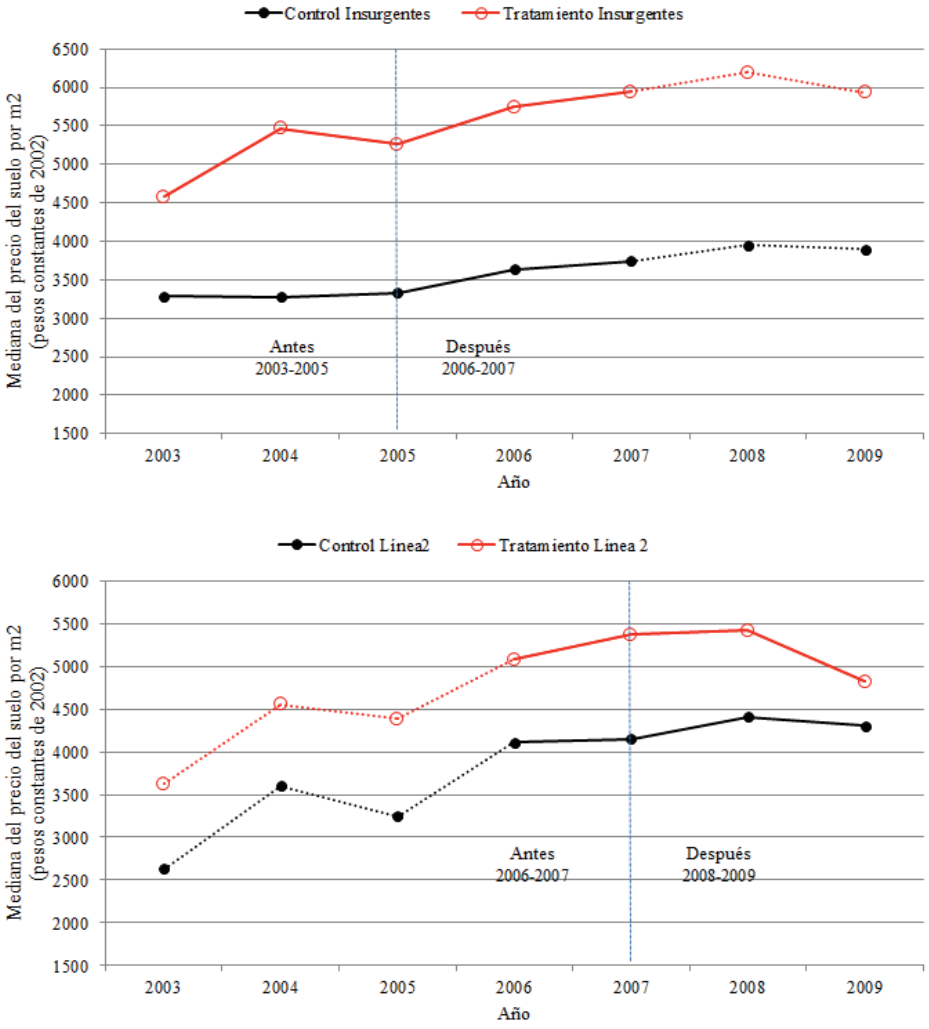


Source: Drawn by the authors with data from the Department of Finance

Note: The observations around Insurgentes Ave. are for the 2003–2007 period. The observation around the other axes and Line 12 of the Metro are for the 2006–2009 period.

percent). We also find differences in access to the subway system between the two groups. In the control group there is no observation within the area of influence of the Metro (500 meters), which is not true for the treatment group. Finally, the murder rate, introduced as a quality of life indicator, is statistically different and greater in the treatment area. These unbalanced covariants are included in the analysis to control for biases due to observed differences.

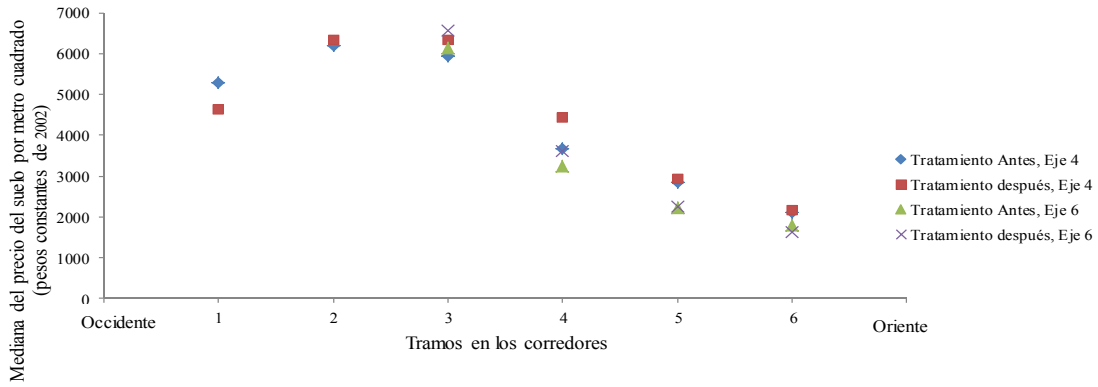
Graph 3. Prices of Land per m2 around Metrobus Line 1 (Insurgentes) and Line 2 (Axis 4 South) Periods "Before" and "After"



Nota: Los datos son la mediana de los precios del suelo habitacional en un rango de 0 a 500 metros los corredores y ejes viales.
Fuente: Elaboración propia. Secretaría de Finanzas Públicas del Distrito Federal

Regarding differences in sample size, note that the number of observations for the control group in the Insurgentes (Line 1) is much smaller than that for the treatment group. This fact, besides being associated with the different lengths of the Insurgentes Avenue segments considered part of the control and treatment groups, also shows that the residential real estate market along Insurgentes avenue has different dynamics, which could trend differently in time, and therefore could affect the price of land.

Graph 5. Median Land Prices between 0 and 500 Meters to the Corridor in Different Sections of the Metrobus Line 2 and Its Control Group



Tramos, vialidades que cortan los ejes 4 y 6 sur
1. Constituyentes-Patriotismo
2. Patriotismo-Insurgentes
3. Insurgentes-Calzada de Tlalpan
4. Calzada de Talpan-Rio Churubusco
5. Río Churubusco-Anillo Periférico
6. Anillo Periférico-Calzada Igancio Zaragoza

Empirical Specification

Given that observations were made before and after the inauguration of the Insurgentes corridor and the Axis 4 south corridor, we can estimate a difference-in-difference equation as an econometric specification, which allows us to identify the effect of each BRT line on the price of land. The equation we estimate is:

$$p_{it} = \alpha + \delta t + \gamma D_i + \tau t D_{ti} + \beta X_{it} + \mu_{it} \quad t = 0,1 \qquad (1)$$

The result variable, p_{it}, is the price of land per square meter in each period *t*, with *i*=1, 2,…n, for the Insurgentes corridor, and *i*=1, 2,…m for the Axis 4 south corridor (the equations for these two corridors are estimated separately with the same methodology). The dummy variable for time, t =1 indicates the period of time after treatment, and *t*=0 otherwise. D_i is the dummy variable that indicates the treatment group. It has a value of 1 if the observation belongs to the treatment group and 0 otherwise. The interaction $t * D_i$ identifies if an observation, i.e. a parcel of land, is in the treatment group after the inauguration of the BRT. Vector X_i allows for heterogeneity between observations that are unbalanced between groups, but stay fixed in time. Finally, μ_i is the idiosyncratic error.

The difference-in-difference indicator is $\hat{\tau} = (\bar{p}_{T,1} - \bar{p}_{T,0}) - (\bar{p}_{C,1} - \bar{p}_{C,0})$. The DD indicator identifies the effect after treatment, where the T subindex indicates treatment, and C indicates control, the numbers 1 and 2 identify correspond to the period before and after the inauguration of the BRT, respectively, and the bar above the result variable indicates the average value. The estimate $\hat{\tau}$ of difference-in-difference is the average effect of the introduction of a Metrobus line.

The coefficient(s) of the observable covariants between groups would disappear in cases where the value of $x \in X$ does not change from one period to the other. The DD indicator also allows for bias corrections for non observed covariants which maintain the same trend between periods; the possible bias in the second period (after treatment) if we were not to control for the permanent difference in the price of land between the control and treatment groups would also be eliminated. In sum, the difference-in-difference identifies the effect of the treatment and the effect of the time trend, as it eliminates the changes that affect all observations, treated and not treated, equally.

6. Main Results

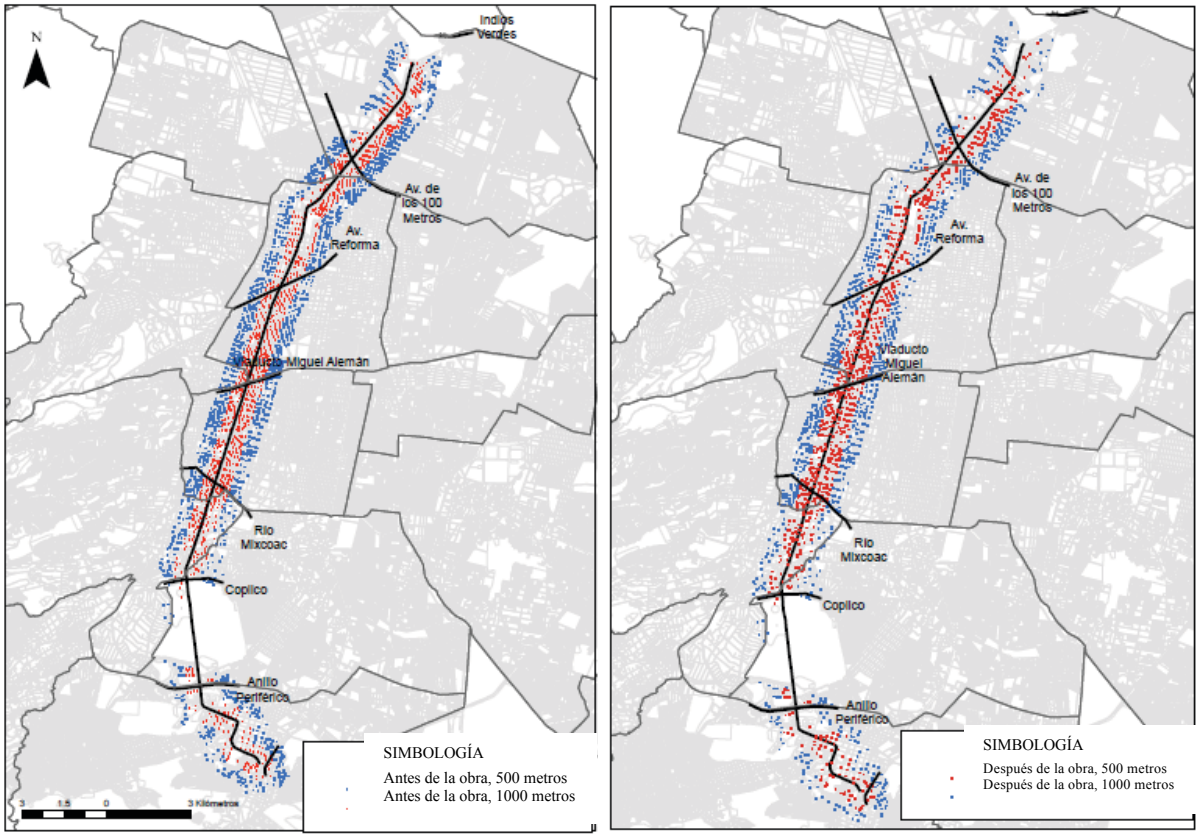
The results of the estimate of the difference-in-difference equation for repeated sections, as specified in equation (1), are presented in table 2 for Insurgentes and table 5 for Axis 4.[11] The estimated coefficient [432.72 (table 2, column (1)] is the *Effect of the Insurgentes BRT Corridor* on the price of land if the treatment and control groups were directly comparable. In this case, the difference between the control group prices before and after the inauguration of the BRT would also be positive (720 pesos) and significantly different than zero; and the prices of the treatment group for the period "before" would be 862 pesos higher that the control group prices.

Table 2, column (2) shows that when we include the variables that account for the differences in land attributes across groups, such as the specific regulations (zoning), the social and demographic characteristics of the population, and the location factors (such as the distance to the corridor, closeness to a subway station, hospital, or school), the calculated *Effect of the Insurgentes BRT Corridor* increases (to 823 pesos) when compared with the one estimated in column (1). Also, the difference in price between the treatment and control groups in the period "before" is significant (807 pesos) and stays at practically the same level as in the case when controls are not included (862 pesos). In addition, the coefficient of the *period* variable is not significant, indicating that the prices in the control group for the period before and after the treatment are not significantly different.

The estimation in table 2, column (3) controls for unbalanced covariants between the treatment and control groups, as in column (2), but also includes the dummy variable *Business Center Area*, which has a value of 1 for the observations in the area of influence of the section Reforma Ave.-Copilco Ave. of the Insurgentes Metrobus. This variable is positive and significant, and its inclusion changes the significance and magnitude of the treatment estimators. When we eliminate the influence of higher prices of land in the *Business Center* section of Insurgentes, the column (3) coefficients are telling us that the prices of land before the Metrobus in the treatment and control groups were not statistically different (nonsignificant coefficient of the *control treatment group*); it also tells us that the prices of the control group before and after the

[11] The coefficients shown in tables 1 and 4 were calculated using the geographic unit region-block as a cluster, to correct for the correlation between groups of observations. The regressions were also corrected using the following geographic units as clusters: *ageb*, colony (neighborhood), zip code and value area (see definition of aged in footnote 6 and of value are in footnotes 9). The coefficients remain significant regardless of the cluster used; we present the region-block cluster because it renders the most conservative statistics.

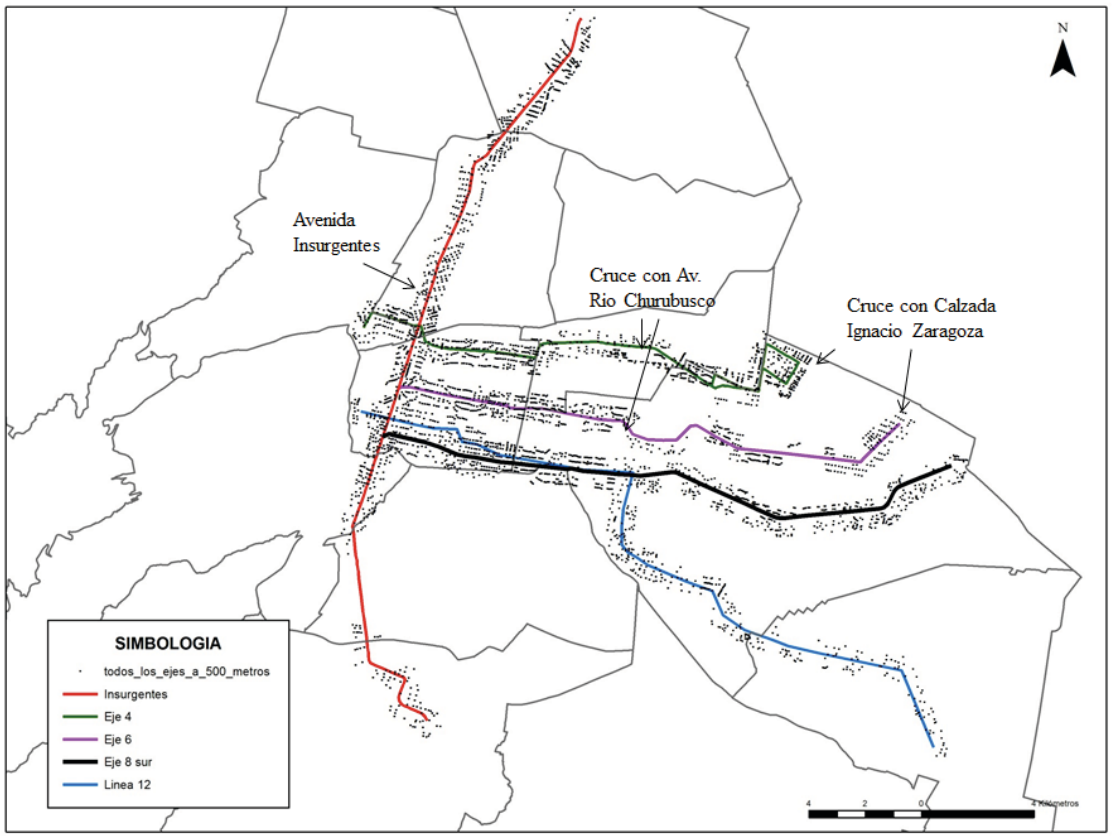
Map A2. Federal District. Sample Distribution in the Insurgentes Corridor (Metrobus Line 1) Before and After Construction of the Metrobus



Source: Drawn by the authors with data from the Department of Finance

Note: The observations around Insurgentes Ave. are for the 2003–2005 period on the left panel map, and for 2006–2007 on the right panel map.

Map A3. Federal District. Sample Distribution in the Insurgentes Corridor (Line 1 of the Metrobus) and Axis 4 (Line 2 of the Metrobus)



Source: Drawn by the authors with data from the Department of Finance

Note: The observations around Insurgentes Ave. are for the 2003–2007 period. The observation around the other axes and Line 12 of the Metro are for the 2006–2009 period.