Land Value Impacts of Bus

The Case of Bogotá's TransMilenio

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During the last decade, bus rapid transit (BRT) has revolutionized regional transportation planning in much of the developing and developed world. BRT went from being a fringe transportation option used in a handful of Brazilian and Australian cities to becoming a prominent mass transportation alternative for local and national governments.

BRT is not a single concept; rather, it encompasses a variety of applications designed to improve the level of service of bus-based mass transportation to deliver comfortable, cost-effective mobility emulating rail transit (Wright and Hook 2007, 11). It relies on coordinated improvements in technology, infrastructure, and equipment to achieve quality service (U.S. General Accounting Office 2001). Operationally, BRT applications can include buses running on exclusive rights-of-way with dedicated stations and preboarding fare payments, or buses operating in mixed traffic lanes on city arterials.

Arguably the BRT concept with highest recognition is the provision of an exclusive right-of-way for bus transit coupled with high-frequency service. In South America, BRT systems in Curitiba, Brazil, and Bogotá, Colombia, feature networks of dedicated lanes designated for exclusive use by large-capacity, articulated buses, with expedited boarding and alighting.

Twelve Latin American cities, three Australian cities, seven U.S. cities, eight Asian cities, and eighteen European cities have BRTs in place. Some are complete systems while others are single lines. Systems actively under construction also span the globe, including Dar es Salaam in Tanzania, Jinan in China, Bologna in Italy, Mérida in Venezuela, and Auckland in New Zealand. As of March 2007, GTZ, Germany's federal development enterprise, estimated that there were at least 27 cities with

Rapid Transit

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active BRT planning processes, while 14 BRT systems are considering further expansions (Wright and Hook 2007).

The dramatic success of BRT is due in part to the cost-effectiveness and relative flexibility of the investments required. BRTs often can transport as many passengers as most conventional light rail systems at a fraction of the cost. BRTs also compare well with heavy rail systems, except under circumstances of very high passenger demand exceeding 50,000 passengers per hour per direction. Like rail systems, however, the cost-effectiveness of BRT hinges on the ability to have supportive land uses that concentrate activity along system corridors. Therefore, in most cases BRTs have been built in corridors with proven demand.

Transportation Investments and Land Re/development

It is also plausible that BRTs can attract dense development that will in turn enhance the BRT system in the future. This reciprocal connection between BRT investments and land development has been a cornerstone of Curitiba's success. Despite the importance of this connection for the future viability and cost-effectiveness of BRTs, however, there is limited empirical evidence available. With many cities considering new BRT lines or system expansions, understanding whether changes in land development can occur is critical to anticipate the benefits of the system and to estimate the fiscal impacts of the investment.

Urban economic theory provides a starting point to explain how transportation investments can influence land development or redevelopment. Such investments are expected to provide accessibility benefits to those positively affected by it, through travel time savings afforded by the investment.

In a metropolitan land market, a transportation investment is expected to provide accessibility advantages to parcels close to the investment compared to parcels relatively unaffected by it. Because the number of parcels benefiting from the accessibility improvements is finite, households and firms valuing such benefits in a competitive market are expected to be willing to pay more for properties with good access over other properties, all else held equal. In this way, the access benefits of transportation investments, if they exist, will be capitalized into property values.

The capitalization of accessibility benefits stimulates development by enhancing the attractiveness of parcels for development or redevelopment. Parcels that were not previously considered prime candidates for real estate investment appear more attractive after the transportation investment is announced or implemented. Alternatively, a parcel already developed or in the planning stages may be developed more intensely as a result of the increase in values. This relationship is the cornerstone of transit-oriented development (see figure 1).

In addition to the development potential instigated by the transportation investment, land value

FIGURE 1
Transportation Investment and Property Development Flow Chart

increases are also relevant to municipal finances and project-specific financing. The success of local instruments such as tax increment financing and value capture hinges on the land value and related development changes associated with the project.

Bogotá's TransMilenio System

Bogotá, the capital of Colombia, has approximately 6.8 million inhabitants occupying just over 29,000 hectares of urbanized area (Alcaldia Mayor de Bogotá 2003). Before TransMilenio, all public transportation in Bogotá was provided by private bus operators organized into firms or associations, which added and stopped services with little government oversight. Revenue to the bus operators was based solely on passenger fares, causing intense competition among drivers at the curb. This operating framework resulted in considerable social costs, such as congestion, poor quality, and poor safety (due to underinvestment in vehicle maintenance). In 1999 residents experienced average vehicle speeds of only 9 kph (5.6 mph) during the daily peak commuting period.

By the late 1990s, concerned with an oversupply of transit capacity, poor environmental and safety conditions, and decreasing vehicle speeds, the city government invested in an extensive BRT network, but it covered only areas with very high demand for public transportation. Areas of the city not reached by the BRT continued to be served by the original associations, and the environmental and time impacts of their activity remained. The BRT investment, TransMilenio, was part of a broader, integrated strategy to address mobility challenges, reclaim public spaces for pedestrians, and increase access to green space.

TransMilenio has been implemented in two phases, with a third phase currently under engineering design. The first phase was planned in 1998, built in 1999–2000, and launched in December 2000 along two corridors. The second phase, which started operating late in 2003, gradually added three more corridors. All phases have been implemented through a successful public-private arrangement: the government funds the infrastructure and oversees long-term planning functions, and private firms bid for the operation of sets of routes or catchment areas.

The system comprises specialized infrastructure, including exclusive lanes for high-service capacity, enclosed boarding stations, and a fleet of articulated buses with an off-board fare collection system. Coordinated service with feeder routes allows access to TransMilenio from neighborhoods farther away from the bus route. As of November 2007, the system had 114 stations, operated more than 1,000 buses, and carried 1.4 million one-way trips per day at an average speed of 27 kph.

Considered a premier example of BRT, Bogotá's case illustrates the transformation of traditional transportation corridors with severe pollution, safety problems, and unattractive surroundings to a new system with significantly shorter travel

Previous Studies of Bogotá's TransMilenio and Property Values

The first study relied on asking prices for apartment rentals in 2003 (Rodriguez and Targa 2004). The authors examined whether asking prices were related to proximity to the BRT for 494 multifamily residential properties in a 1.5 km area of influence surrounding two TransMilenio corridors. They detected a premium of 6.8 to 9.3 percent for every 5 minutes of walking time closer to a BRT station. They also found that properties on the busway but not necessarily close to a TransMilenio station had a lower premium, presumably due to the negative noise and pollution effects of bus traffic.

In the second study, Muñoz-Raskin (2006) used data on the values of 130,692 new multifamily properties provided by the Bogotá Department of Housing and Control from 2001 to 2004. He found that properties within the immediate proximity of feeder lines (0–5 minute walk) were valued more than those requiring a 5–10 minute walk. His findings also show that high-value properties were valued higher if they were close to a feeder line, but in the case of trunk lines, the effect was the opposite.

The third study was completed in 2007 using assessed property values from cadastral data for 1,547 properties within 1 km of TransMilenio (Mendieta and Perdomo 2007). The study found that property prices increased between 0.12 and 0.38 percent, depending on the distance to the BRT, for every 5 minutes of walking time closer to a BRT station.

The fourth study used 304 residential properties and 40 commercial properties to compare asking prices in two zones, one with and one without BRT access (Perdomo et al. 2007). Properties were matched using propensity scores and asking values were compared. The results were mixed, with most comparisons yielding statistically insignificant results. In only one case a premium of 22 percent for residential properties with BRT access was detected at standard levels of confidence.

times, less noise, and fewer greenhouse gas emissions (Cain et al. 2006).

Land Value Impacts of TransMilenio

TransMilenio has been the focus of at least four studies relating land values to the BRT system (see box). Although the evidence to date of the relationship between TransMilenio and property values has been useful, its ability to inform policy remains limited. For example, these studies rely on cross-sectional data, so it is impossible to isolate whether the BRT caused the land value change, or whether planners sited the stations in locations that were already valued by residents. Furthermore, despite the interest of policy makers in expanding established BRT systems and finding ways to finance them, no studies have examined whether expansions provide benefits to properties that were already served by the BRT system.

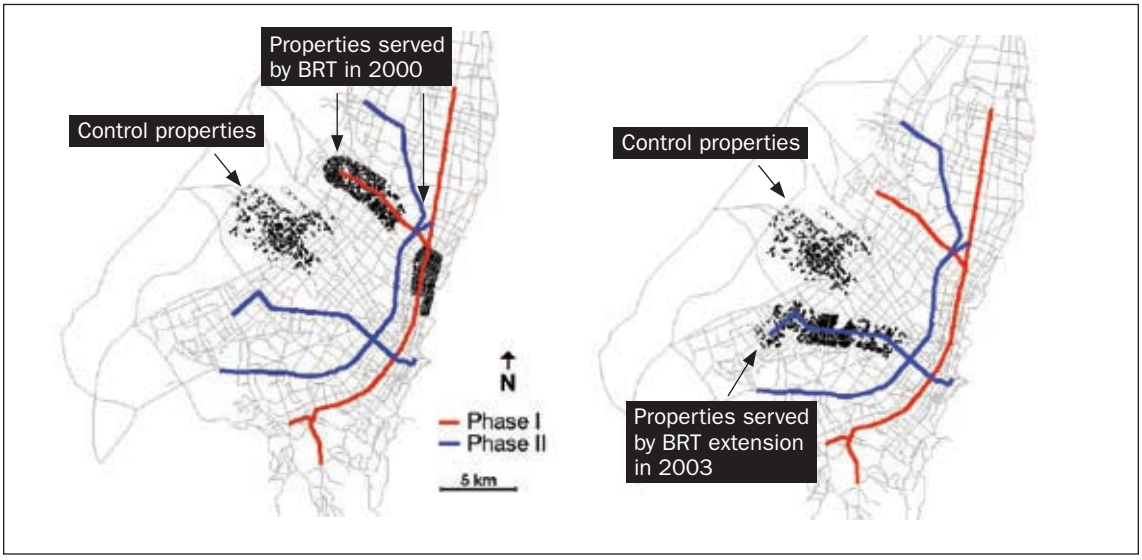
Using before and after data on property asking prices, we examined whether prices changed as the TransMilenio system expanded. Understanding how prices changed in Bogotá is particularly important given the long-standing experience of the Colombian government with land value capture instruments and the increased interest of finding new financing sources for future BRT extensions (Furtado 2000).

Our data came from a sample of properties in the Bogotá metropolitan area between 2001 and 2006. The Phase II TransMilenio extension, opened to the public in December 2003, provided the setting for the study. In the analysis we used single-family properties located within 1 km of the BRT system that benefited from the system extension in one of two ways: by gaining local access to TransMilenio due to the extension, or by gaining regional access due to the expanded reach of the network, which we label "network effect."

To measure network effects we used properties that previously had only local access to a TransMilenio station, but now benefit from the expanded reach of the BRT system. By contrast, properties that did not have local TransMilenio access prior to December 2003, but also benefited from the expansion, are used to examine the local access effects (see figure 2).

All properties likely to be affected by TransMilenio are deemed as belonging to network effect or local access intervention areas. However, because property values may change from before to after intervention for reasons other than the TransMilenio changes, we also include properties in a control area that did not benefit directly from any of the TransMilenio investments, or other bicycle route or major park investments.

FIGURE 2
Mapping Helps Identify Properties to Evaluate TransMilenio's Land Value Impacts



The left panel shows properties in selected neighborhoods that had access to TransMilenio before 2003 (red lines) and that may have benefited from the system extension (blue lines). The right panel shows properties that benefited directly from the extension because prior to 2003 they had no local access to TransMilenio. Properties that did not benefit directly from the 2003 extension or from other large public works projects are used as controls.

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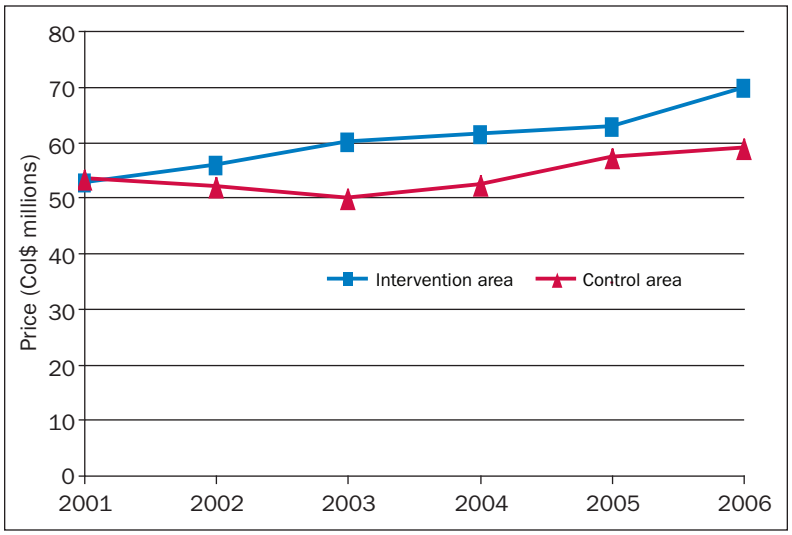
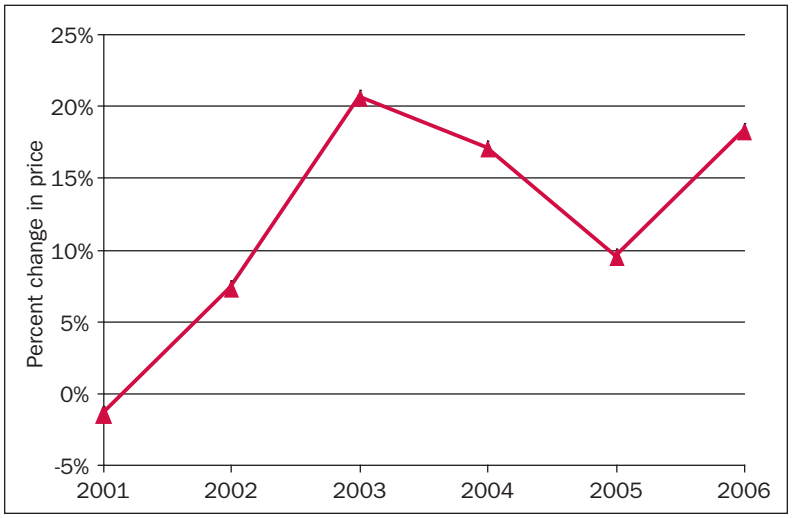
FIGURE 3
Network Effects: Estimated Yearly Changes in Prices for Intervention and Control Area Properties, 2001–2006



Note: As of May 2007, US$1 = Col$1,980.

FIGURE 4
Network Effects: Estimated Yearly Percent Difference in Prices for Intervention and Control Area Properties, 2001–2006



Simple descriptive statistics from both intervention areas and the control area show that properties in the network effect area were more expensive than those of the other two areas, both before and after. Properties in the local access area had similar prices to the control area before and after. Furthermore, asking prices increased at different rates. For properties in the network effect area, prices appreciated 5.1 percent, compared to 9.5 percent for properties in the local access area and 7.7 percent for those in the control area during the same period. These differences can be deceptive, however, because the properties being offered in the market may have been different before and after the intervention.

For example, the control area has significant amounts of industrial uses (22.7 percent) and vacant lots (14.1 percent) relative to the other two areas (network effect area: 0.5 percent industrial and 0.8 percent vacant; local access area: 13.7 percent industrial and 7.0 percent vacant), even though population densities are similar. The control and local access areas have little or no commercial uses, while the network effect area has a more balanced mix of residential and commercial land uses. Therefore, a regression analysis was necessary to help us isolate the price variation identified from the effects of inflationary pressures, differences in the supply of housing, or the impact of the TransMilenio extension on housing prices. Our models also corrected for the correlation that exists for properties that are closer together in space, relative to those that are further apart.

Property Value Changes in BRT Serviced Areas

Our regression model findings for the network effect area relative to the control area showed consistent evidence that prices for 2001 and 2002 were similar between the intervention and the control areas, with no appreciation occurring. However, we detected a consistent positive appreciation in the intervention area from 2003 onwards, relative to the control area.

The resulting asking prices from the estimates are shown in figure 3, which was constructed using a simulation based on estimated coefficients and their variance–covariance matrix. The values represent a property that was between 10 and 20 years old, with all other variables set to their median values, while changing the year from 2001 to 2006.

Properties in the intervention area appreciated earlier and more than properties in the control area. Figure 4 shows changes in prices between the intervention and the control areas in percentage terms. The 2003 spike in prices in the intervention area may be the result of owner anticipation of the opening of the BRT extension, or other real estate submarket changes not accounted for in our variables. Although similar anticipation effects for mass transit extensions have been documented elsewhere (Knaap, Ding, and Hopkins 2001), none have been examined or documented for the network effects that such extensions create.

Property Value Changes in Non-BRT Serviced Areas

Our regression model findings for the local access area relative to the control area showed mixed evidence of price increases in areas not previously serviced by the BRT system. In some cases (depending on the model specified) prices in the intervention area were higher than in the control area for properties offered in 2001, 2003, 2004, and 2006. Other models showed less consistent relationships. A test of the coefficients for the before period and the coefficient for the after period shows no joint difference in property prices.

The Bottom Line: TransMilenio and Property Values

Overall our results paint a mixed picture of the appreciation of prices due to BRT extensions. On the one hand, the evidence suggests price appreciation for properties already served by BRT, since they also benefited from the extensions. The estimated asking price premium is between 15 and 20 percent, although the appreciation began one year before the extension was inaugurated. This is significant, given that we know little about the potential magnitude of these effects. By contrast, we found limited evidence of asking price increases for properties along a corridor that previously did not have a local BRT station, but that now is served by the extension.

We cannot claim unequivocally that the price increases were the result of the BRT extension, because they may be the result of local real estate submarket variations. For example, the City of Bogotá emerged from a deep recession that ended in the early 2000s. If the recession effects were not uniform across neighborhoods, it is possible that they can explain the differential found. Furthermore, it is possible that the properties already served by BRT were simply capitalizing the benefits of the original investment made only four years earlier.

CONTINUED ON PAGE 24

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THE CASE OF BOGOTÁ'S TRANSMILENIO

CONTINUED FROM PAGE 7

Other potential explanations for the results that may be of interest to planners considering BRT investments include the timing of the effects. The capitalization of benefits from the BRT extensions may take a long time to occur. Our analysis covers only up to three years after the extension was inaugurated, but the development impacts of transportation projects tend to take longer. A related explanation is that properties also appreciate in anticipation of transportation investments, rather than when extensions are inaugurated.

It is also possible that the effects differ for neighborhoods within each study area. Although we used properties within 1 km of a BRT station (the catchment area identified by local planners in their TransMilenio feasibility studies), it is possible that prices increased, but only for a subset of properties (for example, those closest to a station). Finally, it is likely that the land value impacts of public investment in transportation are different for commercial, multifamily, and single-family properties. Price increases for commercial space have been detected in other cities (Cervero and Susantono 1999; Cervero and Duncan 2002).

There is no simple way of unambiguously examining the land value impacts of large public investments. In this study, we attempted to build on prior studies and overcome their limitations. Our findings show some promise for financing infrastructure through the land value increases they may create. But ambiguities and caveats remain that are not easily resolved. In the meantime, decision makers will continue to explore solutions to mass transportation options and ways to finance it, and BRT will contribute to addressing the pressing mobility needs of cities around the world.

Research Fellowships Available

The Lincoln Institute's Program on the People's Republic of China offers research fellowships through the newly established Lincoln Institute–Peking University Center for Urban Development and Land Policy in Beijing. These fellowships are designed to help qualified scholars enhance their capacity in land and tax policy fields that address the Institute's primary interest areas in China. Priority topics include urban economics, land use and policy, urban and rural planning, local public finance, and property taxation. The deadline for these applications is May 16, 2008.

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