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Radical uncertainty and the effect of transport infrastructure on land prices

Incerteza radical e o efeito da infraestrutura de transporte nos preços da terra

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RESUMO: A maioria das contribuições na literatura acadêmica identifica um efeito positivo da infraestrutura de transporte nos preços da terra. No entanto, sua dinâmica de curto prazo não tem sido analisada rotineiramente. Uma das razões para essa falta de pesquisa é porque os modelos neoclássicos de economia fundiária urbana fundamentam, em alguns casos implicitamente, a maior parte da literatura disponível sobre o tema. Nesta teoria, os valores da terra convergem para suas tendências de longo prazo, independentemente dos choques de curto prazo. Baseamo-nos na teoria do circuito monetário pós-keynesiano para projetar uma estrutura de teste de economia espacial urbana, com base nas contribuições de Abramo (2011) e Alfonso (2007, 2017). Nesta tradição, choques de curto prazo têm efeitos de longo prazo na distribuição espacial dos valores da terra devido à incerteza radical. Nosso estudo de caso é o Transmetro, um projeto de Bus Rapid Transit (BRT) em Barranquilla (Colômbia). Usamos estimativas de painel estáticas e dinâmicas para testar a dinâmica de curto prazo dos ajustes espaciais dos preços da terra durante 2000-2010, incluindo os anos de construção e entrega de 2006-2010. Este estudo de caso oferece uma boa oportunidade de avaliação por apresentar problemas e atrasos proeminentes. Encontramos ajustes voláteis de curto prazo que vão contra as previsões neoclássicas, ao mesmo tempo que se assemelham a ajustes espaciais de preços de terras expostos a uma incerteza radical.
PALAVRAS-CHAVE: Circuito monetário; economia pós-keynesiana; economia urbana; transporte rápido de ônibus; mercado de terras urbanas; metropolização.

ABSTRACT: Most contributions in the academic literature identify a positive effect of transport infrastructure on land prices. However, their short-run dynamics has not been routinely analyzed. One of the reasons for this lack of research is because neoclassical urban land eco-

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nomics models underlie, in some cases implicitly, most of the available literature on the topic. In this theory, land values converge to their long-term trends regardless of short-term shocks. We build upon post-Keynesian monetary circuit theory to design a spatial urban economics testing framework, building upon the contributions of Abramo (2011) and Alfonso (2007, 2017). In this tradition, short-term shocks have long-term effects on the spatial distribution of land values due to radical uncertainty. Our case study is Transmetro, a Bus Rapid Transit (BRT) project in Barranquilla (Colombia). We use static and dynamic panel-estimation to test the short-run dynamics of spatial land price adjustments during 2000-2010, including the construction and delivery years 2006-2010. This case study offers a good assessment opportunity because of featuring prominent problems and delays. We find volatile short-run adjustments that run counter to neoclassical predictions, while resembling spatial land price adjustments exposed to radical uncertainty.
KEYWORDS: Monetary circuit; post-Keynesian economics; urban economics; bus rapid transport; urban land market; metropolization.
JEL Classification: B41; B52; E12; R30.

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1. INTRODUCTION

There is abundant academic literature regarding the effect of infrastructure on real estate prices (Higgins & Kanaroglou, 2016; Mohammad et al., 2013). However, there are few analyses about its short-term effects. (Devaux et al., 2017; Dubé et al., 2018). This relative scarcity of research on short-term adjustments is due to the predominance of Neoclassical economics in urban research. According to Neoclassical theory, urban areas are long-run spatial general equilibrium systems with trends detectable by market agents and government assessors. Short-term real estate price adjustments are simply intermediate steps in the convergence to long-run trends, in which transport infrastructure is fully capitalized into land prices (Wang et al., 2015; Yen et al., 2018; Park, 2014).

In contrast to Neoclassical economics, short-term adjustments are fundamental in Monetary Circuit, a post-Keynesian macroeconomic theory. This theory states that money is endogenously created by the financial system via credit (Cesaratto, 2017), an inherently uncertain process, where conventional agreements between the government and financial sector are necessary to even 'create' capitalism itself (Aglietta & Cartelier, 2002). In this paper we extract an urban economics prediction from Monetary Circuit macroeconomics: in Global South cities the conventional agreements among government-finance-developers are weak, generating 'urban radical uncertainty'. This is a situation where market agents require incentives and extra official information from city authorities to engage in urban development processes (Abramo, 2011; Alfonso, 2017; and Bao Nguyen et al., 2017).

We use a case study to test urban radical uncertainty: the spatial distribution of land prices before, during and after the construction of a Bus Rapid Transit (BRT) project in Barranquilla, Colombia. This project was impacted by significant delays and public controversy. In this case study, the land market did not perform Neoclassical-style convergent short-term price adjustments.

Urban radical uncertainty is a serious problem in the Global South, making ex-ante land valuation an almost insurmountable task. The uncertainty in these urban markets is such that the most convenient funding source for transport infrastructure is debt, which can be subsequently recovered using land exactions and property taxes. This process can be performed only after city-wide spatial markets have fully accommodated construction infrastructure shocks, and long-run trends have been established.

Our paper has five sections, including this introduction. Section two presents the conceptual framework and the empirical strategy. Section three introduces the case study, highlighting its turbulent development process. It also presents the database compilation. The fourth section presents regression results, and section five concludes.

2. CONCEPTUAL FRAMEWORK AND EMPIRICAL STRATEGY

2.1 Two Different Approaches to Uncertainty in Urban Land Markets

Here we explain uncertainty in Neoclassical models, before proceeding to show our alternative approach. In the Neoclassical tradition it is optimal to develop a property when the present value of newer land rents, due to planning or infrastructural changes, equals the present value of the old rents (opportunity cost) plus development cost. Development timing is a moving target which, regardless of short-term uncertainty, can be predicted in the long-run. Figure 1 represents this "predictable uncertainty".

Figure 1: Land Price, infrastructure, and short-term (predictable) uncertainty

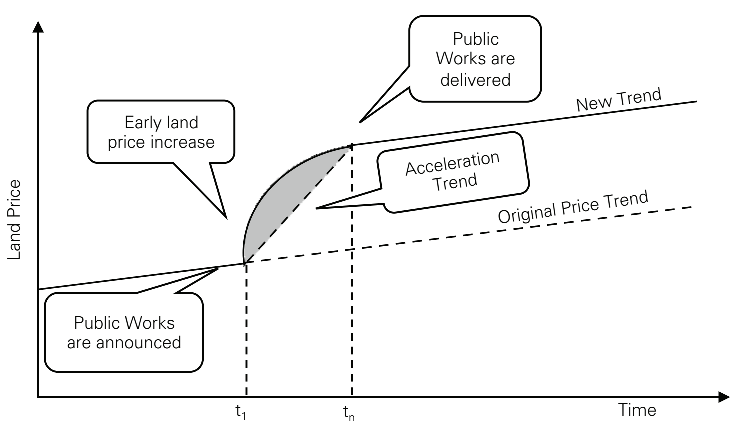


Figure 1 shows the effect of public works on the price of a plot of land. The positive price trend reflects ongoing, city-wide growth, with observable prices represented by continuous lines. Public works temporarily accelerate the positive price trend, represented by a steeper, dashed line. When the infrastructure is delivered for public use, land prices return to the long-run trend, although with a higher absolute value. Well-informed sellers can anticipate the dashed-line increase, if: 1) buyers do not know the trend and are willing to pay the sellers' price; or 2) buyers are not willing to pay the sellers' price, but the price difference between t_1 and t_n, is high enough to compensate the sellers' opportunity cost of not using the land during that period.

In Figure 1, the predictable delivery of public works at t_n allows the agents to base their decisions on long-run trends. This is uncertainty in Neoclassical terms (Loasby, 2011). Devaux et al. (2017) and Dubé et al. (2018) find spatial evidence of such processes, even when not testing for uncertainty in the sense we do here.

Neoclassical economics has short-run uncertainty with long-run predictability because money is exogenous in its macroeconomic core model. Money is created when the central bank supplies it to commercial banks, and market agents merely adapt to this exogenous money supply in the long run. With the certainty of exogenous and perfectly inelastic (to the interest rate) money supply by the central bank, observable short-term price adjustments always converge to the long-run money supply (money neutrality).

In contrast to the Neoclassical approach, in the Monetary Circuit, a post-Keynesian macroeconomic theory, money creation is endogenous and occurs when commercial banks lend it to market agents (Penido, 1999; Palley, 2017). There is no certainty that the central bank automatically determines commercial bank loans and economic activity; furthermore, market agents request loans only if they perceive that demand for their products is going to be strong enough to pay back the loans. In other words, the monetary circuit is exposed to an endogenous and unavoidable source of uncertainty.

Economic recessions have offered quasi-experimental evidence in favor of Monetary Circuit macroeconomics, where central banks have given money to commercial banks, but these banks have been unable to lend it out, regardless of low or zero interest rates. This is evidence that money is created when agents take it from commercial banks in the form of loans, as opposed to when central banks send it to the commercial banks (Deleidi & Fontana, 2019).

An efficient monetary circuit requires a stable and trustworthy system of institutional arrangements between the government and financial institutions and differs by countries. These institutional arrangements are the product of very long-run historical processes, which have determined the evolution of capitalism itself (Aglietta & Cartelier, 2002; Fratianni & Spinelli, 2006).

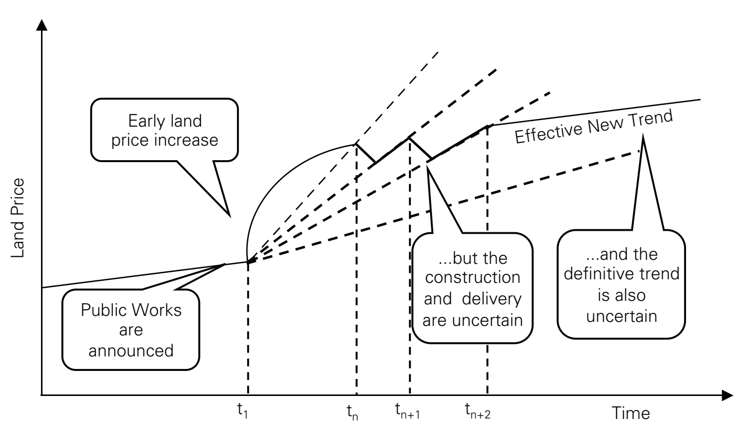
Urban development is a sub-circuit of the macroeconomic monetary circuit, determined by both national and local institutional arrangements. In developed countries, the arrangements operate reasonably well; the process resembles autonomous market-driven urban dynamics. Government interventions are minor corrections to an on-going market process. In contrast, in Latin America the arrangements are weak, because most of the money creation is done by government agencies, using external loans intermediated by the central bank. That is, public reassurance is needed by the monetary urban sub-circuits (Alfonso, 2007; Abramo, 2011).

Monetary Circuit theory does not have a microeconomics subfield as such. However, its logic can be extended to the institutional arrangements required to launch urban development processes. Analyses along this line describe how market agents require regulatory action, infrastructure development and incentives from local governments, before launching development projects (Almeida & Monte-Mor, 2017; Cirolia & Berrisford, 2017; Von Mettenheim, 2006).

Figure 2 represents radical uncertainty, which occurs when the delivery date of public works cannot be guaranteed. Market agents want to anticipate the land value increase; however, the long-run trend is also moving at the moments t_n, t_{n+1}, and t_{n+2}. Empirical analyses will not depict a smooth transition towards the long-run trend line (the curved continuous line in Figure 1), as the trend line cannot be determined in the first place (Alfonso, 2017).

Figure 2 represents our case study, where market agents cannot make decisions based on long-run trends. We derive two empirical hypotheses from the figure: 1) the short-term spatial adjustments to the BRT construction are not consistent (regression parameters changes do not have same sign). The reason for such inconsistency is that: 2) market agents cannot a-priori determine the long-run price trends. These are the differences in the price behavior between the interval $\left[t_0 : t_n\right]$ of figure 1, and the interval $\left[t_0 : t_{n+m}\right]$ of figure 2. We test these hypotheses by verifying short-term price fluctuations as a function of distance to transport infrastructure, on a baseline citywide model of land prices. This baseline model is presented in section 2.2.

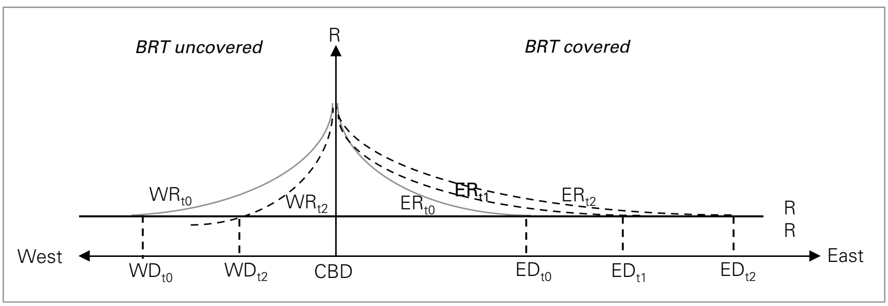
Figure 2: Land price, infrastructure, and radical uncertainty



2.2 Spatial Dynamics and Empirical Strategy

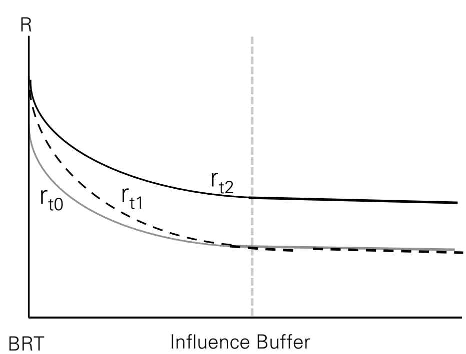
Figure 3 represents a Neoclassical urban economics model. The continuous lines R_{t0} (East and West) are initial period $t0$ bid-rent functions, decreasing as a function of distance to the center (CBD) in every direction. The city limit is where the bid-rent functions intersect the Rural Rents (RR). When a BRT is built on the east radial street but not on the west, the model predicts three adjustment stages: 1) all the locations to the east are more accessible, diminishing location pressure and the slope of the bid rent function to ER_{t1}; 2) development migration from the west side drops its bid-rent function to WR_{t2} and its urban limit to WD_{t2}; and 3) the development potential has migrated to the east side, shifting-up the bid-rent to ER_{t2}, with city limit ED_{t2}.

Figure 3: City-wide distribution of land rents after transport improvement



The baseline model of Figure 3 can be observed using panel estimation on data that includes these moments: before, during and immediately after, transport improvement (Yen et al., 2018). Figure 3 represents the BRT construction effect city-wide, not just on its vicinity, which is analyzed in the accessibility gradient of Figure 4.

Figure 4: Price adjustment in the BRT vicinity



The initial bid-rent function r_{t0} in Figure 4 already assigns higher prices to locations closer to the original radial road. This distribution is superimposed to every D_t ring location in Figure 3 (any location at the same distance from the city center). When the BRT is built, land rents increase to r_{t1} in Figure 4. However, subsequent development migration fills-in the accessibility gradient up to r_{t2}. Notice that r_{t2} is higher but has the same slope as r_{t0}, because the accessibility conditions to the radial road that contains the BRT have not changed. In the empirical section below, we use an influence buffer of 500 meters to portray these land rent movements in relation to BRT. This distance is used for visualization purposes only; it does not have any effect on regression results because our regression all the metro area data[1].

To detect the above-described processes, garzwe implement the regressions described by equations (1) and (2). These regressions represent a baseline Neoclassical model: $r_{i,t}$ is the land price per square meter at neighborhood i and time t; which decreases in the Distance to Center and to BRT, requiring negative parameters for γ (R_t in figure 3) and δ (r_t in figure 4). The model also requires correct signs of the β_g parameters for the X control variables[2].

$$r_{i,t} = \alpha + \gamma DistCenter_{i,t} + \delta DistBRT_{i,t} + \rho BRT_{t+n} + \pi\left(BRT_{t+n} \cdot DistBRT_{i,t}\right) + \Sigma \beta_g X_{i,t} + \epsilon_i + \varepsilon_{i,t} \qquad (1)$$

$$r_{i,t} = \alpha + \gamma DistCenter_{i,t} + \delta DistBRT_{i,t} + \varphi BRT_{t+n+m} + \sigma\left(BRT_{t+n+m} \cdot DistBRT_{i,t}\right) + \Sigma \beta_g X_{i,t} + \epsilon_i + \varepsilon_{i,t} \qquad (2)$$

We use spatially controlled Difference in Differences (DiD) estimation to detect the short-term fluctuations, by sequentially adding period (BRT_{t+n}) and year (BRT_{t+n+m}) dummy variables. These dummies have the value 1 during the construction period $(t+n)$ and for every construction year $(t+n+m)$, and are zero otherwise. The dummies shift the key parameters of the described baseline model: The shifts from ER_{t0} to ER_{t1} in Figure 3, and from r_{t0} to r_{t1} in Figure 4, require positive ρ and negative π in equation (1). A smooth transition to the long-run trend is represented by the shift from ER_{t1} to ER_{t2} in Figure 3, and from r_{t1} to r_{t2} in Figure 4, and requires positive φ and negative σ in equation (2). In addition, σ must have a lower absolute value period-by-period, i.e.: less negative in $(t+n+2)$ than in $(t+n+1)$. A less strict test requires the mere consistency of the changes in σ, either positive or negative. Changes with a consistent direction (same sign) at every $(t+n+m)$ period, would be evidence of converging with the long-run trend of Figure 1. A fluctuating sign of σ will resemble the prediction problems of Figure 2. ϵ_i are neighborhood panel effects; and $\varepsilon_{i,t}$ are regression residuals.

Our model can portray two types of uncertainty: 1) if the parameter γ is consistently negative in any of the specifications, the city-level structure resembles Figure 3, and there are detectable long-run trends towards which to converge; and

[1] Literature on the interactions between transport and real estate customarily uses pre-determined buffers of impact in data collection and estimation. That is, quasi-experimental research designs that dismiss analyses at the city-wide scale.

[2] The expected and obtained signs for these parameters are discussed in section 4.

2) if the sign of γ fluctuates with the introduction of the construction period $(t+n)$ and/or the yearly $(t+n+m)$ dummies, the uncertainty is such that it is impossible for market agents to even perceive the long-run trends by zone[3].

Our second set of tests is performed in equations (3) and (4), where we correct the implicit trend using a positive (because of population and economic growth) Auto-Regressive (AR) component θ:

$$r_{i,t} = \alpha + \theta r_{i,t-1} + \gamma DistCenter_{i,t} + \delta DistBRT_{i,t} + \rho BRT_{t+n} + \pi\left(BRT_{t+n} \cdot DistBRT_{i,t}\right) + \Sigma \beta_g X_{i,t} + \epsilon_i + \varepsilon_{i,t} \quad (3)$$

$$r_{i,t} = \alpha + \theta r_{i,t-1} + \gamma DistCenter_{i,t} + \delta DistBRT_{i,t} + \varphi BRT_{t+n+m} + \sigma\left(BRT_{t+n+m} \cdot DistBRT_{i,t}\right) + \sum \beta_g X_{i,t} + \epsilon_i + \varepsilon_{i,t} \quad (4)$$

Finally, we use dynamic estimation in equations (5) and (6), to eliminate the effect of trends in all the variables while ruling out regression endogeneity. We implement Arellano-Bond panel in first-differences (θ represent first-difference), differencing-out the constant and panel effects, and including lags of all the variables as instruments:

$$\Delta r_{i,t} = \theta \Delta r_{i,t-1} + \gamma \Delta DistCenter_{i,t} + \delta \Delta DistBRT_{i,t} + \rho \Delta BRT_{t+n} + \pi \Delta\left(BRT_{t+n} \cdot DistBRT_{i,t}\right) + \sum \beta_g \Delta X_{i,t} + e_{i,t} \quad (5)$$

$$\Delta r_{i,t} = \theta \Delta r_{i,t-1} + \gamma \Delta DistCenter_{i,t} + \delta \Delta DistBRT_{i,t} + \varphi \Delta BRT_{t+n+m} + \sigma \Delta\left(BRT_{t+n+m} \cdot DistBRT_{i,t}\right) + \sum \beta_g \Delta X_{i,t} + e_{i,t} \quad (6)$$

In summary, we have a sequential testing framework. First, we estimate a baseline urban land market where parameters must have their expected signs. In the second stage, we add construction period and year dummies, and their interactions with Distance to BRT. These are the Difference-in-Differences (DiD) test parameters. We want to verify: 1) the consistency (same sign) of the short-run spatial adjustments to the BRT construction; and 2) if the inclusion of dummies and interactions changes the signs of the baseline model parameters. In the third stage, we verify all the results using dynamic estimation.

3. CASE STUDY AND DATA

Barranquilla is the fourth largest Metropolitan Area in Colombia. Located at the confluence of the Magdalena River and the Caribbean Sea, its conurbation includes the neighboring municipality of Soledad. Barranquilla Metro has governability problems and a weak institutional structure (Perez-Valbuena et al., 2016; Arellana et al., 2021; Alfonso, 2009)[4].

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[3] Recent contributions by Devaux et al. (2017) and Dubé et al. (2018), detect similar fluctuations in their city gradient and Distance to BRT parameters. However, they do not discuss the underlying theoretical model, emphasizing the technical spatial analysis details instead.

[4] In recent years Barranquilla, although not Soledad, has improved its indicators of institutional performance, increasing property tax collection and revenue administration efficiency.

We are focusing on Barranquilla-Soledad, even though the Metro Area includes other three municipalities: Galapa, Malambo, and Puerto Colombia. The reason is that Barranquilla and Soledad have the clearest conurbation phenomena. Conurbation between Barranquilla and Puerto Colombia was incipient during 2000-2010, and no BRT connection was developed or planned.

Barranquilla-Soledad 2000-2010 is an interesting case study because the construction of Transmetro, its BRT system, had extreme delays. A transport infrastructure project with a long and convoluted construction process during which the weak institutional arrangements supporting urban development city-wide were readily apparent. Transmetro provides an opportunity to examine radical uncertainty as characterized in Figure 2.

Barranquilla's Transmetro is part of the 2000s wave of Colombian BRTs, inspired in the model of Bogota's Transmilenio (Jaramillo et al., 2012; Combs, 2017). The national government provided a large portion of the funding for Transmetro construction. This was seen by some as a central government attempt to curry favor with local governments to gain future political support (*Semana*, 2006).

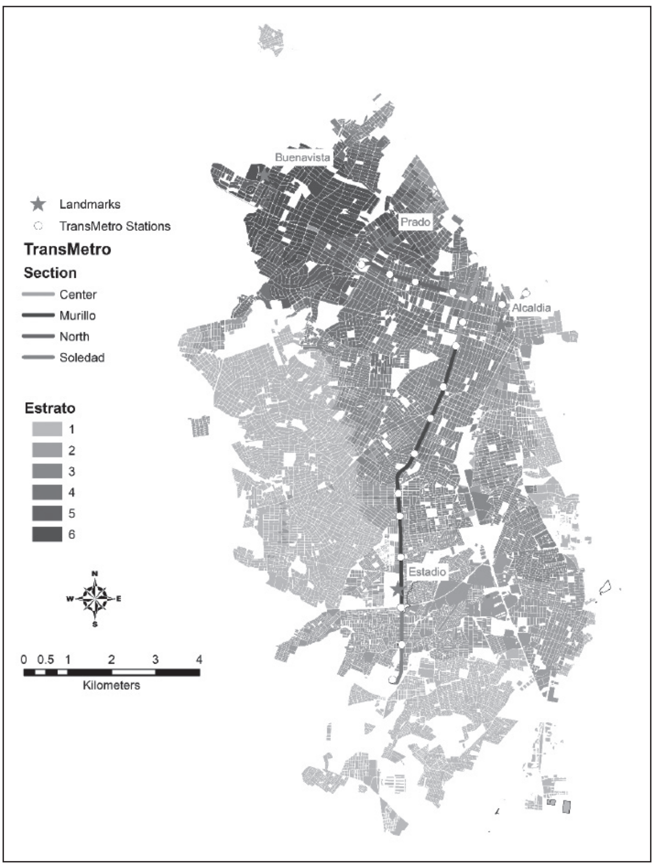
Transmetro works started in November of 2005, with completion scheduled for 2007. However, the original delivery date was not met, underperforming in relation to comparable cities (Pereira, Bucaramanga). The inauguration of the first station was surrounded by local corruption scandals (La Silla Vacía, 2010; El Heraldo, 2011). The project, originally projected to cost 310,000 million pesos, was completed in 2010 at a cost of 750,000 million pesos (Portafolio, 2010).

Figure 5 shows Barranquilla's TransMetro two lines and 17 stations. The first line departs from Portal de Soledad in the southeast and goes through Avenida Murillo (Calle 45) into downtown. The second line departs from the Barranquillita market, close to the Magdalena River, and heads northwest across Avenida Olaya Herrera (Carrera 46) to Joe Arroyo terminal (Calle 74). Figure 5 includes a background of the built environment by blocks, including their estratos for Barranquilla-Soledad. Estrato is a national socio-spatial classification used to cross-subsidize utilities' bills by income groups. The Colombian Statistics Agency (DANE) does not report income data at the level of blocks or neighborhoods, and social researchers proxy it using estrato. There are six estratos. One is the lowest (poorer) estrato and Six is the highest (wealthier). Barranquilla has the six estratos, while Soledad, a smaller and poorer municipality, has only One-Three. Elite housing and commercial activities, including landmarks Buenavista Shopping Mall and El Prado Office Center, are located in the north-northwest (the highest estratos) areas of Barranquilla. The south and southeast areas are middle-income residential, while the southwest is industrial and low-income residential. The downtown and river margin are predominantly industrial and working-class commercial.

Our database comprises 4,874 certified geocoded appraisals for the period 2000-2010. The appraisals include yearly information on use, built area, construction age, land plot size (or imputed land plot size) and value. The appraisals were conducted by the Local Appraisers Association (Lonja de Propiedad Raíz de Barranquilla), and we compile them into 62 neighborhoods, which are our spatial unit of analysis[5]. We limit our database to the 62 neighborhoods with available land value information in all the years, to perform panel estimation.

We use appraisals because: 1) we do not have any large transaction-based database (which in any case would mix improvements and land); and 2) idiosyncrasies of buyers and sellers might affect transactions, while appraisals respond to valuators' mental models (Garza & Lizieri, 2019). These valuators are informed agents, whom in our theoretical framework can be affected only by radical uncertainty, not by lack of knowledge or irrationality. Figure 6 uses natural breaks to depict the land price per M2 in three different years (2000, 2005 and 2010), including the spatial distribution of the appraisals (our data source), and their average by neighborhoods (our spatial analysis unit).

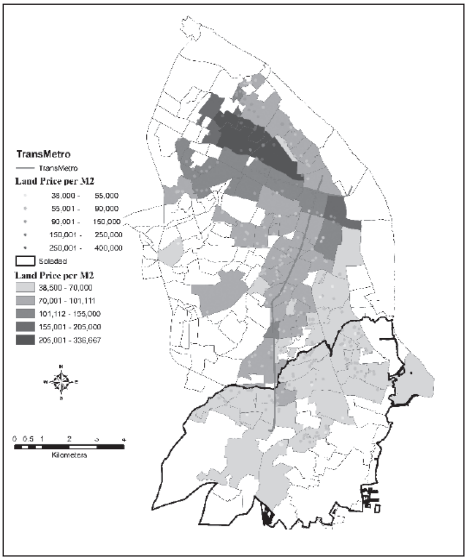
Figure 5: Barranquilla-Soledad, Transmetro and Estratos



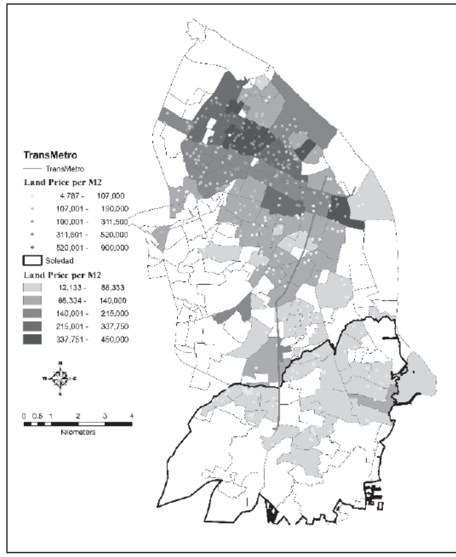
[5] We must clarify that Colombian *Lonjas* are private but regulated institutions, and appraisals can be legally and technically challenged. Property Valuation is a relatively established and trustworthy professional activity. *Lonja de Barranquilla* uses the database to produce its yearly land prices reports, and to support its department of technical analysis and valuation (Payares, 2012).

Figure 6: Land prices per M^2 by observation and neighborhood (constant COP$ 2016)*

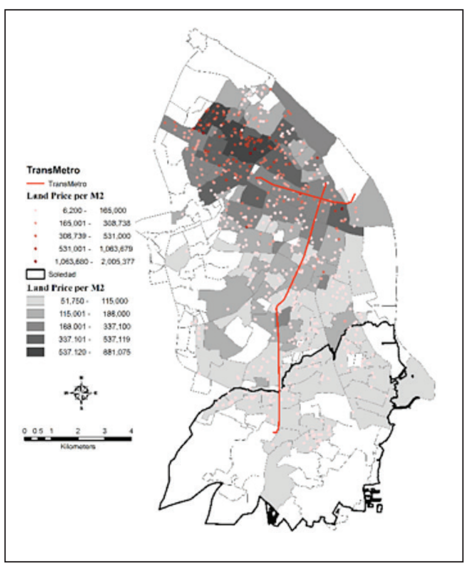
2000



2005



2010



* In 2016: US$ 1 = COP$ 3,052. Prices by observation and neighborhood are reported as natural breaks for five brackets

Our empirical approach builds on a growing body of work that uses panel estimation in Difference-in-Differences (DiD) spatial assessments of transport infrastructure and property prices. From a methodological point of view, we extend panel DiD assessments because:

a) We use land price appraisals, not repeat sales databases, which are scarce in most Global South cities due to land informality. Our database of appraisals simulates a 'census' because it includes all the appraisals performed by licensed agents in the Barranquilla-Soledad area, even in markets of informal origin.
b) Appraisals smooth-out individual idiosyncrasies. Therefore, counter theoretical short-term price adjustments cannot be attributed to irrationality or market agents' ignorance.
c) Our land price appraisals exclude the value associated with improvements, which is not a pure financial asset, and therefore not explained by either the canonical Neoclassical or our post-Keynesian theories.
d) Our database includes all the land uses, not just residential real estate.

Table 1 shows the variables used in the empirical section. Property Types is the neighborhood average of properties by land use (average of dummies by property). Stations is the neighborhood average of dummies by property for which the closest station is in the corresponding TransMetro section. According to our baseline model Distance to Sub-Centers (Downtown, Buenavista, Prado, Stadium) should have a negative effect on land prices.

Our panel database is relatively small (62 Cross-section units 11 Periods = 682 observations), and our regression analyses require time-lags (AR), first differences, and instrumental variables. Therefore, we limit the number of baseline model variables to six, including: Distance to BRT; Distance to best-fit Subcenter (Prado in this case); Built Total M^2; Distance to closest station (stations by TransMetro section), and two Property Types chosen using a stepwise procedure. Descriptive statistics are reported in Table 1.

Table 1: Descriptive statistics of panel variables by neighborhood

Variable	Unit of Measure	Mean	Std.Dev.	Max	min
Appraisals Count	Number	76,51	85,85	320,00	16,00
Land Price per M^2	Constant COP$ 2016 *	228.774	135.853	667.380	106.698
Built Price per M^2	Constant COP$ 2016 *	722.538	314.698	1.340.948	413.498
Land M^2	Squared Meters	644,81	3.306,62	5.667,37	73,05
Built M^2	Squared Meters	246,67	1.034,00	1.825,84	69,10
Age of Construction	Years	20,14	12,14	32,09	10,59
Permitted Height	Floors	7,21	1,65	13,89	0,00
Distance to BRT	Meters	1.440,15	892,88	3.312,39	292,20
Estrato Average	Ordinal (1 - 6)	3,54	1,25	5,75	1,00
Setbacks	Meters	3,60	1,88	7,86	0,00
Lateral Setbacks	Meters	6,72	3,23	10,00	0,00
Distance to Downtown	Meters	4.110	1.752	8.524	892
Distance to Buenavista	Meters	5.319	3.224	12.587	747
Distance to Prado	Meters	3.673	2.497	10.291	747
Distance to Stadium	Meters	5.759	2.795	10.347	728
Stations Center	Closest Station	0,08	0,25	0,91	0,00
Stations Murillo	Closest Station	0,34	0,47	1,00	0,00
Stations North	Closest Station	0,50	0,49	1,00	0,00
Stations Soledad	Closest Station	0,08	0,27	1,00	0,00
Type Residential	Dummies average (0 - 1)	0,83	0,25	1,00	0,20
Type Other	Dummies average (0 - 1)	0,06	0,15	0,24	0,00
Type Mixed	Dummies average (0 - 1)	0,02	0,07	0,16	0,00
Type Institutional	Dummies average (0 - 1)	0,01	0,06	0,12	0,00
Type Industrial	Dummies average (0 - 1)	0,02	0,07	0,18	0,00
Type Commercial	Dummies average (0 - 1)	0,07	0,15	0,50	0,00

* In 2016: US$ 1 = COP$ 3,052

4. REGRESSION RESULTS

In this section we perform the tests proposed in section 2. In section 4.1 we perform the linear panel regression equations (1) and (2), and then, the trend-corrected equations (3) and (4). Section 4.2 presents the results of the same regressions using Instrumental Variables (IV) to control endogeneity. In section 4.3 results of the dynamic panel (equations 5 and 6) are presented. All the methods produce similar results, reported in tables in the Appendix, and in graphs of their predicted land price time-series in the text.

4.1 Static Panels: Linear Regression with and without AR

Figures 7A and 7B below, and Tables A1 and A2 in the Appendix, show results when using static estimation with and without AR. Fixed Effects (FE) are the best panel effects according to Breusch-Pagan and Haussman tests. In addition, FE specifications always have the highest R2 and the lowest Standard Error. The residuals do not have any spatial autocorrelation, according to the p-value of their Spatial Autoregressive (SAR) parameter.

In Tables A1 and A2, Distance to BRT is negative and significant in most of the specifications. Distance to Prado improves in the AR(1) models, as it is negative and significant in all the models. The Period dummy is always positive and significant, but its interaction is not significant in the AR(1) models[6]. The Year dummies and their interactions are not significant in six cases and have non-consistent signs (positive and negative), rejecting the smooth-transition prediction of Neoclassical models.

Figures 7A and 7B are simulations extracted from the regressions (Models FE2 and FE2006 to FE2010). They represent the 10-year evolution of two land price indexes: a) properties in the immediate vicinity of a BRT station, and b) properties located 500 meters away[7]. The percentage price difference between those two prices is represented by gray bars in the figures. The effect of Distance to BRT is strong in 2006, decreased during 2007-2009, and increased in 2010. This is evidence in favor of the hypothesis that the markets overreacted at the beginning of the construction in 2006, and cooled down until 2009 due to the construction delays. In order to verify these linear results, we use IV Panel regression in the next section.

4.2. Static Panels: IV Regression with and without AR

The IV panel regressions are reported in Tables A3 and A4 in the Appendix, and in Figures 7C and 7D. The instruments are consistent in all the regressions, according to the J-Statistic[8]. RE is the best specification according to the Haussman test. All the errors clear panel unit-root according to Levin, Lin & Chu, and do not have spatial autocorrelation. The effect of Distance to BRT is negative, although it is not significant in many specifications. Distance to Prado is always negative and significant. The Period dummy has non-consistent changes of the sign. Its interaction with Distance to BRT is positive and significant, while the dummies per years and their interactions have changing signs. These results confirm the linear regressions and further reject the Neoclassical smooth-transition prediction.

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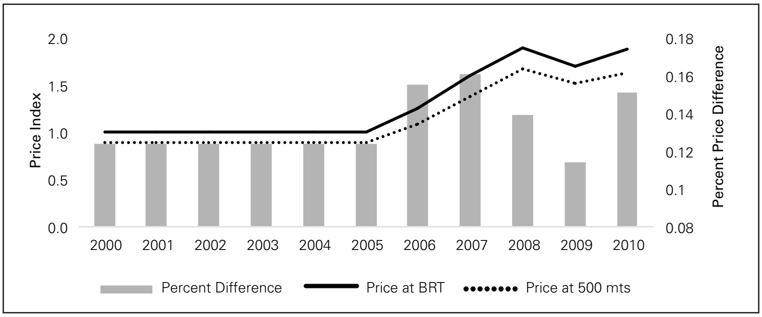
[6] We use the AR(1) component to control prices trend. This component performed better than alternative macroeconomic (exogenous) trend controls in our regressions: GDP per capita, Unemployment, and Interest Rate, in accordance to post-Keynesian analyses on the topic (Deleidi, 2018). We must mention that Colombian macroeconomic indicators have been relatively stable (for Latin American standards). Its positive GDP yearly growth rate has been interrupted only three times in the existing records (1929, 1999 and 2020)

[7] The selection of the 500 meters buffer does not change any of the regression results, because as explained above, we are using all the available appraisals at the metropolitan scale (a census). We use the buffer only for visualization.

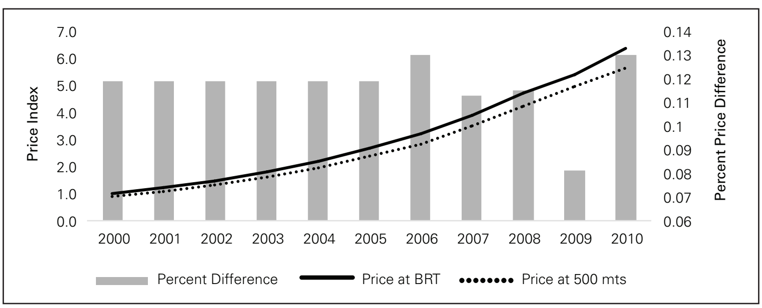
[8] The list of instruments is at the bottom of the tables.

Figure 7: Simulated Land Prices Time-Series using different static panel estimations

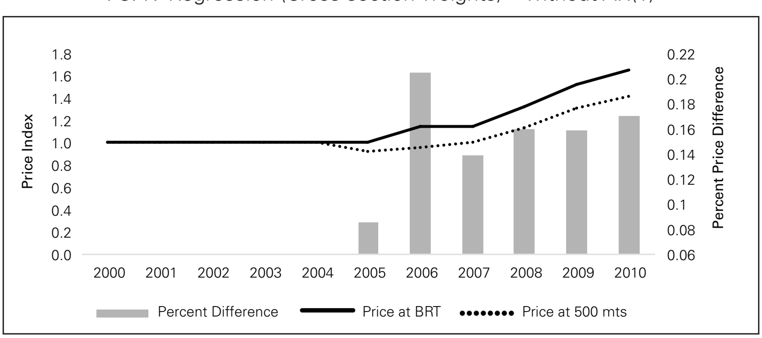
7A: Linear Regression (Cross-section weights) – without AR(1)



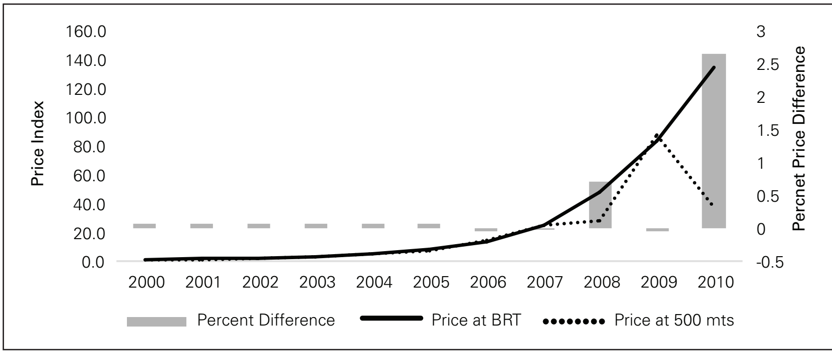
7B: Linear Regression (Cross-section weights) – with AR(1)



7C: IV Regression (Cross-section weights) – without AR(1)



7D: IV Regression (Cross-section weights) – with AR(1)



All the panels in Figure 7 depict the overreaction to the TransMetro construction in 2006, and its fluctuating adjustment. We would be willing to accept the Neoclassical smooth-transition interpretation if the short-term adjustments were in the same direction (consistent signs). However, the parameter is fluctuating, as predicted by post-Keynesian Monetary Circuit theory.

4.3 Dynamic Panel: Arellano-Bond GMM

Figure 8 and Table A5 in the Appendix show dynamic panel results. All the models have correctly specified instruments (variables lagged) according to the J--Statistic, and their residuals have cleared unit-root according to Levin, Lin & Chu. The differentiation has made the panel effects redundant while eliminating spatial autocorrelation. The AR(1) is always significant, and has negative sign in 2008[9]. Distance to BRT is always significant and negative. Period dummy is always significant, except in GMM2009, and its interaction in GMM2 is positive. Year dummies and their interactions are significant in all the models, except GMM2010.

Figure 8 simulates the estimated growth rates for hypothetical properties in the immediate vicinity of a BRT station, at 500 meters, and the city-wide average. Prices at the BRT and at 500 meters away grew faster than the city-wide average before the announcement and construction of the BRT (2002 to 2004). During construction and delivery, the graph portrays fluctuations that reject the Neoclassical smooth-transition prediction: lower prices in 2006 and 2007, higher in 2008 and 2009, and decreasing again in 2010.

[9] A land prices growth deceleration (not decrease) due to an exogenous shock: the US sub-prime crisis.

Figure 8: Simulated Land Prices Time-Series using Dynamic Panel estimation

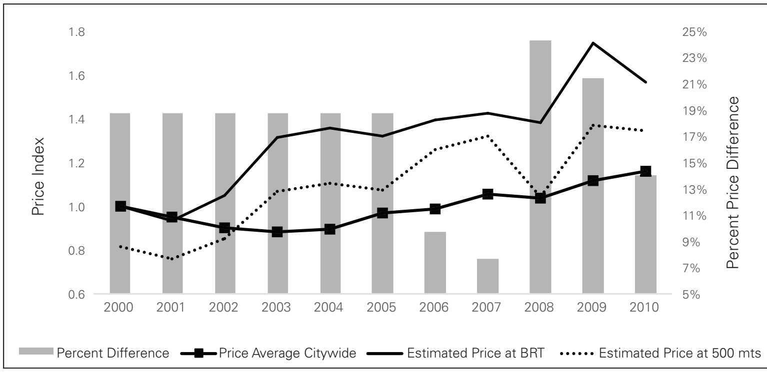


Figure 8 simulates the estimated growth rates for hypothetical properties

Distance to Prado in Table A5 is consistently negative, but not significant in all the specifications. Therefore, it even rejects the baseline city-wide model (Figure 3). This is a situation akin to the radical uncertainty depicted in Figure 2, where even well-informed market agents (appraisers) cannot determine the long-run trends.

5. CONCLUSIONS

Transport infrastructure construction, including BRT systems, tends to have positive long-run effects on land prices. However, the short-term effects have been less analyzed because Neoclassical urban economics underlies most of the research in the field, implicitly taking the role of transport engineering or transport geography. In Neoclassical general equilibrium the short-term adjustments are merely intermediate steps toward long-run convergence, and uncertainty is limited: city-wide land price spatial structures smoothly converge to long-run trends by zones and uses.

To illuminate the existence of radical uncertainty we use Monetary Circuit, a post-Keynesian theory where money is endogenous to the economy and subject to uncertain institutional arrangements. These conditions result in uncertain arrangements among developers-financiers-government in the urban monetary sub-circuits. There is radical uncertainty because market agents cannot set on the spatial distribution of land prices in the long-term. Radical uncertainty causes lack of development, urban informality, and poor-quality built environment (Abramo, 2020).

We test radical uncertainty using dynamic and non-dynamic panel DiD regression in Barranquilla (Colombia), during the period 2000-2010. This metropolitan area offers an ideal case study because of the uncertainty introduced into the city-wide land price market because of delays in the construction of Transmetro, its BRT system. We verify that its short-term land price adjustments do not converge to a predictable spatial-temporal adjustment pattern, as there is inconsistency in signs across years. In addition, the city-wide spatial land market had inconsistent parameters. We conclude that market agents, even well-informed ones like property appraisers, cannot identify the long-run land price trends. In other words, market agents are exposed to radical uncertainty, as predicted by the Monetary Circuit theory applied to urban economics.

That it is nearly impossible to forecast prices per city zone comes as no surprise to practitioners. The predictions change with the availability of information, the progress of public works projects, and ongoing urban development. A practical implication of this observation is that government assessors cannot accurately determine ex-ante land value exactions; they can only do it ex-post. It is fairer and more efficient to develop urban infrastructure using government debt and charge the land value increases only after the long-run city-wide spatial distribution is clear (long-run trends settled), using either land exactions or property taxes.

Urban radical uncertainty causes more than forecasting challenges, it illuminates the impacts that the weakness of the institutional arrangements can have on urban development in the long-run. Because of radical uncertainty, models based upon long-run Neoclassical general equilibrium, even in its implicit forms, are misleading conceptual frameworks for urban economics research in the Global South.

We must clarify that we are not discussing the validity of using the Neoclassical approach to describe the static spatial structure of urban land uses and prices. In fact, we use it as our baseline estimation model. What we argue is that its static conceptual properties cannot simply be extrapolated to its spatial adjustment dynamics, which include normative propositions as urban development guidelines. Alternative conceptual approaches to urban economics research are needed.

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APPENDIX: REGRESSION RESULTS

A1: Linear Regression – pooling, F.E. and R.E. – Cross-section Weights – no AR(1)

	Pooling	FE	RE	Pooling	FE	RE	FE	FE	FE	FE	FE
Constant	13.135 ***	14.632 ***	13.554 ***	12.945 ***	14.129 ***	13.273 ***	14.367 ***	14.297 ***	14.402 ***	14.461 ***	14.566 ***
Distance to BRT	-0.060 ***	-0.234 ***	-0.092 ***	-0.045 ***	-0.192 ***	-0.071 **	-0.212 ***	-0.215 ***	-0.224 ***	-0.225 ***	-0.245 ***
Distance to Prado	-0.171 ***	-0.061 *	-0.134 ***	-0.166 ***	-0.047	-0.129 ***	-0.051	-0.050	-0.053	-0.058 *	-0.053
Estrato Average	0.595 ***	-0.095 *	0.352 ***	0.600 ***	-0.054	0.367 ***	-0.065	-0.035	-0.061	-0.045	-0.061
Built M2	0.067 ***	0.009	0.030 **	0.059 ***	0.002	0.026 *	-0.002	0.005	0.007	0.004	0.007
Type Commercial	0.154 *	-0.034	-0.115	0.210 **	0.002	-0.050	-0.033	0.002	-0.005	-0.017	-0.011
Type Residential	-0.372 ***	-0.246 ***	-0.314 ***	-0.323 ***	-0.205 ***	-0.241 ***	-0.234 ***	-0.218 ***	-0.216 ***	-0.234 ***	-0.234 ***
Stations Soledad	0.159 ***	0.056	-0.079	0.157 ***	0.066	-0.077	0.054	0.058	0.067	0.052	0.054
Stations North	0.119 ***	-0.035	0.135 ***	0.127 ***	-0.010	0.142 ***	-0.015	-0.016	-0.019	-0.027	-0.011
D_After				0.340 **	0.314 ***	0.360 **	0.078 ***	0.064 ***	0.061 ***	0.042 ***	0.032 **
D_After*(Distance to BRT)				-0.041 *	-0.037 **	-0.041 *					
D_2006							0.174				
D_2006*(Distance to BRT)							-0.040 *				
D_2007								0.297 *			
D_2007*(Distance to BRT)								-0.047 *			
D_2008									0.232		
D_2008*(Distance to BRT)									-0.038		
D_2009										-0.244	
D_2009*(Distance to BRT)										0.045 *	
D_2010											0.150
D_2010*(Distance to BRT)											-0.006
R2 (adjusted)	0.770	0.892	0.251	0.774	0.897	0.273	0.901	0.897	0.896	0.897	0.902
S.E. of Regression	0.288	0.203	0.222	0.287	0.201	0.220	0.199	0.201	0.201	0.200	0.200
Breush-Pagan	0.000			0.000							
Redundant Fixed Effects		0.000			0.000		0.000	0.000	0.000	0.000	0.000
Hausman Random Effects			0.000			0.000					
Levin, Lin & Chu	0.001	0.006	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observations	682	682	682	682	682	682	682	682	682	682	682

** Significant at 1%; ** Significant at 5%; * Significant at 10%

ıfter = dummy variable for 2006 - 2010; Year = dummy variable for the corresponding year in the specification

:ontrols = Distance to Prado; Estrato Average; Built M2; Type Commercial; Type Residential; Stations Soledad; Stations North. All the variables introduced as ɔgarithms, except the dummies or percentages

nstruments: AR(1) of Distance to Prado; Estrato Average; Built M2; Land M2; Type Commercial; Type Residential; Stations Soledad; Stations North; and of the ıfter, After·Distance to BRT, Year and Year·Distance to BRT dummies

. H_0: Redundant Panel Effects; 2. H_0: Fixed Effects are redundant; 3. H_0: Random Effects are not correlated with the X variables; 4: H_0: There is Unit Root in the esiduals; 5. H_0: IV estimation is not overidentified; 5. p-value of the Panel Spatial Autorregresive parameter: µit = $^2 W_{NT}$µit + uit

A2: Linear Regression – pooling, F.E. and R.E. – Cross-section Weights – with AR(1)

	Pooling	FE	RE	Pooling	FE	RE	FE	FE	FE	FE	FE
Constant	4.355 ***	11.744 ***	4.875 ***	4.455 ***	11.689 ***	4.963 ***	11.923 ***	11.797 ***	11.715 ***	11.720 ***	12.186 ***
AR(1)	0.671 ***	0.216 ***	0.620 ***	0.664 ***	0.191 ***	0.613 ***	0.173 ***	0.191 ***	0.200 ***	0.202 ***	0.179 ***
Distance to BRT	-0.011	-0.225 ***	-0.022 *	-0.017	-0.200 ***	-0.028 *	-0.201 ***	-0.214 ***	-0.217 ***	-0.218 ***	-0.244 ***
Distance to Prado	-0.061 ***	-0.033	-0.051 **	-0.062 ***	-0.020	-0.052 **	-0.017	-0.023	-0.024	-0.026	-0.025
Estrato Average	0.229 ***	-0.092 *	0.280 ***	0.240 ***	-0.048	0.287 ***	-0.051	-0.038	-0.052	-0.039	-0.050
Built M2	0.025 *	0.000	0.041 ***	0.023 *	-0.008	0.040 ***	-0.011	-0.007	-0.005	-0.006	-0.006
Type Commercial	0.085	-0.029	-0.042	0.113	0.016	-0.011	-0.014	0.018	0.014	0.008	0.015
Type Residential	-0.265 ***	-0.253 ***	-0.301 ***	-0.249 ***	-0.222 ***	-0.280 ***	-0.241 ***	-0.233 ***	-0.223 ***	-0.237 ***	-0.242 ***
Stations Soledad	0.082 ***	-0.008	0.085 **	0.083 ***	0.010	0.086 **	-0.006	0.006	0.012	-0.015	0.006
Stations North	0.040	-0.023	0.071 **	0.041	0.005	0.069 **	0.009	0.004	0.001	-0.006	0.013
D_After				-0.021	0.186 *	-0.019	0.082 ***	0.070 ***	0.070 ***	0.051 ***	0.044 ***
D_After*(Distance to BRT)				0.010	-0.017	0.009					
D_2006							0.219				
D_2006*(Distance to BRT)							-0.044 **				
D_2007								0.078			
D_2007*(Distance to BRT)								-0.015			
D_2008									0.095		
D_2008*(Distance to BRT)									-0.018		
D_2009										-0.367 **	
D_2009*(Distance to BRT)										0.062 ***	
D_2010											0.243
D_2010*(Distance to BRT)											-0.021
R2 (adjusted)	0.883	0.915	0.790	0.888	0.919	0.791	0.922	0.918	0.918	0.919	0.922
S.E. of Regression	0.229	0.201	0.232	0.228	0.198	0.231	0.196	0.198	0.198	0.196	0.196
Breush-Pagan	0.270			0.349							
Redundant Fixed Effects		0.000			0.000		0.000	0.000	0.000	0.000	0.000
Hausman Random Effects			0.000			0.000					
Unit Root	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observations	620	620	620	620	620	620	620	620	620	620	620

*** Significant at 1%; ** Significant at 5%; * Significant at 10%

After = dummy variable for 2006 - 2010; Year = dummy variable for the corresponding year in the specification

Controls = Distance to Prado; Estrato Average; Built M2; Type Commercial; Type Residential; Stations Soledad; Stations North. All the variables introduced as logarithms, except the dummies or percentages

Instruments: AR(1) of Distance to Prado; Estrato Average; Built M2; Land M2; Type Commercial; Type Residential; Stations Soledad; Stations North; and of the After, After·Distance to BRT, Year and Year·Distance to BRT dummies

1. H_0: Redundant Panel Effects; 2. H_0: Fixed Effects are redundant; 3. H_0: Random Effects are not correlated with the X variables; 4: H_0: There is Unit Root in the residuals; 5. H_0: IV estimation is not overidentified; 5. p-value of the Panel Spatial Autorregresive parameter: $\mu it = {}^{2} W_{NT} \mu it + uit$

A3: I.V. Regression – pooling, F.E. and R.E. – Cross-section Weights – no AR(1)

	Pooling	FE	RE	Pooling	FE	RE	RE	RE	RE	RE	RE
Constant	13.036 ***	97.213	15.921 ***	12.539 ***	83.919	15.263 ***	15.397 ***	15.963 ***	13.375 ***	14.373 ***	14.556 ***
Distance to BRT	-0.030	0.084	-0.164 ***	-0.026	-0.183	-0.249 ***	-0.373 ***	-0.260 ***	-0.297 ***	-0.295 ***	-0.314 ***
Distance to Prado	-0.107 ***	0.076	-0.277 ***	-0.093 ***	-1.501	-0.169 *	-0.125	-0.233 ***	-0.027	-0.062	-0.059
Estrato Average	0.554 ***	-0.453	0.145 *	0.554 ***	-0.294	0.057	0.006	-0.064	-0.054	-0.041	-0.048 *
Built M2	0.014	-0.027	-0.004	0.014	0.099	-0.007	0.009	-0.012	0.044	-0.006	0.006
Type Commercial	0.360	-1.255	-2.067 ***	0.787 ***	-6.196	-1.428 ***	-0.846 *	-1.481 ***	0.365	-0.837 ***	-0.894 ***
Type Residential	-0.879 ***	-0.873	-0.685 ***	-0.552 ***	-0.006	-0.317 *	0.021	-0.196	0.587	0.021	-0.049
Stations Soledad	0.149 ***	-166.206	-0.136	0.135 ***	-457.200	-0.264 *	-0.292	-0.283 **	-0.318 **	-0.284	-0.476 *
Stations North	0.284 ***	105.172	0.414 **	0.287 ***	-41.293	0.619 ***	0.718 ***	0.591 ***	0.822 ***	0.904 ***	0.850 **
D_After				0.433 *	-0.611	-0.003	0.150 **	0.034	0.171 ***	0.201 ***	0.132 ***
D_After*(Distance to BRT)				-0.043	0.112	0.018					
D_2006							-1.155				
D_2006*(Distance to BRT)							0.169				
D_2007								-0.201			
D_2007*(Distance to BRT)								0.073			
D_2008									5.456		
D_2008*(Distance to BRT)									-0.776		
D_2009										1.940	
D_2009*(Distance to BRT)										-0.300	
D_2010											-2.279
D_2010*(Distance to BRT)											0.328
R2 (adjusted)	0.773	-25.247	-0.174	0.815	-11.409	-0.102	-0.134	-0.332	-0.726	-0.261	-0.152
S.E. of Regression	0.319	8.684	0.296	0.305	3.248	0.249	0.238	0.270	0.306	0.253	0.231
Hausman			0.993			0.997	0.998	0.996	0.956	1.000	0.999
Unit Root	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
J-Statistic	5.038	0.006	2.345	5.630	0.001	0.176	0.096	0.177	0.099	0.044	0.000
Instrument Rank	10	10	10	12	12	12	13	13	13	13	13
P-Value (J-Statistic)	0.025	0.938	0.126	0.018	0.974	0.675	0.757	0.674	0.753	0.834	0.965
Observations	558	558	558	558	558	558	558	558	558	558	558

*** Significant at 1%; ** Significant at 5%; * Significant at 10%

After = dummy variable for 2006 - 2010; Year = dummy variable for the corresponding year in the specification

Controls = Distance to Prado; Estrato Average; Built M2; Type Commercial; Type Residential; Stations Soledad; Stations North. All the variables introduced as logarithms, except the dummies or percentages

Instruments: AR(1) of Distance to Prado; Estrato Average; Built M2; Land M2; Type Commercial; Type Residential; Stations Soledad; Stations North; and of the After, After·Distance to BRT, Year and Year·Distance to BRT dummies

1. H_0: Redundant Panel Effects; 2. H_0: Fixed Effects are redundant; 3. H_0: Random Effects are not correlated with the X variables; 4: H_0: There is Unit Root in the residuals; 5. H_0: IV estimation is not overidentified; 5. p-value of the Panel Spatial Autorregresive parameter: $\mu it = {}^{2} W_{NT} \mu it + uit$

A4: I.V. Regression – pooling, F.E. and R.E. – Cross-section Weights – with AR(1)

	Pooling	FE	RE	Pooling	FE	RE	RE	RE	RE	RE	RE
Constant	0.543	-17.410	7.724 ***	0.584	34.097	2.466 ***	2.301 ***	2.092 ***	3.437 ***	2.316 ***	10.126 ***
AR(1)	0.957 ***	0.445	0.518 ***	0.970 ***	0.215	0.814 ***	0.797 ***	0.811 ***	0.590 ***	0.771 ***	0.390 ***
Distance to BRT	-0.021	-0.298	-0.121 ***	-0.056 **	-0.328	-0.086 ***	-0.012	-0.043 ***	0.056 **	-0.009	0.066
Distance to Prado	-0.038	0.279	-0.159 ***	-0.034	-0.715	-0.037 ***	-0.038 *	-0.039 ***	-0.048 **	-0.036 *	-0.141 ***
Estrato Average	0.026	-0.261	0.081 ***	0.030	-0.185	0.124 ***	0.126 **	0.104 ***	0.217 ***	0.133 ***	0.124 ***
Built M2	0.047 **	-0.047	0.036 ***	0.048 **	0.077	0.061 ***	0.051 ***	0.065 ***	0.107 ***	0.061 ***	-0.135 ***
Type Commercial	0.154	1.261	-0.589 ***	0.139	-3.179	0.387 ***	0.302	0.581 ***	1.241 ***	0.613 ***	-4.223 ***
Type Residential	0.208	-0.025	-0.020	0.208	0.364	0.242 ***	0.144	0.385 ***	0.735 ***	0.356 ***	-1.819 ***
Stations Soledad	0.043	104.565	-0.016	0.043	-139.997	0.042 **	0.046 *	0.032 *	0.035	0.034	-0.166 ***
Stations North	-0.025	31.976	0.141 ***	-0.031	-10.580	0.001	0.025	0.000	0.041	0.022	0.602 ***
D_After				-0.413 *	-0.392	-0.525 ***	0.043	0.010	0.118 ***	0.063 ***	-0.089 **
D_After*(Distance to BRT)				0.063 **	0.075	0.084 ***					
D_2006							1.012				
D_2006*(Distance to BRT)							-0.156				
D_2007								0.214			
D_2007*(Distance to BRT)								-0.003			
D_2008									8.439 ***		
D_2008*(Distance to BRT)									-1.207 ***		
D_2009										2.511	
D_2009*(Distance to BRT)										-0.351	
D_2010											19.139 ***
D_2010*(Distance to BRT)											-2.669 ***
R2 (adjusted)	0.887	0.033	0.311	0.886	0.090	0.728	0.752	0.705	0.326	0.676	-6.031
S.E. of Regression	0.271	1.019	0.238	0.273	1.062	0.268	0.255	0.279	0.421	0.292	0.774
Hausman			0.198			0.266	1.000	0.999	1.000	0.031	1.000
Unit Root	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
J-Statistic	0.260	0.119	0.204	0.255	0.110	0.166	0.995	0.079	0.014	0.091	0.000
Instrument Rank	11	11	11	13	13	13	14	14	14	14	14
P-value (J-Statistic)	0.610	0.730	0.651	0.613	0.740	0.684	0.319	0.779	0.907	0.763	0.998
Observations	558	558	558	558	558	558	558	558	558	558	558

*** Significant at 1%; ** Significant at 5%; * Significant at 10%

After = dummy variable for 2006 - 2010; Year = dummy variable for the corresponding year in the specification

Controls = Distance to Prado; Estrato Average; Built M2; Type Commercial; Type Residential; Stations Soledad; Stations North. All the variables introduced as logarithms, except the dummies or percentages

Instruments: AR(1) of Distance to Prado; Estrato Average; Built M2; Land M2; Type Commercial; Type Residential; Stations Soledad; Stations North; and of the After, After·Distance to BRT, Year and Year·Distance to BRT dummies

1. H_0: Redundant Panel Effects; 2. H_0: Fixed Effects are redundant; 3. H_0: Random Effects are not correlated with the X variables; 4: H_0: There is Unit Root in the residuals; 5. H_0: IV estimation is not overidentified; 5. p-value of the Panel Spatial Autorregresive parameter: $\mu it = {}^2 W_{NT} \mu it + uit$

A5: Dynamic Panel GMM – First Differences – Arellano-Bond Dynamic Instruments – White Period Instrument Weighting Matrix – Robust Errors (White Period)

	GMM 1	GMM 2	GMM 3	GMM 4	GMM 5	GMM 6	GMM 7
AR(1)	0.410 ***	0.785 ***	0.491 ***	0.185 ***	-0.280 ***	0.384 ***	0.640 ***
Distance to BRT	-0.414 ***	-3.323 ***	-0.104 ***	-0.228 ***	-0.689 ***	-0.419 ***	-0.303 ***
Distance to Prado	0.061	-0.232 **	-0.041	-0.102 ***	-5.569 ***	-0.048	0.366 ***
Estrato Average	-2.538 ***	-1.712 ***	-0.084 **	-0.131 ***	-0.257 *	-2.246 ***	-0.528 ***
Built M2	-0.073 ***	-0.031 **	-0.130 ***	0.004	-0.343 ***	-0.168 ***	-0.157 ***
Type Commercial	-0.378 ***	-0.951 ***	-1.379 ***	0.143 **	-1.273 ***	-0.412 ***	0.130
Type Residential	-0.189 ***	0.162 *	-0.259 ***	-0.007	0.668 ***	-0.152 ***	0.032
Stations Soledad	-0.246 **	0.574 ***	-0.962 ***	0.008	1.524 ***	-0.160 *	3.103 ***
Stations North	-0.051	-0.258 *	-0.024	-0.010	-4.257 ***	-0.260 ***	0.602 ***
D_After		-25.796 ***	0.097 ***	0.084 ***	0.087 ***	-0.002	0.016 ***
D_After*(Distance to BRT)		3.649 ***					
D_2006			0.606 ***				
D_2006*(Distance to BRT)			-0.099 ***				
D_2007				-0.477 ***			
D_2007*(Distance to BRT)				0.069 ***			
D_2008					-1.051 ***		
D_2008*(Distance to BRT)					0.131 ***		
D_2009						0.536 ***	
D_2009*(Distance to BRT)						-0.064 **	
D_2010							-0.264
D_2010*(Distance to BRT)							0.059
R2 (adjusted)							
S.E. of Regression	0.517	1.154	0.406	0.289	1.345	0.503	0.481
Unit Root	0.000	0.000	0.000	0.000	0.000	0.000	0.000
J-Statistic	46.646	49.911	53.054	51.411	47.681	47.149	48.584
Instrument Rank	54	56	57	57	57	57	55
P-value (J-Statistic)	0.405	0.284	0.191	0.237	0.364	0.385	0.258
Observations	558	558	558	558	558	558	558

*** Significant at 1%; ** Significant at 5%; * Significant at 10%

After = dummy variable for 2006 - 2010; Year = dummy variable for the corresponding year in the specification

Arellano-Bond Dynamic Instruments - White Period Instrument Weighting Matrix - Robust Errors (WhitePeriod)

Controls = Distance to Prado; Estrato Average; Built M2; Type Commercial; Type Residential; Stations Soledad; Stations North. All the variables introduced as logarithms, except the dummies or percentages

Instruments: AR(1) of Distance to Prado; Estrato Average; Built M2; Land M2; Type Commercial; Type Residential; Stations Soledad; Stations North; and of the After, After·Distance to BRT, Year and Year·Distance to BRT dummies

4: H_0: There is Unit Root in the residuals; 5. H_0: IV estimation is not overidentified; 6. p-value of the Panel Spatial Autorregresive parameter: $\mu it = {}^2 W_{NT} \mu it + uit$