Analysis of Bogotá's Bus Rapid Transit System and its Impact on Land Development

Recent experiences in Latin American cities supporting world-class public transportation systems have resulted in the creation of livable spaces with a significant potential to spur land development. In cities like Bogotá, Colombia, and Curitiba, Brazil, bus rapid transit (BRT) has re-emerged as a cost-effective transportation alternative for satisfying growing demands for urban mobility. Bogotá's BRT system has allowed for a 32 percent reduction in average travel times and significant reduction in accident and air pollution levels along the busway corridors. Although previous research suggests that the impacts of access to BRT facilities on the nearby land value and use have been minor, new BRT systems like the one in Bogotá feature intensive infrastructure facilities and their effects in terms of accessibility and mobility have been impressive. This paper provides first-hand empirical evidence on the evaluation of how the BRT system is related to land development outcomes such as land values. Future BRT extensions will have a large potential to influence future land development and induce desirable urban forms and land uses around stations and busway corridors.

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Introduction

Urban transportation infrastructure, in addition to serving its explicit goal of providing mobility, historically has served as means of attracting and stimulating urban development. By effectively altering where people live, work, and how they travel, transportation systems have played a significant role in reshaping the location of activities, patterns of interaction, and growth of cities. Mimicking the experience of cities in developed countries, auto-centered transportation policies prevailed in most 20th-century cities in the developing world. However, recent experiences in urban areas that support world-class public transit systems suggest that rather than relying on automobile policies that reinforce patterns of seclusion and isolation, policies supporting mass transportation systems and favoring non-motorized transportation alternatives have resulted in the creation of livable spaces and the collective appropriation of these systems as images and symbols of the public.

Although initially decried by multilateral lenders, this quiet revolution is now heralded by planners and elected officials as an agent of urban redevelopment and sustainability. One element of this revolution is the provision of high quality bus transit service. With several successful cases

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worldwide, bus transit service has re-emerged as a cost-effective transportation alternative for satisfying growing demands for urban mobility while hopefully stimulating land development and livable spaces. This new concept for delivering bus service, known as Bus Rapid Transit systems (BRTs), is revolutionizing bus transit provision around the world, particularly in Latin American cities. BRTs like the ones in Curitiba, Brazil, and Bogotá, Colombia, are systems with lanes designated for exclusive use by large-capacity buses, and specialized bus stations with pre-board ticketing and fast boarding. These characteristics have drastically improved the level of service of bus-based transit systems including average speeds, reliability, and capacity.

However, despite the resurgence of bus transit services and the success of several BRTs around the world, there is limited research examining the relationship between BRT and land development. The paucity exists despite the fact that a careful examination of BRT impacts is critical for the transportation planning process. Potential misperceptions of these impacts can lead to significant facility redesign, construction delays, or compensation to affected parties, all of which may amount to millions of dollars. Furthermore, the success of innovative infrastructure financing tools, such as value-capture, hinges on understanding whether or not positive infrastructure impacts are capitalized into land values.

This paper presents an examination of Bogotá's BRT system and its development as part of an integrated urban mobility and land development strategy. Additionally, the paper investigates the extent to which accessibility to the BRT system is capitalized into residential property rents as a measure of land values. Results from hedonic price models suggest a positive elasticity of local accessibility to BRT stations after controlling for proximity-related effects to the BRT right-of-way, structural, and neighborhood attributes. This empirical evidence has a wide range of practical applications, from determining the usefulness of innovative land-based tax instruments that hinge on the capitalization of positive effects of transportation investments, to informing policy-makers about the land development consequences of transportation infrastructure alternatives.

Bogotá's Urban Mobility Strategy

Bogotá, the capital of Colombia, has approximately 6.4 million inhabitants occupying 28,153 hectares (69,566 acres) of urbanized area (DAPD, 2000). This makes Bogotá one of the most dense cities in the world, with approximately 230 people per hectare. Despite a 1999 per capita GDP of US $2,300, 15 percent higher than the national average, Bogotá's automobile ownership rate (130 cars per 1,000 inhabitants) is low compared to cities in South America of similar size. Notwithstanding this low motorization rate, the city is greatly affected by severe mobility problems, partially due to the high population density. By 1999, the average speed during the peak hour on the main roads declined to less than 12 kilometers per hour (7.45 mph).

With approximately 70 percent of motorized trips taken by bus and other transit modes such as paratransit, Bogotá's quasi-deregulated and free-enterprise transit system had one of the largest per capita public transportation fleets in the world by 1996 (JICA, 1996). The excess of vehicle capacity and the lack of regulation resulted in low transit vehicle occupation levels, inferior to the minimum required to make the service profitable and efficient. The transit system was also complemented by illegal bus operations and inter-municipal services that originate in areas surrounding the metropolitan region.

Although many studies diagnosing Bogotá's mobility problems were conducted during the last decade , a long-term plan to achieve a desirable urban form and to promote its co-existence with an efficient and equitable transportation system was off the agenda of local administrations. This changed during the last two administrations of the city (1998-2001 and 2001-2004), when a sustainable strategy for the transportation system of the city was developed and implemented. In addition to providing competitive alternatives to auto-based

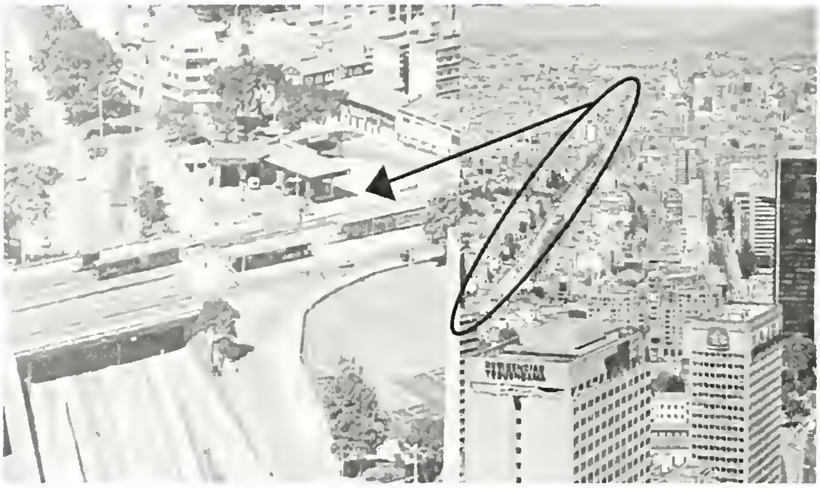


Figure 1. TransMilenio BRT Caracas Corridor

Concerned with an oversupply of the transit service, poor environmental and safety conditions, and decreasing vehicle speeds, the Bogotá city government decided to upgrade mass transportation by embarking on extensive investments to support a BRT system. The uniqueness of Bogotá's case lies in the transformation of its old system into an integrated system. The Caracas corridor (Figure 1) revolutionized an undesirable mobility system (e.g., aesthetically displeasing, with high noise and diesel exhaust levels) into a new BRT system with significantly lower travel times, lower noise and fewer greenhouse gas emission levels (Rodriguez and Targa, 2003). The BRT is now a source of local pride.

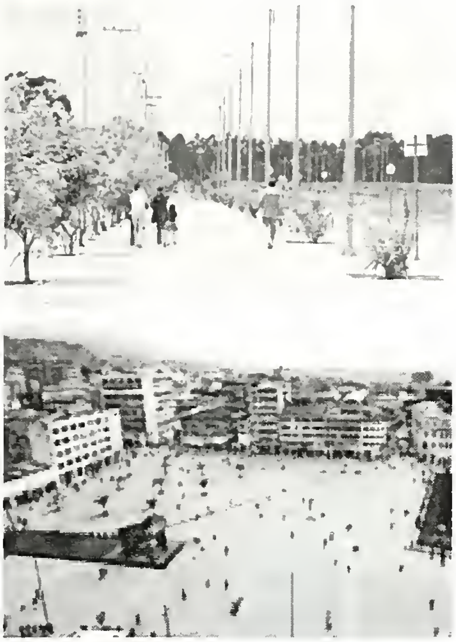
Complementary Urban Policies

The BRT system is part of a comprehensive strategy that includes restraining the use of private cars, improving air quality, providing urban and natural spaces for individual recreation and fare, and the provision of public space and non-motorized transport facilities. At a glance, ancillary policy measures include:

- A partial ban on peak-hour auto use. This license plate-based private vehicle ban applies to 40 percent of the vehicle fleet during peak hours on weekdays. There is also an annual car-free weekday.
- The reclamation of public use of spaces previously appropriated by automobiles (such as sidewalks) or neglected by former city authorities (such as parks and plazas).
- The implementation of a 350-km bikeway network, one of the largest in the world.

Bogotá's strategy was designed not only to provide competitive alternatives to auto-based transportation options, this strategy, called "mobility strategy," was designed to achieve larger societal objectives such as enhancing public spaces, improving social integration, and developing a sense of ownership and pride around redeveloped urban form.

A cornerstone of the administration's mobility strategy was the implementation of a high level of service, BRT system. This required the revamping of a prior initiative implemented between 1988 and 1992, which provided exclusive lanes for bus operations. The 16 kms (9.94 mi) of lanes traversed the city's CBD and connected the south and north parts of town. More than a network of bus lanes, the Troncal Caracas acted as a high capacity collector fed by routes needing to cross the city rapidly (Ardila and Rodriguez, 2000). Passenger flows exceeded 36,000 passengers per hour on a given direction during the peak period (Ardila and Rodriguez, 2000), but the system lacked an operations management plan, allowing free entry to operators meeting specific bus size requirements (Rodriguez and Ardila, 2002). The infrastructure itself and the bus stops were not adequately maintained, traffic lights were not synchronized and gridlock was common in several streets crossing the busway (Ardila and Rodriguez, 2000). Nevertheless, average bus speeds in 1999 were 24 kilometers per hour (14.9 mph), significantly higher than the citywide average.



Source: El Tiempo and IDU.

Figure 2. Public Spaces

mobility, but also to achieve larger societal objectives such as enhancing public spaces, improving social integration, and developing a sense ownership around redeveloped urban form. In the words of its former mayor, Enrique Peñalosa, who left his office with a record approval rating, the strategy consisted of creating a "city environment where the majority of people will be as happy as possible" (Peñalosa, 2002). He visualized that people would be happier in healthier, safer, and more enjoyable places in which to live, work, shop, and socialize. One of the means to achieve this objective was to transform the transportation system, and to reverse the trend towards an increasingly auto-oriented transportation system (Peñalosa, 2002). Perhaps for this reason, 42.5 percent of the city's investment budget (US$ 1.8 billion for the three-year term) was devoted to the ancillary policy measures described above (Ardila and Menckhoff, 2002).

One of the most polemic policies, but at the same time one of the most emblematic ones of that administration, was the reclamation of public use of spaces. Consistent with several planning concepts hinging on urban design and city form as an input to comfortable, navigable, and participatory urban public spaces (Whyte, 1988; Lynch, 1985; Jacobs, 1961), the former Bogotá mayor thought that a quicker and more effective way to achieve quality of life was to invest in public spaces. To accomplish this, the reclamation of public use of spaces included the reconstruction of 1,123 parks, the implementation of a car-free street in the historic CBD, the construction of wide and continuous pedestrian sidewalks, including a 17-km pedestrian greenway through poor neighborhoods (Figure 2, top), and the redevelopment of a 20-hectare park in a crime-ridden area (Figure 2, bottom) by demolishing more than 600 deteriorated houses (Ardila and Menckhoff, 2002).

Another key project for the city is the implementation of one of the largest permanent bicycle network in the world (Figure 3), a 350-km bikeway network, intended to capture 30 percent of the total daily trips in the city. This travel mode share is similar to the one in Copenhagen, where a 300-km network captures 34 percent of the total daily trips. Considering the year-round mild climate, the flat valley where the city is located, and the high urban density that makes most of the trips being relatively short, the demand has currently responded with increases on the proportion of non-motorized trips. More than providing alternative and sustainable transportation options to mobility, the assembling of the bikeway network and extensive wide sidewalks were also conceived as measures to improving pedestrian and bicycle

Source: El Tiempo.

Figure 3. Bikeways

Source: Sandoval and Hidalgo (2002)

Figure 4. TransMilenio BRT Stations

accessibility to BRT stations and swaying people to leave their cars at home. Anecdotal evidence suggests that approximately 10 percent of the regular BRT system riders have switched from private cars to TransMilenio, Bogotá's mobility strategy.

Bogotá's BRT System

The mass transit policy element TransMilenio, is a BRT system resulting from a successful public-private partnership, with the government funding the infrastructure and overseeing long-term planning functions, and private contractors bidding for the operation of a handful of BRT lines on a cost-plus basis (Rodriguez and Targa, 2003). The system comprises specialized infrastructure, including exclusive lanes for high-capacity articulated buses privately operated with an off-board fare collection system.

The first phase of the system operates with 62 stations, 470 articulated buses, and 300 feeder buses. The vehicles operate in the central lanes of urban roads, and are longitudinally segregated from general traffic. Stations are located in the median, approximately every 500 meters, with pedestrian access provided by overpasses, tunnels, or signalized intersections (Figure 4). Walkways, plazas, and sidewalks are also constructed to supply pedestrian and bicycle access (Sandoval and Hidalgo, 2002).

With a flat fare of 1,000 Colombian pesos (US$0.33), revenues are sufficient for the participating private bus companies to be profitable. Simultaneously, a new public authority for planning, developing and controlling the system was created (TransMilenio S.A.). TransMilenio began operations in December 2000. The system moves approximately 800,000 daily trips over 42,4 km (26.2 miles) of busways, and carries more travelers than entire mass transit systems in many other cities around the world (IEA, 2002). Figure 5 shows the first phase of the system (38 kilometers; 23.6 miles), which includes three corridors: Caracas, Calle 80 (80th street), and Autopista Norte (north highway).

The first phase of the system cost around US$5 million per kilometer (US$ 8.1 million per mile), and its net economic benefits accounted for US$1.2 billion with a social rate of return of 60.9% (CONPES, 2000). Similar to any transportation project, the most significant impact of the system for its users has been travel time savings. Commercial speeds increased from 12 kilometers per hour (7.5 mph) to 26.7 kilometers per hour (16.6 mph) in the Calle 80 and Caracas corridors. This

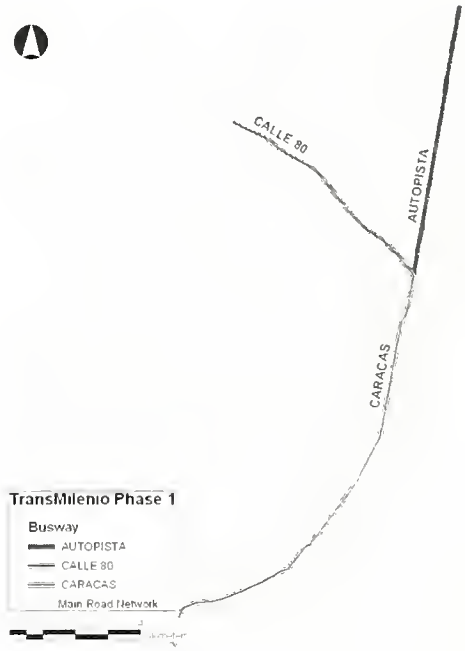


Figure 5. TransMilenio, First Phase

increase in bus speeds allowed for a 32 percent reduction in average trip times for users of the system (Sandoval and Hidalgo, 2002). Additionally, comparisons between before and after system implementation have shown a significant reduction in accident and air pollution levels. Between 1999 and 2001, fatalities in the BRT corridors resulting from traffic accidents were reduced by 89 percent. Similarly, injuries and the number of collisions were reduced by 75 and 79 percent, respectively (Sandoval and Hidalgo, 2002). Contamination and emissions such as sulfur dioxide, nitrogen oxides, and particulate matter were reduced by 43, 18, and 12 percent respectively (Sandoval and Hidalgo, 2002).

Extensions are planned over the next 13 years, when a 388-kilometer (241 miles) BRT network will be completed. This network system will cover 80% of the daily transit trips in the city (5 million trips per day), with a capital investment of more than US$2.9 billion. The infrastructure component of the project (US$1.9 billion) is being financed by local and national public funds. The city covers 33 percent of the total cost via local fuel taxes, and the national government is contributing the remaining 67 percent.

Although there are several operational and cost-efficiency qualities of the system, one of the most important characteristics was its impressive implementation time. In less than three years, the first phase of the BRT system was planned, built, and inaugurated. Additionally, the implementation process did not suffer any significant change in design or construction delays. This speed has come at a cost, though. For example, both the beneficial and deleterious impacts upon the neighborhoods and property owners that have resulted from the system were neglected in the evaluation and planning process. Anecdotal evidence also suggests that there was little community participation and poor quality control in the planning process. As a result, the first phase of the system was successfully implemented without any substantial compensation to affected parties.

Another apparently neglected aspect of Bogotá's BRT system is its potential to spur land development. Although the planning of the BRT system took into account the location of major activity nodes, the reverse relationship, how BRT can promote additional dense development along its corridors was neglected. This omission is somewhat surprising if one considers that land development induced by BRT was the cornerstone of Curitiba's success. In Bogotá's case, expediency and practicality dominated the discourse around the BRT station. Furthermore, aside from Curitiba, there is scant evidence of the relationship between BRT and its land development potential.

From the perspective of planning, it is interesting to perform a posthoc evaluation of how the BRT system is related to land development outcomes such as land uses and values. Transportation planners and policy makers have relied on the notion that transportation improvements enhance accessibility, and by doing so increase the values of the nearby properties. However, the extent of these impacts for BRTs, and the differentiation with proximity-related impacts, are largely unsubstantiated by empirical evidence. It is this lack of existing research, and the increasing relevance of BRT systems as transportation mobility solutions for several cities around the world, that motivated the empirical analysis conducted in this paper. An evaluation of accessibility impacts provides first-hand empirical evidence of the importance of transportation policy alternatives on land use. This information will strengthen the planning process for urban transit systems and will be valuable for understanding the local conditions for which innovative land-based tax instruments, such as value-capture, will be most useful.

Valuation of Access to TransMilenio

As in several other studies, we adopt a hedonic price model approach to empirically evaluate the capitalization of accessibility effects of Bogotá's BRT on residential property rents as a measure of land values. Based on the theory of the market for heterogeneous goods (Rosen, 1974), the hedonic technique allow us to estimate prices of goods that are not explicitly exchanged in observable market transactions, such as accessibility to transportation

Variable	Definition	Mean	Std. Dev.	Coeff.	t-value
Measures of value					
RENT	Rent offered price ($Col 1,000,000)[1]	0.5	0.4		
Structural attributes					
ULAREA	Usable living area (square meters)	77.8	44.1	0.005***	9.96
BEDS	Number of bedrooms	2.2	1.1	0.034**	2.05
BATHS	Total number of bathrooms	1.5	0.7	0.095***	3.66
LROOM	Dummy variable indicating if property has both living and dinning room	5.5%		0.094	1.41
AGE	Dummy variable indicating property < 10 years of age	44.1%		0.084***	3.30
Neighborhood attributes					
STRATUM[2]	Ordinal variable for socioeconomic stratum (from 1 to 6)	3.0		0.124***	5.02
POP_DENS	Population density (1,000 people per square kilometer)	16.0	7.4	-0.006**	-2.05
EMP12_DENS	Primary and secondary sector employment density (1,000 jobs per square kilometer)	5.6	4.4	-0.015***	-3.34
EMP3_DENS	Tertiary sector employment density (1,000 jobs per square kilometer)	24.8	24.0	0.001	1.14
COMER_%	Percentage of area dedicated to commercial use	1.0	4.3	0.007**	2.04
RESID_%	Percentage of area dedicated to residential use	0.6	3.9	-0.003	-0.69
INST_%	Percentage of area dedicated to institutional use	4.8	6.9	-0.004**	-2.38
POVER_%	Percentage of area under base line poverty condition	0.4	2.2	-0.010	-1.55
ROB_RES	Number of break-ins on residential properties per year and 1,000 people	0.2	0.1	-0.804***	-3.01
ROB_PER	Number of robberies to individuals per year and 1,000 people	2.5	1.0	0.133***	7.29
HOMICIDES	Number of homicides per year and 1,000 people	0.6	0.5	-0.143***	-2.67
BUSWAY	Dummy variable indicating property along Caracas corridor (=1, 0 = otherwise)	87.9%		-0.033	-0.40
Accessibility					
LOCAL_ACC	Network access distance from property to nearest BRT station (Km.)	0.8	0.5	-0.207**	-2.38
REG_ACC	Network access distance from nearest BRT station to trip destination center of gravity for each station in the AM peak period (Km.)	5.3	1.5	0.013	0.62
DIST_CBD	Network access distance from the nearest BRT station to the Financial District station (76th street)	4.6	3.1	-0.015	-1.34
DIST_DT	Network access distance from the nearest BRT station to the down town station (13th street)	4.2	3.2	-0.008	-0.55
Proximity-Related					
DIST_BUSW	Straight distance from property to busway (km)	0.6	0.4	0.301***	2.99
Data					
DATA	Dummy variable indicating if data was collected by field-visual inspection (=1, 0 = otherwise)	35.8%		-0.001	-0.04

N =494. [1] SUS 1 = SCol 2,280 of 2002 (average for February-April period). [2] The mean corresponds to the median. ***, **, and * denote coefficient significantly different from zero at the 1%, 5%, and 10% level of significance (two-tail test), respectively. Intercept is equal to -1.820 (t-value=-8.09). R^2 is equal to 0.74. See Notes, facing page.

Table 1. Description of Variables, Summary Statistics, and Hedonic Model (semi-log)

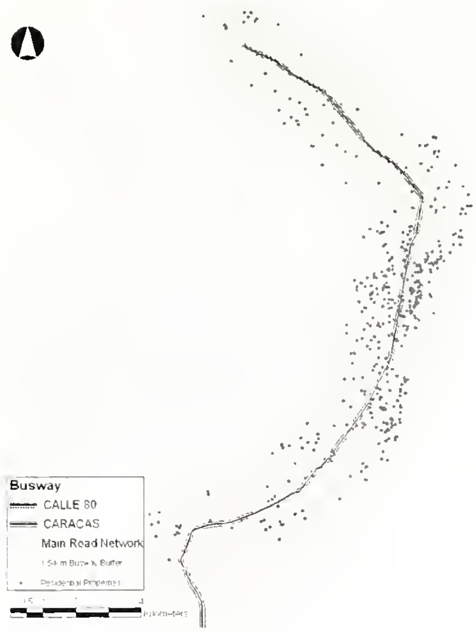


Figure 6. Area of Study

systems. The basic empirical relationship to be evaluated under this approach is the equilibrium implicit rent of the property as a function of its attributes:

$$P_i = c + \vec{\beta}_S \vec{X}_i^{Structural} + \vec{\beta}_N \vec{X}_i^{Neighborhood} + \vec{\beta}_A \vec{X}_i^{Accessibility} + \vec{\beta}_P \vec{X}_i^{Proximity} + \varepsilon_i$$

where Pi is the rental price of the ith residential property, Xij is the jth attribute for the ith property, $\vec{\beta}_S$, $\vec{\beta}_N$, $\vec{\beta}_A$ and $\vec{\beta}_P$ are vectors with coefficient estimates for structural, neighborhood, accessibility, and proximity-related effects or attributes (implicit empirical marginal price for each attribute), c is the intercept constant term, and ei is the random error term for the ith property. Table 1 presents a description of the variables and the summary statistics of the data employed in this paper.

In order to specify and evaluate the hedonic price function, our empirical examination requires an estimate of land values, as well as information on structural and neighborhood characteristics of residential properties. As a result, we undertook a primary data collection effort. The data collection process began with the selection of a 1.5 kilometer (0.93 mile) buffer area around the two BRT lines (Caracas and Calle 80 corridors). Information regarding residential advertised rent prices and structural attributes was collected for all properties available for rent within this buffer area. The final data set consists on a sample of 494 multi-family residential properties surveyed from February to April of 2002 (Figure 6).

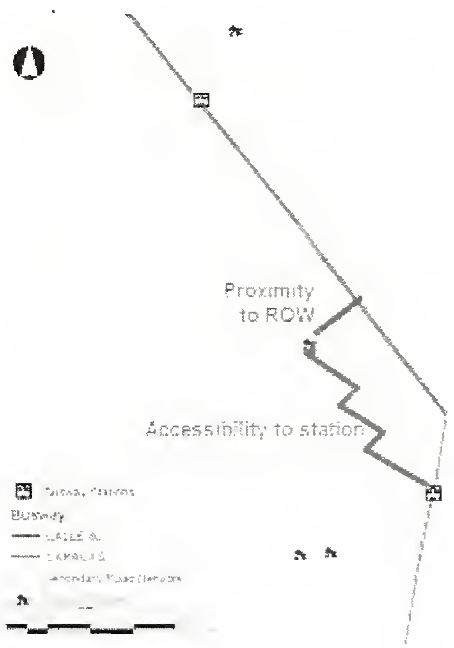


Figure 7. Accessibility & Proximity

Table 1. Notes:

a) 32 missing values (6.5%) from ULAREA were filled by best-subset regression (imputed). Similarly, the 23 missing values (4.7%) from the dummy AGE variable were set to the median. For each of these two variables dummy variables are used in the models to capture the effect of these imputed observations.
b) Rent offered price and structural attributes were collected between February and April of 2002. Socioeconomic variables such as population and employment data are from 1998, while crime data are from 2001.
c) Neighborhood attributes, except Stratum and Busway, were weight-assigned from TAZ-level to 250-meter buffer areas around residential properties.

Local access distance to BRT stations was measured based on the shortest roadway-based path from each residential property to the nearest BRT station, rather than a mere Euclidean distance (Figure 7). In addition to accessibility to BRT stations, Euclidean distance from the residential property to the BRT right-of-way was used as a measure of nuisance proximity-related effects such as noise and air pollution (Figure 7). Structural attributes include usable living area (in square meters), number of bedrooms, total number of bathrooms (including half baths), and dummy variables for living and dining room area, and if the property is less than 10 years old. Neighborhood attributes include socioeconomic stratum, population and employment density, percentage of urbanized area dedicated to retail, residential, or office uses, and crime data such as homicide rates and robberies.

Results from the semi-logarithmic hedonic price functional form using OLS regression suggest that the current valuation of local access to Bogotá's BRT system is capitalized into asking rent prices. Particularly, the parameter estimated suggests a monthly rental discount of 1.87% for every additional 0.1km (328 feet) from a BRT station, all else being equal. Evaluated at the mean rental asking price (Table 1), this translates into an elasticity of -0.16.

By determining the capitalization of positive BRT effects (local access to BRT stations), the localized evidence from this study provides, on the one hand, tools for exploring the usefulness of innovative land-based tax instruments. For example, a value capture tax that theoretically should hinge on the capitalization of positive benefits on land values from infrastructure improvements is validated from the empirical evidence presented on this paper. Local governments and local transit agencies could justify the nature and magnitude of charges derived from value capture, known as valorizacion , to parcels nearby transportation improvements or new construction facilities.

On the other hand, the capitalization of access on land rents also suggests that there is a potential for future land development. Similar to Curitiba's experience, where complementing land-use initiatives were taken in order to induce desirable urban forms and land uses around BRT stations or along corridors, Bogotá's future BRT extensions have a large potential to influence future land development and urban growth. For example, a world of unexplored proactive land use planning for a workable transit-land use nexus, that has been absent from the planning process, should be in the agenda of Bogotá's transit and urban planners. Local officials could take advantage of the land market (e.g., fostering faster and more concentrated urban development) as a response to the capitalization effects from access to BRT stations.

Finally, there are three main limitations of this study that should be underscored. First, the use of cross-sectional data limits the absolute attribution of the premium found on asking rental prices to the presence of the BRT, instead it is an actual measure or valuation of access. Further research (e.g., using time-series data for a before and after study) may determine if the premium detected can be attributed to the presence of the BRT. Second, the use of asking rental prices, instead of actual prices, may bias the results if there is any systematic bias in the difference between asking and market rental price associated with unobservable characteristics on the study. And third, further research should focus on commercial and office land values in order to evaluate the other parts of the expected relationship between accessibility and the land market.

Conclusions

Rather than relying on automobile policies that reinforce patterns of seclusion and isolation, recent experiences in Latin American cities supporting world-class public transportation systems have resulted in the creation of livable spaces with a significant potential to spur land development and future urban growth. In cities like Bogotá and Curitiba, bus transit service has re-emerged as a cost-effective transportation alternative for satisfying growing demands for urban mobility. For example, Bogotá's BRT has allowed for a 32 percent reduction in average travel times for users of the system in addition to significant reduction in accident and air pollution levels along the busway corridors. In addition to serving its explicit goal of providing mobility, this revolution for provision of high quality bus transit service has shown its potential for stimulating land development and livable spaces. Despite cases like Curitiba, where BRTs have played an integral role in the successful articulation of an integrated land use and transport strategy, there is scant evidence of the relationship between BRT and its land development potential. This paper provides first-hand empirical evidence on the evaluation of how the BRT system is related to land development outcomes such as land values.

Previous research suggests that the impacts of access to BRT facilities on the nearby land value and use have been minor. However, new BRT systems like the one in Bogotá feature intensive infrastructure facilities and their effects in terms of accessibility and mobility have been impressive. Based on this previous premise, this paper finds evidence that the current value of accessibility to Bogotá's BRT are capitalized into residential property rental prices. Given the empirical housing rent-land value relationship, these results suggest that property rental prices are a theoretical representation of the land value for housing services.

To the degree that the results from this study can be generalized, this evidence has a wide range of practical applications, from determining the usefulness of innovative land-based tax instruments that hinge on the capitalization of positive BRT effects, to informing policy makers about the land development consequences of transportation infrastructure alternatives. Recent studies about incentive taxation have shown that value capture represents an alternative approach to capital cost recovery that has not been fully explored and examined in the tax policy context. Batt (2001) noted how only a few studies, if any, have recognized the relationship between transportation, land use, and taxation. However, there is enough evidence from studies that show the merits of value-capture as an instrument of public infrastructure finance (Allen, 1987; Cervero, 1994; Johnson and Hoel, 1985).

In addition to being an efficient method for public funding of transit infrastructure, value-capture also encourages faster and denser urban development in areas in close proximity to BRT lines, assuming that density caps are not a constraining factor. Given the higher rents on land values in locations with good access, it is expected that landowners will try to recover their investments rather than hold them for speculative gain (e.g., BRT fosters faster and more concentrated development). This is always a desired outcome for policy makers regarding transit-oriented developments because it has implications for the viability of transit operation. However, to ensure this urban development outcome it is necessary to complement this taxation policy with mechanisms such as higher density caps and mixed-use land-use zoning.

The extent to which positive effects of Bogotá's BRT system are capitalized into property values provides a promising approach for public institutions to fund BRT extensions and general transit infrastructure. With extensions planned over the next 13 years, issues related to both its beneficial and deleterious impacts may become of growing concern to both the affected public and to transit planners. When completed, 85 percent of Bogotá's population will be located in a 500-meter area of influence of the BRT system, where positive and negative impacts are expected to influence property values and future land development.

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