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REAL ESTATE PRICES AND LAND USE REGULATIONS: EVIDENCE FROM THE LAW OF HEIGHTS IN BOGOTÁ *

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ABSTRACT: Between 2015 and 2017, the Law of Heights (Policy-562) regulated areas of urban renewal in specific locations of Bogotá (Colombia). Using a novel dataset based on detailed information at the block level between 2008 and 2017, we study whether this policy affected real estate prices. Our empirical strategy compares the price per square meter before and after Policy-562 in treated blocks and in control blocks with similar pre-treatment traits. Results show that prices increased more in treated blocks than in the rest of the city. We also provide evidence that results are heterogeneous from a temporal, land use and strata point of view.

JEL Codes: R14, R31, R58
Keywords: Real estate prices, land regulations

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1. Introduction

The relationship between land use regulations and real estate prices is well documented in developed countries (Quigley and Rosenthal, 2005, Turner, Haughwout, and van der Klaauw, 2014, Freemark, 2020, Greenaway-McGrevy, Pacheco, and Kade, 2021). In general, empirical evidence centered on housing markets finds that a greater degree of regulation not only increases housing prices (Ihlanfeldt, 2007), but also accelerates their reduction in an economic recession (Huang and Tang, 2012), and the effects vary considerably at the intra-city level (Kok, Monkkonen, and Quigley, 2014).

On the other hand, little is known about this relationship in developing countries. Mayo and Sheppard (1996) compare housing supply regulations in Malaysia, Thailand, and South Korea. Brueckner and Sridhar (2012) find that building height limits caused spatial expansion of Indian cities. Monkkonen (2013) focuses on Indonesia, a country with an important informal housing market, with particularly stringent rules on urban land use, but with a low level of enforcement, and finds that the impact of a greater degree of regulation on formal market prices is unclear. Monkkonen and Ronconi (2013) finds a negative relationship between regulation and land prices in the three major Argentinian metropolitan areas with higher levels of regulation and lower levels of compliance. For the case of Beijing (China), Ling, Dao-lin, and Ke-lin (2013) find that land control policies accelerated housing prices when they were implemented. Finally, Brueckner, Fu, Gu, and Zhang (2017) find that building height restrictions in terms of floor area ratio increases land prices in Chinese cities.

This paper aims to contribute to this literature by studying the impact of a particular regulation, the so-called Law of Heights (Policy-562), on real estate prices in a city of a developing country, Bogotá (Colombia), between 2008 and 2017. Using annual data for 837,505 registered lots[1] grouped in 42,993 blocks, we rely on an empirical strategy based on Difference-in-Differences (DiD) techniques to compare real estate prices before and after the implementation of Policy-562 in treated blocks and in control blocks with similar pre-treatment traits. Besides the average effects, we also explore the heterogeneity of the effects by year of the treatment subperiod, the main land uses of the blocks, and the strata where they are located[2]

There are various reasons why Bogotá and its Law of Heights (Policy-562) provide an excellent testing ground of the relationship between regulation and real estate prices. First, the new policy aimed to regulate the conditions for urban renewal not in the whole city, but only in some specific areas. As a result, it is possible to identify treated blocks. Second, the treatment period of this policy is also easy to identify: It was in force between 2015 and February 2016, but new projects were still approved and executed between March 2016 and December 2017. Third, the Law of Heights increased the degree of land use regulation in Bogotá because, despite relaxing the height limits for the new buildings (which required a monetary compensation), the new set of

[1]In this research, we interpret a *lot* as an area of land with one or more owners that may contain one or several *properties*.

[2]The strata system in Colombia is a system of subsidizing public services by regulating their prices. Every block in Colombia's urban areas, including Bogotá, are assigned to an specific strata level, from 1 to 6, depending on its physical characteristics and surrounding conditions. Strata 1 to 3 receive a subsidy from the higher strata 4 to 6. See Appendix A for a further definition of the strata system in Bogotá and its relationship with Policy-562.

rules clearly increased construction costs. Finally, detailed data at the lot level is available for the 2008 to 2017 period.

In general, this paper furthers our understanding of the effects of land use regulations. The related empirical literature shows that they limit city size (Hannah, Kim, and Mills, 1993), increase real estate prices (Quigley and Rosenthal, 2005, Ihlanfeldt, 2007, Huang and Tang, 2012), follow the market (Wallace, 1988, Garcia-López, Solé-Ollé, and Viladecans-Marsal, 2015), and, in general, affect many other aspects of development (Cheshire and Sheppard, 2004). Furthermore, regulations seems to negatively affect welfare (Turner *et al.*, 2014). As above mentioned, most of the literature has focused on developed countries, and only few recent works has analyzed other countries with inconclusive and, sometimes, opposite results. This paper contributes to this literature by providing empirical evidence for a particular regulation in a city of a middle-income developing country.

Our results show that, on average, Policy-562 positively affected real estate prices. In particular, our pure DiD approach reports an estimated effect of 33.5% in treated blocks. This result holds when we consider more balanced samples of treated and untreated blocks in terms of observables by combining DiD with Propensity Score and Nearest Neighbor Matching techniques. When we follow Brueckner *et al.* (2017) matched-pair approach to consider balanced samples in terms of unobservables, we estimate a Policy-562 effect of 16.4%. Finally, in Appendix D we show that the effect of Policy-562 is heterogeneous in three dimensions. By year, the effect decreased during the treatment subperiod. By main land uses of blocks, Policy-562 only affected Residential and Services prices. By strata, while Policy-562 increased prices in low strata 1 and 3 and high strata 6 treated blocks, it decreased prices in high strata 4 and 5.

The rest of the paper is structured as follows. In Section 2, we briefly describe land use regulation in Colombia and in Bogotá, with an especial attention to the Law of Heights. In Section 3, we present the city of Bogotá, the dataset to study real estate prices at the block level, and the procedure to identify the blocks (un)affected by Policy-562. The empirical strategy based on Difference-in-Differences techniques is discussed in Section 4. Section 5 presents the main results and robustness checks, and Section 6 concludes.

2. The Law of Heights (Policy-562)

Colombia has a national land use regulatory framework that can be considered strong in the Latin American region[3]. Law 388 of 1997 exemplifies this. This Law enshrines how to use urban land and grants cities with more than 100,000 inhabitants the freedom to draft their master zoning plan or Plan de Ordenamiento Territorial (POT). According to Cámara de Comercio de Bogotá (2018), a POT comprises a set of goals, guidelines, policies, strategies, programs, actions, and norms aimed at directing and managing the physical development and land use in the territory.

[3]According to Cabeza (2006), Latin American countries can be classified according to their level of land use regulation. First, countries with specific (centralized) national laws on land use planning (Uruguay, Colombia, Salvador, Honduras, and Cuba). Second, countries with several (decentralized and non-coordinated) regional laws (Argentina, Bolivia, Ecuador, Venezuela, and Mexico). Finally, coungries without land use regulation laws (Chile, Paraguay, Brazil, Panama, Costa Rica, and the Dominican Republic).

Thus, the zoning plan constitutes a road map for the long-term (12-year) development of urban and rural areas to consolidate a 'coherent' city model.

The first POT of Bogotá was approved in 2004 and it classified the territory according to three structures: (i) a main ecological structure, (ii) a functional and services structure, and (iii) a socioeconomic-spatial structure. More specifically, the 2004 POT regulated height limits, floor area ratio and developer payments that affected all areas of the city indistinctly. The norm remained in force until December 30th 2021, when a new POT (Law 555 of 2021) was approved for the 2022-2035 period.

In December 2014, Bogotá implemented a new policy (562 of 2014) regulating the conditions for urban renewal in defined city areas. The policy aimed to promote the improvement, beautification, development and, in particular, densification of some specific parts of the city with public and private interventions. Unfortunately, there is no technical document justifying the selection of the areas (see Figure 2a). It seems that they were close to public transportation (Transmilenio) and main roads, to metropolitan and zonal parks, to facilities (public safety, defense and justice, food supply and consumption, hospitals, fairgrounds, cemeteries and public administration services), and they were not protected (not developable land). However, it is also true that other areas satisfied the above mentioned characteristics and were not selected (for example, areas in the south of the city with many illegal settlements).

To achieve these goals, Policy-562 first removed height limits on new buildings conditional on some payments from the developers. In general, these payments in Colombia refer to the amount of area (A) that developers must give to the city. This land comes from the lots to be developed and it is used to satisfy the 'needs' of the surrounding area in terms of public space, road infrastructure, parking lots, front gardens, or public services, among others. It is calculated as follow:

$$A = P \times K$$

where P is the total lot area, and K is the payment factor.

Secondly, Policy-562 modified developer payments (A) by updating the value of K. Under the 2004 POT, K had a unique value of 0.20. Under Policy-562, the value of K depended on the floor area ratio (FAR, the ratio between a building's total floor area and the total lot area).

Table 1 reports K values for different floor area ratio intervals: The higher the FAR, the higher the K. It also shows that developer payments were lower under Policy-562 when the floor area ratio was bellow 4. On the contrary, Policy-562 payments were higher than 2004 POT ones for higher floor area ratios.

Using an example discussed by Ruiz and Moncada (2017), in Table 2 we compute developer payments under the 2004 POT and Policy-562 for a residential project with 100 m^2 apartments in a lot of 8,694 m^2 (138 m $\times$ 63 m). First, to build 100 apartments (Columns 1 and 2) a developer would have to give to the city 1,739 m^2 of the lot area under the 2004 POT, but only 52 m^2 under Policy-562. Second, developer payments would be roughly the same with the two policies when building 310 apartments (Columns 3 and 4). Third, to build 433 apartments[4] (Columns 5 and 6), developer payments under Policy-562 would be 120% higher (3,817 m^2 vs. 1739 m^2).

[4]Because of the 2004 POT height limits (10-story buildings), computations in Column 5 are hypothetical.

Finally, if we consider the maximum number of floors that could be built according the 2004 POT (10) and the maximum number of apartments per floor[5] according to each policy (31 and 43), developer payments by apartment would increase by 58% (from 5.61 (=1739/310) (Column 3) to 8.88 (=3817/430) m^2 per apartment (Column 6)).

It is important to clarify that, under this policy, developer payments could be also monetary. That is, if the amount of land (A) that was to be given to the city was not available in the area (or was less than 2,000 m^2), the developer could make a monetary payment (based on cadastral values) that the city would use for infrastructures and urban amenities in other areas.

Table 1: Policy-562 K values to compute developer payments in Bogotá

Floor Area Ratio	K
$2.0 < FAR \leq 2.4$	0.006
$2.4 < FAR \leq 2.8$	0.035
$2.8 < FAR \leq 3.3$	0.092
$3.3 < FAR \leq 4.0$	0.197
$4.0 < FAR \leq 4.4$	0.322
$4.4 < FAR \leq 5.0$	0.439
$5.0 < FAR \leq 6.5$	0.553
$6.5 < FAR \leq 9.0$	0.655
$9.0 < FAR \leq 14$	0.757
$FAR > 14$	0.833

Table 2: Developer payments in a residential project: 2004 POT vs. Policy-562

	200 Apartments		310 Apartments		433 Apartments	
	2004 POT [1]	Policy-562 [2]	2004 POT [3]	Policy-562 [4]	2004 POT [5]	Policy-562 [6]
Total lot area (m^2)	8,694	8,694	8,694	8,694	8,694	8,694
Number of floors	6	5	10	7	14	10
Total floor area (P) (m^2)		20,000		31,000		43,000
Floor area ratio (FAR)		2.30		3.57		4.98
Payment factor (K)	0.20	0.006	0.20	0.197	0.20	0.439
Developer payment (A) (m^2)	1738.80	52.16	1738.80	1712.72	1738.80	3816.67

In February 2016, Policy-562 was repealed, among other reasons, because its approval was considered illegal. By that date, 901 projects were approved, and 2,362 applications had been filled while the new policy was in force. Between March 2016 and December 2017, most applications were approved and executed. The 2016 Resolution 079 revoked Policy-562. The cancellation of the decree meant that Policy-562 had no effect on newly issued construction licenses as of February 22, 2016. However, any license requested prior to February 21, 2016, if authorized, was governed

[5]This number depends on other requirements of the policies (e.g., the land use index) and explains why the number of floors is different for the two policies in the three studied scenarios in Table 2.

by Policy-562. Similarly, all projects approved and under construction with Policy-562 continued to adhere to this policy even after the repeal declaration and until project completion. [6].

Policy-562 was also important for the city budget. According Secretaria de Hacienda de Bogotá (2015), 200,000 million COP (US$ 50 million) in developer payments were raised in 2015, representing 20% and 2% of non-tax revenues and total revenues, respectively. Compared to 2004 POT payments between 2005 and 2014, Policy-562 raised 50% of them in just 15 months (Cámara de Comercio, 2015).

Finally, it is important to mention that Colombia and, in particular, Bogotá have an active law enforcement system with a low percentage of informality and a reasonable time to approve building permits. On average, 12,000 building permits are issued every year in Bogotá. Each permit is issued in an average of 50 calendar days. Secretaría Distrital de Gobierno (SDG) is responsible of the related law enforcement according to article 135 of the National Police Code. On average, 900 stop-workers orders are issued every year: 62% of them for not having any type of building permit, 30% due to breach obligations related to the construction process itself, 7% for allocating a property to a use other than that authorized in the building permit, and 1% to protect properties of cultural, historical and architectural interest. This scenario differs from other developing countries like Indonesia, with restrictive land registration and building permits (160 days), and inefficient law enforcement (Monkkonen, 2013).

3. Data

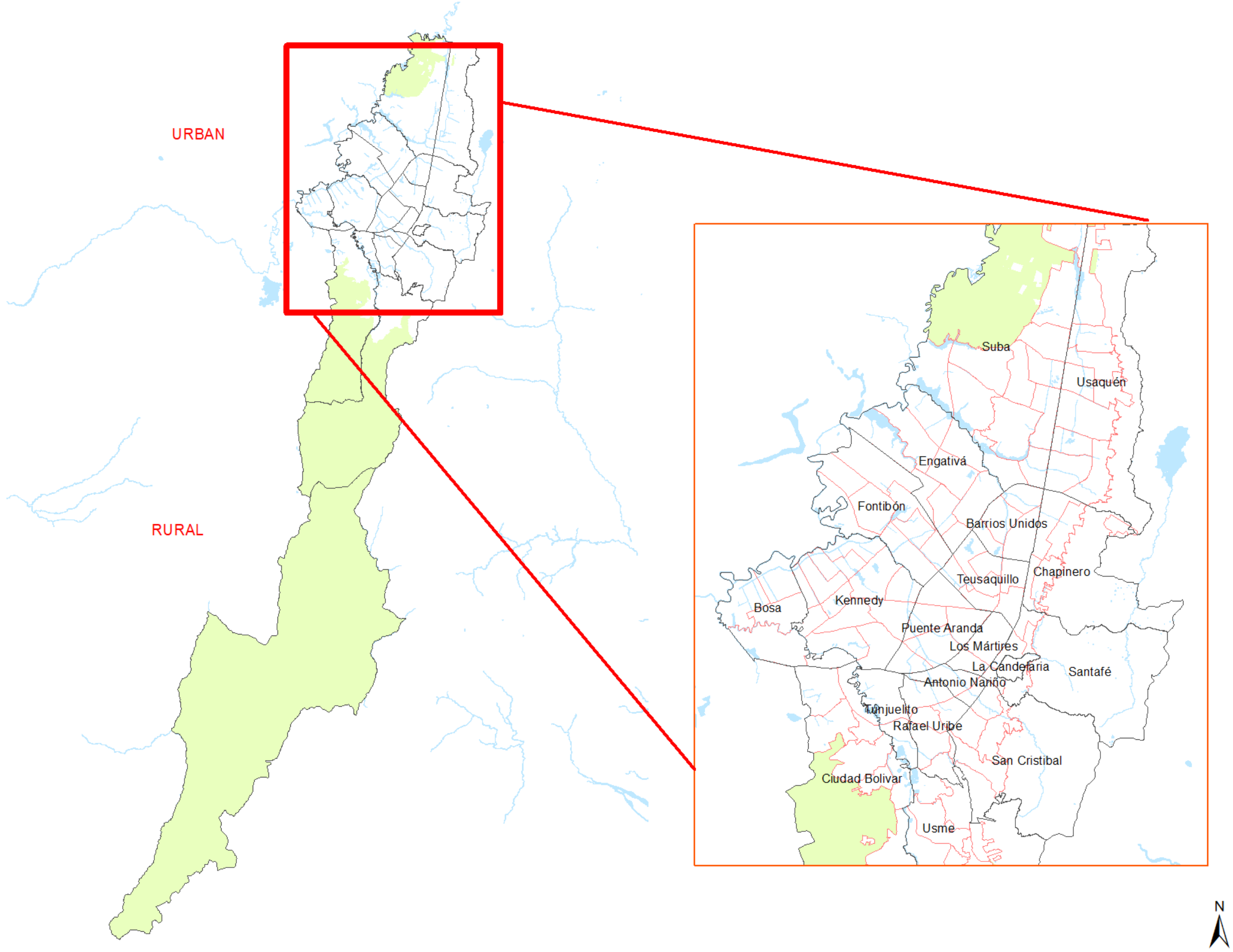
3.1 Bogotá (Colombia)

We study the metropolitan area of Bogotá, with 10,121,956 inhabitants in 2021 according to Departamento Administrativo Nacional de Estadística (DANE) living in 4,000 km^2, that is, with roughly 2,530 inhabitants per km^2.

Figure 1 shows the urban and rural areas of metropolitan Bogotá. As can be noticed, two-thirds of the city is rural (in green). We focus the analysis on the urban areas, which includes 19 municipalities (black lines). After the city, the municipality is the largest level of zoning. For planning purposes, the city is also divided into 108 zonal planning units (ZPU) (red lines) and their 1090 neighborhoods.

[6]The repeal decree literally says:"... If, during the term that elapses between the application for a license or its modification and the issuance of the administrative act that grants the license or authorizes the modification, there is a change in the urban regulations that affect the project submitted ... the applicant will have the right to have the license or modification granted based on the urban planning regulations in force at the time of the filing of the application, provided that it has been submitted legally and duly ..."

Figure 1: Urban and rural areas in Bogotá



3.2 *Real estate prices*

To measure real estate prices, we use the dataset developed by Secretaría Distrital de Planeamiento (SDP). It is based on annual studies of the real estate market monitoring the trends in the commercial value of properties. Opposed to the traditional cadastral values, these SDP values contain real estate market elements such as sales offers, leases and financial transactions, and appraisals[7]. SPD prices represent the commercial reference values (per m^2) and reflect the dynamics of the real estate market[8].

The SPD dataset also includes information about the floor area (m^2) and the predominant land use of the lots (residential, manufacturing and services). Unfortunately, no other property

[7]The annual appraisal process is carried out by the cadastral unit (Unidad Administrativa Especial de Catastro Distrital, UAECD), an autonomous entity belonging to the Bogotá finance office and independent from SPD. Appraisals are processes that reflect the characteristics of homogeneous geographical and economic zones to determine the current value of properties. New projects and development plans only affect these values once the properties are physically changed. In other words, SDP prices do not respond to regulatory changes via appraisals that happened at the same time that the norm changed. On the contrary, SPD prices adjust in the medium and long term.

[8]As a robustness check, we compared the SPD dataset with the best available alternative dataset (Coordenada Urbana developed by Cámara Colombiana de Construcción CAMACOL), which includes average transaction prices at the neighbourhood level. Both datasets are highly correlated and a simple test for difference of the means shows that they are not statistically different. Unfortunately, we did not have access to individual transaction prices.

characteristic (e.g., height) is included in the dataset.

Our initial sample includes data for 837,505 registered lots in 2017. They represent 88% of registered lots[9]. To avoid inconsistencies due to missing values in previous years[10], we fix these 2017 lots for the whole studied period. By doing so, we avoid inconsistencies due to missing values in the previous years. Then, we group lot data into blocks and we end up with 42,993 blocks. The real estate price at the block level is then computed as the average price (per m^2) of the lots that make up each block.

3.3 *Areas (un)affected by Policy-562*

As we explain in more detail in the next sections, we study the impact of Policy-562 on real estate prices with a before–after analysis that compares the evolution of prices in treated areas (affected by Policy-562) and untreated areas (unaffected by Policy-562).

The identification of the affected areas of the city is challenging because, first, this information is not at the same spatial level of aggregation as that of real estate prices (block level), and, second, we do not have a map of the blocks (we only know their municipalities, ZPUs and neighborhoods). In fact, all we can resort to are documents and paper maps of the city in which the areas affected by Policy–562 are presented schematically and without precise geographic detail. For example, Figure 2a is a paper map published by the planning authority identifying the ZPUs of the city affected by Policy-562 (in yellow), non-affected (in white), and under special protection (in red). It is important to notice that not all blocks that make up each ZPU were affected by Policy-562.

To identify whether or not each of the 42,993 defined blocks are affected by the Policy-562, we follow a top-down analysis, i.e. from the largest level of aggregation to the smallest one, in order to obtain a dummy variable that takes a value of 1 for areas included under Policy–562 and 0 otherwise.

We begin by identifying with zero the blocks located in ZPUs of municipalities without areas designated under Policy–562. Then, we use a lower level of aggregation, the ZPUs, and assign a value of 1 to blocks located in ZPUs with more than 75% of their total area affected by Policy–562. For ZPUs with less than 75% of affected area, we use an smaller spatial unit, the neighborhood, and repeated the exercise: We assign a value of 1 to blocks located in neighborhoods with more than 75% of their total area affected by Policy–562.

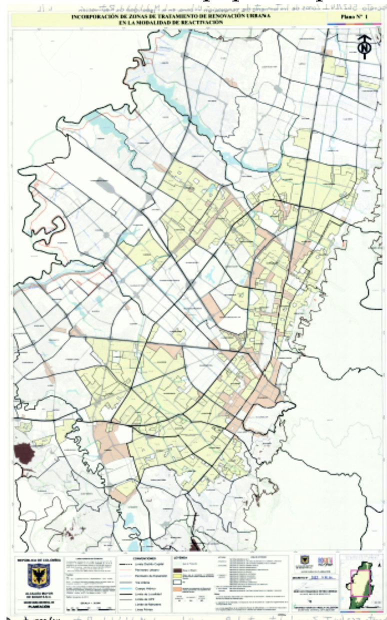
At the end of this procedure, we identify 7,700 blocks affected by Policy-562 (18% of blocks) (the blue areas in Figure 2b) and 35,293 unaffected blocks (the yellow areas in Figure 2c). The former are our (initial) treatment group and the latter our (initial) control group.

[9] According to the 2017 cadastral census, there were 2,543,290 properties in 951,749 registered lots.

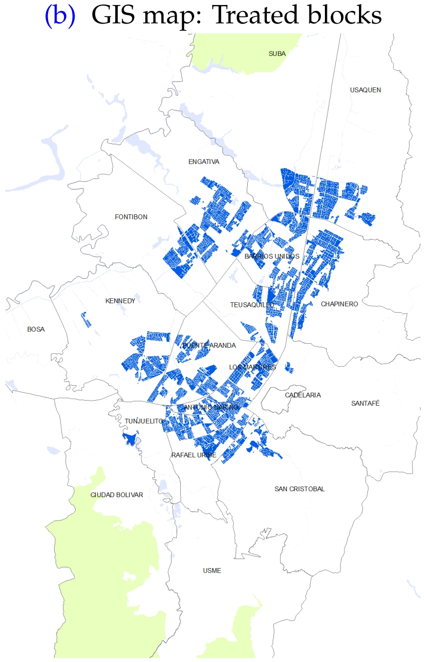
[10] For example, when new lots are added to the city boundaries, or when lots are excluded because they are merged due to the construction of new buildings.

Figure 2: From a paper map to GIS maps of (un)affected blocks by Policy-562

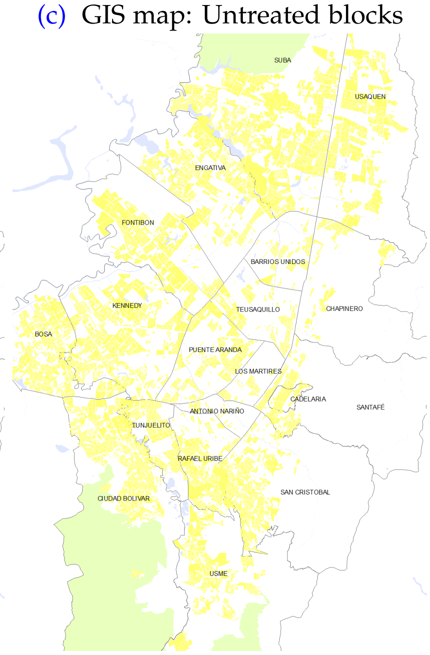
(a) Official paper map



(b) GIS map: Treated blocks



(c) GIS map: Untreated blocks



Notes: In Figure 2a, yellow and white zones are ZPUs affected and unaffected by Policy-562, respectively. Red zones are ZPUs under special protection. In Figures 2b and 2c, blue and yellow zones are blocks in areas affected and unaffected by Policy-562, respectively. In both figures, gray lines are municipality boundaries.

4. Empirical strategy

4.1 *Timing of the analysis*

Using the SPD dataset, we have information on real estate prices from 2008 to 2017. We split this period into two subperiods. First, the treatment subperiod (2015–2017) considers the years in which Policy-562 was in effect (2015 and February 2016) and the years in which the last projects approved by Policy-562 were developed (March 2016 and 2017). Second, the subperiod 2008–2014 is the period before treatment.

4.2 *Estimated equation*

We estimate the effect of the Law of Heights (Policy-562) on real estate prices using a Difference-in-Differences (DiD) strategy. In particular, with our 10 year dataset, we estimate the following equation:

$$\begin{aligned}\ln(\text{Price}_{it}) = \beta_0 + \beta_1 \times \text{Policy-562}_i \times \text{After-562}_t \\ + \beta_2 \times \text{Time-variant controls}_{it} + \beta_3 \times \text{Time-invariant controls}_i + v_t + \epsilon_{it}\end{aligned} \tag{1}$$

where $\ln(\text{Price}_{it})$ is the log of the average property price in block i in year t.

Policy-562_i is a dummy equal to one if block i is affected by the new policy, and zero otherwise. After-562_t is a dummy equal to one if year t corresponds to the period of implementation of the Law of Heights (2015–2017), and zero otherwise. We are interested on the DiD estimator, that is, on the estimated value of β_1, the coefficient of the interaction between Policy-562_i and After-562_t. It measures the effect of the new policy in treated vs. untreated (control) areas.

$\text{Time-variant controls}_{it}$ is a vector of time-variant block and ZPU characteristics. First, we control for the log of the average floor area (m^2) in the block. Second, to control for socioeconomic characteristics, we add the log of the number of inhabitants per hectare (density) and the log of population per household. Summary statistics are reported in Table B.2 of Appendix B.

$\text{Time-invariant controls}_i$ is a vector of time-invariant ZPU characteristics. First, we control for time-invariant socioeconomic characteristics with dummy variables for each of the five strata. Second, we add controls for the accessibility to the city's main services such as the log of km^2 of metropolitan parks, the log of km^2 of zonal parks, the number of health–related private institutions (small and medium), and the number of facilities (public safety, defense and justice, food supply and consumption, hospitals, fairgrounds, cemeteries and public administration services). These variables are from 2017. In the same group, we added the number of Transmilenio stations, the system of Bus Rapid Transit (BRT) responsible for the majority of public transport trips in the city[11].

Finally, v_t are year fixed-effects, and ϵ_{it} is an error term with the usual properties.

In our preferred specification we replace the time-invariant controls with block fixed-effects (α_i) that fully control for all time invariant differences between blocks:

$$\ln(\text{Price}_{it}) = \beta_1 \times \text{Policy-562}_i \times \text{After-562}_t + \beta_2 \times \text{Time-variant controls}_{it} + v_t + \alpha_i + u_{it} \tag{2}$$

4.3 *On the parallel trends assumption*

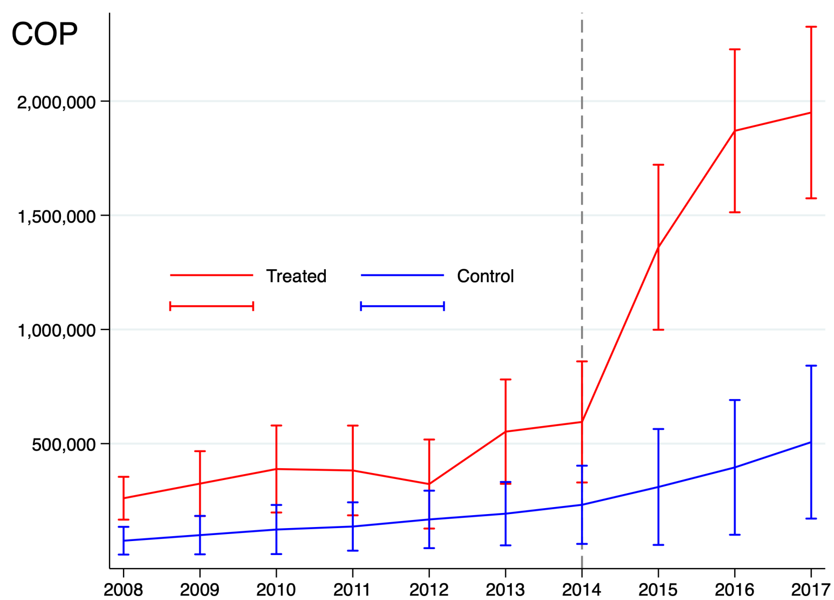
To use the DiD strategy, we assume parallel trends, which implies that the time effects (v_t) take account of any time trend in the data that is common to both the treatment and control groups

[11] We include this variable as time-invariant using most recent values because there was no new construction of lines or stations between 2013 and 2020. The last one before such a pause was the enlargement to connect Soacha (the neighbouring municipality in the south of Bogotá) in 2013.

(Jones, 2009). The presence of this common trend prior to the implementation of Policy–562 means that the behavior of the two groups should be homogeneous and independent of the future impact that will affect the treated group. Several authors stress the importance of studying this assumption by comparing the observable characteristics of the treated and control groups (Zhang, 2017, Givord, Quantin, and Trevien, 2018) which, in this case, means verifying if there is a systematic difference in the behavior of the real estate prices prior to the introduction of Policy–562.

Figure 3 shows the evolution of the average prices in treated and control groups between 2008 and 2017. It shows that, before the Law of Heights (2008-2014), real estate prices of the two groups evolved in a similar way and, in fact, they were not statistically different. These parallel pre-trends are suggestive evidence in support of the parallel trends assumption. On the other hand, it is clear that the average prices of the two groups followed different trends when Policy-562 was in place (2015-2017).

Figure 3: Evolution of real estate prices in treated and control groups: Mean and S.D.



Notes: 7,700 treated blocks and 35,293 untreated (control) blocks as described in Section 3.3.

5. Results

5.1 *Main results*

Table 3 reports DiD results when we regress the log of price on the interacted Policy-562 variable. In Column 1, we follow a pooled strategy and estimate Equation (1) without control variables. Then, we gradually add time-variant (Column 2) and time-invariant (Column 3) controls. Column 4 shows results when we follow a block fixed-effects panel strategy and estimate Equation (2). Since our dependent variable is based on the average price of the lots that make up each block, we weight block-year observations by the number of lots-year.

The estimated coefficient of interest is positive and statistically significant in all columns and decreases when we add control variables and, in particular, when we control for block fixed-effects. Our preferred result is in Column 4, it reports an estimated coefficient of 0.289 indicating that blocks affected by Policy-562 experienced an increase in real estate prices around 33.5% higher than untreated blocks.

Table B.1 in Appendix B shows that average prices of treated blocks increased from 592,000 to 1,942,000 COP/sq.m. between 2014 and 2017, which represents a total growth of 228.1% in the treatment period. As a result, the Law of Heights explains roughly 15% of this growth. Similarly, if we consider that average prices of untreated blocks increased by 120.7% (from 241,000 to 533,000 COP/sq.m.), Policy-562 would explain a third of the difference in growth rates between treated and untreated blocks.

Table 3: The effect of Policy-562 (Law of Heights) on real estate prices: DiD main results

	[1]	[2]	[3]	[4]
Policy-562×After-562	1.130[a]	1.168[a]	0.850[a]	0.289[a]
	(0.032)	(0.033)	(0.032)	(0.037)
Time-variant controls		✓	✓	✓
Time-invariant controls			✓	
Block fixed-effects				✓
Time fixed-effects	✓	✓	✓	✓
Adjusted R^2	0.100	0.133	0.139	0.217

Notes: 429,930 observations (= 42,993 blocks × 10 years) in each regression. Regressions are weighted by the number of lots that make up each block. Robust standard errors are clustered by ZPU and are in parenthesis. The coefficient of interest remains significant when clustering at the neighborhood and block levels. [a], [b], and [c] indicates significant at 1, 5, and 10 percent level, respectively.

Since Bogotá's real estate market is not perfectly segmented by block, in Appendix C we consider potential spillover effects when prices in one block are affected by prices (or their determinants) in nearby blocks. In particular, in Table C.1 we add controls for the log of average price per square meter in neighbouring blocks located at different distances and ZPUs. The estimated coefficient of interest remains positive and statistically significant in all specifications. Furthermore, these results are not statistically different from our preferred specification in Column 4 of Table 3.

In Appendix D we investigate the heterogeneity of the above results. First, we study whether the effect of Policy-562 changed over time during the treatment period. Results in Column 1 of Table D.1 shows that the positive effect of this policy on prices decreased every year (from 2015 to 2017). We relate this decreasing effect with the political context of Bogotá during these years and, in particular, the announcement and effective repeal of the Law.

Second, we also explore heterogeneous effects related to the main land use of the blocks. Results in Column 2 indicates that the Law of Heights only affected Residential and Services treated blocks. On the contrary, Manufacturing prices were not significantly affected.

Finally, we consider the strata where blocks are located. Results in Column 3 confirm heterogeneous effects of Policy-562 at the strata level. While prices in low strata 1 and 3 and high strata 6 treated blocks were positively affected, prices in high strata 4 and 5 zones were negatively affected by the Law.

5.2 *Robustness checks*

Despite the parallel pre-trends reported in Figure 3, we fear that treated and control groups might be different in terms of observables. To alleviate this concern, we consider three alternative methods that aim to redefine our treated and control groups. First, we apply a Propensity Score Matching (PSM) to select treated and controls that are similar in terms of explanatory variables[12]. We end up with 34,449 blocks (80% of the initial sample). The treated and controls groups are made up of 6,186 and 28,263 blocks, respectively. Alternatively, we consider a Nearest Neighbor Matching (NNM) using the 100-nearest neighbors on all explanatory variables[13]. With this method, we select a total of 6,177 blocks, 3,818 treated and 2,359 untreated. Finally, we follow Brueckner *et al.* (2017) matched-pair approach and consider what we name the Geographical Approach (GA): We focus on the control group to select those untreated blocks that are adjacent to treated blocks. The idea is that, at this spatial level, adjacent blocks may only differ on the treatment. In this case, we end up with a total of 13,546 blocks, that is, the original 7,700 treated blocks and 5,846 untreated blocks (16.7% of the initial untreated sample).

Table 4 reports results when we combine the DiD approach with the PSM (Column 1), the NNM (Column 2) and the GA (Column 3). As previously, the estimated coefficient of interest is positive and statistically significant in all three alternative approaches.

Regarding the magnitude of the estimated coefficients, the PSM and NNM ones (0.296 and 0.324) are statistically similar to their pure DiD counterpart (0.289) in Column 4 of Table 3. They show that Policy-562 increased prices by 34.5% and 38.3%, respectively.

On the other hand, the GA estimated coefficient (0.152) is statistically smaller and differs by a factor of 2 with the pure DiD estimated coefficient (0.289) in Column 4 of Table 3. This GA result indicates that Policy-562 (only) caused a 16.4% growth in real estate prices in treated blocks[14].

Table 4: The effect of Policy-562 (Law of Heights) on real estate prices: Alternative methods

	PSM + DiD	NNM + DiD	GA + DiD
	[1]	[2]	[3]
Policy-562×After-562	0.296^a	0.324^a	0.152^a
	(0.040)	(0.083)	(0.050)
Adjusted R^2	0.214	0.207	0.203
Observations	344,490	61,770	135,460

Notes: Regressions include time-variant controls, block fixed-effects, and year fixed-effects. They are also weighted by the number of lots that make up each block. Robust standard errors are clustered by ZPU and are in parenthesis. ^{a}, ^{b}, and ^{c} indicates significant at 1, 5, and 10 percent level, respectively.

[12] In Appendix E we provide further details on the method and its implementation.

[13] Unfortunately, smaller 'neighborhoods' do not provide enough number of observations. On the contrary, bigger 'neighborhoods' do not significantly change the number of observations and results hold.

[14] In some additional robustness checks that are available upon request, we apply the geographical approach (GA) to the PSM and the NNM samples. In both cases, results hold with significant and smaller estimated coefficients.

We may also fear that the cutoff used in the definition of blocks affected by Policy-562 is somehow arbitrary. As we explain in detail in Section 3, treated blocks are those located in ZPUs with more than 75% of their total area affected by Policy-562. For ZPUs with less than 75% of affected area, we apply this threshold to each of their neighborhoods.

In Table 5 we explore the sensitivity of the results to the chosen cutoff. First, we consider an smaller cutoff of 25% in Column 1 and a more demanding cutoff of 100% in Column 2. Using these alternative thresholds, the number of treated blocks increases from 7,700 to 10,488 (25% threshold) and decreases to 3,075 (100% threshold). The results of estimating Equation (2) confirm the positive and significant effect of Policy-562 for the two thresholds. Furthermore, when comparing with the result counterpart in Table 3 Column 4 (75% threshold), it is clear that the estimated positive effect increases the higher the threshold.

Second, in Column 3 we consider a multilevel treatment by simultaneously using different threshold intervals: Blocks with 25% to less than 75% of affected area, blocks with 75% to less than 100% of affected area, and blocks with 100% of affected area. The omitted category refers to blocks with less than 25% of affected area. The estimated coefficients confirm the positive effect of Policy-562, which is more important for the most affected blocks (100%).

Finally, in Column 4 we consider a continuous treatment variable by directly using the percentage of affected area (instead of a dummy). The significant and positive estimated coefficient indicates that each additional 1 p.p. in the percentage of affected area, increased real estate prices by 0.52%. In other words, blocks with a 100% of affected area experienced a 52% increase in their real estate prices.

Overall, these alternative threshold results confirm results when using the 75% threshold.

Table 5: The effect of Policy-562 (Law of Heights) on real estate prices: Alternative measures

	Thresholds		Intervals	Continuous
	25%≥ [1]	100% [2]	[3]	[4]
Policy-562×After-562	0.234[a] (0.033)	0.538[a] (0.050)		
25-75% Policy-562×After-562			0.060[a] (0.010)	
75-100% Policy-562×After-562			0.119[a] (0.008)	
100% Policy-562×After-562			0.560[a] (0.009)	
Continuous Policy-562×After-562				0.520[a] (0.044)
Adjusted R^2	0.217	0.217	0.217	0.217

Notes: 429,930 observations (= 42,993 blocks × 10 years) in each regression. Regressions include time-variant controls, block fixed-effects, and year fixed-effects. They are also weighted by the number of lots that make up each block. Robust standard errors are clustered by ZPU and are in parenthesis. [a], [b], and [c] indicates significant at 1, 5, and 10 percent level, respectively.

In summary, results in Tables 3, 4 and, 5 confirm that Policy-562 affected real estate prices in Bogotá. In particular, while the pure DiD specification in Column 4 of Table 3 shows that prices increased 33.5% more in treated blocks, the GA specification in Column 3 of Table 4 reports an effect of 16.4%.

A qualifier is important here. There are some identification issues that might affect the magnitude of the estimated coefficient. In this sense, our research faces an endogeneity problem. First, we are worried that some unobserved variable determines both real estate prices and Policy-562. The DiD, the PSM, and the NNM approaches are elaborate ways of comparing blocks that are similar on observable quantities. By comparing near neighbors, the GA approach may do better at controlling for unobservables. Second, as shown in Table 5, we also face a measurement error in our measure of Policy-562. Therefore, the magnitude of the positive effect estimated in the DiD, the PSM, the NNM and the GA specifications should be read with caution.

6. Conclusions

In this paper, we investigate the effect of the Law of Heights (Policy-562) on real estate prices in Bogotá between 2008 and 2017. Our results show that treated blocks experienced an increase in real estate prices. On average, the effect of Policy-562 ranges between 16.4% (GA approach) and 33.5% (pure DiD approach). This effect is also heterogeneous from a temporal, land use and strata point of view: It decreases in time, it is only related to Residential and Services land uses, and it is positive in low strata 1 and 3 and high strata 6 and negative in high strata 4 and 5.

We think that the contributions made by this paper are relevant. First, it provides empirical evidence for a city (Bogotá) in a middle-income developing country (Colombia) and shows that, similar to developed countries, a greater degree of regulation increases real estate prices. Second, while most papers focus on the average effects of the regulation, this research also provides empirical evidence on its heterogeneous effects. In particular, the paper furthers our understanding of how regulation affects different land uses and income groups.

A qualifier is important here. As we previously acknowledge, our research faces an unsolved endogeneity problem related to unobserved variables and potential measurement errors. As a result, the magnitudes of the estimated coefficients in our preferred specification should be read with caution.

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Appendix A. Strata system in Bogotá

Definition

The strata system in Colombia regulates prices of utility services such as water, sewer, electricity, gas, and telephone. According to the 1991 Constitution, these services are basic. At the national level, the strata system is regulated by law 142 of 1994.

In Bogotá, the system divides the city into six strata. Residents in strata 5 and 6 pay utility services according to their consumption plus an additional 20%, which is used to partially pay consumption bills by residents in lower strata. Specifically, strata 1, 2 and 3 residents receive a discount of 50%, 40% and 15%, respectively, on the utility prices. Finally, residents in strata 4 pay utility prices without additional charges or subsidies.

The classification in the different strata depends on the structural differences between the areas of the city, mainly in the housing characteristics/conditions and urban amenities. As a result, the strata system is not directly related to income, but only indirectly through these characteristics.

Policy-562 and strata system

Changes in the strata classification of a block are related to two main facts. The first is the change in the physical characteristics of the houses in a block, and the second is related to the improvements of urban amenities (such as new public transportation, the reconstruction of sidewalks and public places, and improvements in the sewage system, among others) that directly improve conditions around the block.

Regarding the first point, it is important to note that being part of the affected areas of Policy-562 did not directly affect block strata. It could be the case, however, that in the period when Policy-562 was in force (less than two years) plus the period of execution of the projects, some projects generated sufficient conditions to change the strata of a block. Nevertheless, it was neither a massive nor an automatic process. Thus, changes were slower than the window time we are analyzing in the present study.

Regarding the second reason that generated the change of strata in Bogotá (improvements of urban amenities around a block), Policy-562 did not regulate the construction of large-scale public infrastructure works. In addition, it did allow the developer to make a monetary payment instead of the construction of urban amenities in the area of direct influence of the new building (see table 1). Furthermore, since the objective was to regulate the constructions in urban renewal areas, most of the new buildings developed were built in consolidated areas, so developers often opted for the payment of the monetary compensation to the city (see section 2), which means that there was no improvement of urban amenities in the surrounding areas.

Finally, the process of changing strata is constant since there is a continuous committee evaluating every case. However, the legal formalization of the strata is made official by decree law. Since the strata system exists, Bogotá generated decree laws in 1997, 2002, 2004, 2008, 2009, 2013, 2017 and 2019. When analyzing the strata change by blocks between 2008 and 2017, we observe that only 4% (1,692 blocks) presented changes. Of these changes, 3.7% were from low strata (1, 2 and 3), and 0.3% were from high strata (4, 5 and 6). Of the blocks included in the areas of influence of Policy-562, less than 2% changed strata between 2008 and 2017.

Appendix B. Summary statistics

Table B.1: Average (and standard deviation) of real estate prices ('000 COP / sq.m.)

	Full sample			Treated			Control		
	2008	2014	2017	2008	2014	2017	2008	2014	2017
All blocks	172	430	1,078	286	592	1,942	147	241	533
	(143)	(584)	(810)	(184)	(278)	(355)	(118)	(246)	(395)
		42,993 blocks			7,700 blocks			35,293 blocks	
Residential	115	401	833	275	427	1,862	193	517	840
	(123)	(275)	(599)	(171)	(149)	(233)	(148)	(425)	(697)
		38,780 blocks			6,420 blocks			32,360 blocks	
Manufacturing	81	323	625	189	175	1,419	141	208	469
	(105)	(287)	(555)	(142)	(125)	(241)	(105)	(180)	(303)
		1,773 blocks			370 blocks			1,403 blocks	
Services	263	1,139	1,773	405	1,079	2,715	120	113	338
	(206)	(1,119)	(1,509)	(226)	(470)	(734)	(91)	(100)	(189)
		2,440 blocks			910 blocks			1,530 blocks	
Strata 1	70	290	487	143	703	993	304	1,140	1,834
	(91)	(576)	(668)	(170)	(518)	(844)	(177)	(716)	(927)
		11,619 blocks			845 blocks			10,774 blocks	
Strata 2	129	478	879	125	524	983	294	1,120	1,779
	(63)	(208)	(378)	(64)	(235)	(461)	(184)	(733)	(957)
		15,241 blocks			362 blocks			14,879 blocks	
Strata 3	232	864	1,466	234	881	1,506	360	1,389	2,074
	(77)	(316)	(465)	(73)	(277)	(392)	(254)	(1,009)	(1,338)
		11,888 blocks			4,502 blocks			7,386 blocks	
Strata 4	352	1,193	1,886	356	1,249	2,017	276	1,068	1,701
	(105)	(376)	(521)	(97)	(410)	(536)	(191)	(762)	(996)
		2,389 blocks			1,003 blocks			1,386 blocks	
Strata 5	474	1,643	2,431	548	1,974	2,907	268	1,031	1,661
	(173)	(887)	(1,214)	(156)	(952)	(1,285)	(171)	(669)	(872)
		1,016 blocks			499 blocks			517 blocks	
Strata 6	635	2,462	3,432	725	2,907	4,019	256	969	1,588
	(246)	(1,023)	(1,375)	(181)	(635)	(809)	(141)	(548)	(744)
		840 blocks			489 blocks			351 blocks	

Table B.2: Average (and standard deviation) of control variables

	Full sample			Treated			Control		
Time-variant controls	2008	2014	2017	2008	2014	2017	2008	2014	2017
Block Floor area (m^2)	733	913	940	825	950	989	713	905	929
	(3,368)	(7,368)	(4,237)	(2,996)	(3,703)	(3,770)	(3,443)	(7,947)	(4,332)
ZPU Density (inh/ha)	101	108	111	124	126	128	97	104	108
	(133)	(143)	(150)	(112)	(115)	(117)	(137)	(149)	(156)
ZPU Population per household	1.5	1.4	1.3	2.2	2.0	1.8	1.4	1.3	1.2
	(1.7)	(1.6)	(1.5)	(1.6)	(1.5)	(1.3)	(1.7)	(1.6)	(1.5)
Time-invariant controls									
ZPU Metropolitan parks (km^2)	3.5			1.7			3.9		
	(51.6)			(6.8)			(56.8)		
ZPU Zonal parks (km^2)	1.5			2.2			1.4		
	(1.3)			(1.5)			(1.2)		
ZPU Num. health-related inst.	46			163			20.20		
	(171)			(329)			(92)		
ZPU Number of facilities	58			88			52		
	(55)			(33)			(57)		
ZPU Num. Transmilenio stations	0.7			2.1			0.4		
	(1.5)			(2.1)			(1.1)		

Appendix C. Spillover effects

Since Bogotá's real estate market is not perfectly segmented by block, we now consider potential spillover effects when prices in one block are affected by prices (or their determinants) in nearby blocks.

In Table C.1 we control for these spillover effects by including the log of average price per square meter in neighbouring blocks located at 50 m (Columns 1 and 4), 100 m (Columns 2 and 5) and 500 m (Columns 3 and 6) and belonging to any ZPU (Columns 1, 2, and 3) or only to the same ZPU (Columns 4, 5 and 6).

The estimated coefficient of interest is positive and statistically significant in all six specifications, confirming that blocks affected by Policy-562 experienced an increase in real estate prices. Furthermore, these results are not statistically different from our preferred specification in Column 4 of Table 3, indicating that spillover effects from neighbouring blocks do not bias our preferred estimates.

Table C.1: The effect of Policy-562 (Law of Heights) on real estate prices: Controlling spillovers

	[1]	[2]	[3]	[4]	[5]	[6]
Neighbouring blocks	50 m	100 m	500 m	50 m	100 m	500 m
Belonging to	Any ZPU	Any ZPU	Any ZPU	Same ZPU	Same ZPU	Same ZPU
Policy-562×After-562	0.275[a]	0.277[a]	0.327[a]	0.276[a]	0.307[a]	0.317[a]
	(0.036)	(0.037)	(0.037)	(0.036)	(0.037)	(0.037)
Adjusted R^2	0.262	0.267	0.268	0.262	0.265	0.268

Notes: 429,930 observations (= 42,993 blocks × 10 years) in each regression. Regressions include time-variant controls, block fixed-effects, year fixed-effects, and the log of the average price per square meter of neighbouring blocks. Regressions are weighted by the number of lots that make up each block.. Robust standard errors are clustered by ZPU and are in parenthesis. [a], [b], and [c] indicates significant at 1, 5, and 10 percent level, respectively.

Appendix D. Heterogeneous results

We now turn our attention to studying the heterogeneity of our results by year of the treatment subperiod, for each of the three main land uses, and for each of the six strata.

Treatment years

To study whether the effect of the Law of Heights changed over time, we estimate Equation (D.1) allowing for different effects in the years belonging to the treatment subperiod.

$$\begin{aligned} \ln(\text{Price}_{it}) = & \beta_1 \times \text{Policy-562}_i \times \text{Year 2015} \\ & + \beta_2 \times \text{Policy-562}_i \times \text{Year 2016} \\ & + \beta_3 \times \text{Policy-562}_i \times \text{Year 2017} \\ & + \beta_4 \times \text{Time-variant controls}_{it} + v_t + \alpha_i + u_{it} \end{aligned} \tag{D.1}$$

Column 1 of Table D.1 reports the main results: The estimated coefficients for the three years are positive and statistically significant (0.542, 0.207 and 0.139), and show that the effects of Policy-562 decreased over time. In particular, treated blocks experienced an increase in real estate prices around 72% in 2015, 23% in 2016, and 15% 2017.

To understand the decreasing effect of the Law of Heights, it is necessary to look at the political context of Bogotá during these years. In 2015, the campaign for the mayor of Bogotá was advanced. The two candidates with more options to win opposed the current administration that promoted Policy-562, and in both cases, they proposed to repeal the law. A new mayor was elected in October 2015 and, although his term came into effect in January 2016, one of his first announcements was the repeal of the Law of Heights (effective February 2016). As explained in Section 4.1, between March 2016 and December 2017, the last projects approved by Policy-562 were developed.

Land use

We also explore the heterogeneous effects related to the main land use of the block. To do so, we estimate Equation (D.2):

$$\begin{aligned} \ln(\text{Price}_{it}) = & \sum_{j}^{3} \left(\beta_{1j} \times \text{Policy-562}_i \times \text{After-562}_t \times \text{Land Use}_j\right) \\ & + \beta_2 \times \text{Time-variant controls}_{it} + v_t + \alpha_i + u_{it} \end{aligned} \tag{D.2}$$

where Land Use_j are the three main land uses available in the SPD dataset (Residential, Manufacturing, and Services).

Column 2 of Table D.1 reports results showing that Residential and Services blocks were significantly affected by the Law of Heights with estimated coefficients (0.268 and 0.281) similar to their average counterpart in Column 4 of Table 3 (0.289). These estimated coefficients mean that the related blocks experienced increases in their prices around 30.8% (Residential) and 32.4%

(Services). On the other hand, the estimated coefficient for Manufacturing is lower (0.151) and non-significant.

Table B.1 in Appendix B shows that, between 2014 and 2017, Residential and Services treated blocks experienced huge increases in their prices. For the case of Residential blocks, average prices grew from 427,000 to 1,862,000 COP/sq.m., which represents a growth of 336.7% in four years. Policy-562 explains 9% of this growth. Similarly, prices in Services blocks increased 151.8% (from 1,079,000 to 2,715,000 COP/sq.m.), and the Law of Heights explains 21% of the Services growth.

Table D.1: The effect of Policy-562 (Law of Heights) on real estate prices: Heterogeneity

	Year		Land use		Strata
	[1]		[2]		[3]
Policy-562×Year 2015	0.542^a	Policy-562×After-562 ×Residential	0.268^a	Policy-562×After-562 ×Stratum 1 (low)	0.932^a
	(0.057)		(0.038)		(0.198)
Policy-562×Year 2016	0.207^a	Policy-562×After-562 ×Manufacturing	0.151	Policy-562×After-562 ×Stratum 2 (low)	-0.211
	(0.047)		(0.360)		(0.141)
Policy-562×Year 2017	0.139^a	Policy-562×After-562 ×Services	0.281^b	Policy-562×After-562 ×Stratum 3 (low)	0.465^a
	(0.025)		(0.120)		(0.039)
				Policy-562×After-562 ×Stratum 4 (high)	-0.193^b
					(0.091)
				Policy-562×After-562 ×Stratum 5 (high)	-1.652^a
					(0.217)
				Policy-562×After-562 ×Stratum 6 (high)	1.720^a
					(0.173)
Adjusted R^2	0.220	Adjusted R^2	0.220	Adjusted R^2	0.218

Notes: 429,930 observations (= 42,993 blocks × 10 years) in each regression. Regressions include time-variant controls, block fixed-effects, and year fixed-effects. They are also weighted by the number of lots that make up each block. Robust standard errors are clustered by ZPU and are in parenthesis. ^{a}, ^{b}, and ^{c} indicates significant at 1, 5, and 10 percent level, respectively.

Strata

Finally, we study the effects of Policy-562 according to the strata where blocks are located by estimating Equation (D.3):

$$\ln(\text{Price}_{it}) = \sum_{j}^{6} \left(\beta_{1j} \times \text{Policy-562}_i \times \text{After-562}_t \times \text{Strata}_j\right) + \beta_2 \times \text{Time-variant controls}_{it} + v_t + \alpha_i + u_{it} \tag{D.3}$$

where Strata_j are the strata of the city (1, 2 and 3 low strata and 4, 5 and 6 high strata).

Column 3 of Table D.1 reports main results using de 2017 strata definition[15]. They indicate that Policy-562 positively affected prices in low strata 1 (0.932) and 3 (0.465) zones. In particular, their treated blocks increased real estate prices by 154% (strata 1) and 59% (strata 3), respectively. On the contrary, prices in low strata 2 were negatively but not significantly affected. For the high

[15]As commented in Appendix A, the definition of strata changed in some specific years of the studied period. However, only 4% of the blocks were affected by this change of classification. As a robustness check, we re-estimated Equation (D.3) using the 2008 strata definition. Results hold and are available upon request.

strata zones, all estimated coefficients are significant but differ in their sign. While strata 4 and 5 were negatively affected (-0.193 and -1.652), the effect was positive in strata 6 (1.720). These results mean that the Law of Heights decreased real estate prices in strata 4 and 5 by 18% and 81%, and increased them in strata 6 by 458%.

It is important to note that most of these Policy-562 effects at the strata level are either of a different sign (strata 4 and 5) or are larger (strata 1 and 6) than the final price growth experienced by the treated blocks during the treatment period (which can be computed using the average values reported in Table B.1 in Appendix B). This means that there were other confounding factors with opposite and compensating effects.

Appendix E. Propensity score matching

As a robustness check, in Columns 1 and 2 of Table 4 we use the 'propensity score matching' technique to adjust imbalances in the explanatory variables between treated and controls to ensure that the post-treatment effects. We first estimate a logit using the dummy Policy-562_i as the dependent variable. As explanatory variables, we use the set of control variables of Eq. (1) measured in 2007. We then compute the 'propensity score' and control blocks are matched to their treated counterparts based on a similar 'propensity score'. To do so, we use the 'nearest neighbor matching with replacement' method, whereby a given control unit can be matched to more than one treatment unit, which increases the average quality of matching and reduces the bias.

Panel A of Table E.1 reports the results of the logit. They show that areas with more population density, inhabitants per household, metropolitan parks, private institutions and new buildings approved were less likely to be included under the influence of Policy–562. Recall that one of the objectives of the Law of Heights was to reactivate areas suffering some degree of abandonment. On the other hand, the group of variables that seeks to measure access to the city's facilities, and the general advantages related to the location of each lot within the city, presents a positive and significant effect on the probability of being included in the treated areas, where the existence of Transmilenio stations and zonal parks are highly significant factors that increase this probability by 50 and 61%, respectively.

In Panel B of Table E.1 we perform several tests to determine whether or not we achieve a good matching. First, we perform a comparison of means between treated (column 3) and controls (column 4) in the unmatched and matched samples (see Rosenbaum and Rubin, 1985). In the unmatched sample, the treated group are disproportionately located in ZPUs with low population density, inhabitants per household and km^2 of metropolitan parks, and with a large number of private institutions, facilities, Transmilenio stations, km^2 of approved projects, new buildings approved and km^2 of zonal parks. In the matched sample, most of the differences in means between the treated and the control group are statistically non-significant (columns 5 and 6). Second, we also examine standardized bias both before and after matching (column 7); before matching, many variables presented a bias greater than 20%, which is the level above which some authors suggest linear regression coefficients risk being highly biased (Imbens and Wooldridge, 2009). After matching, all the variables present a bias below this level and with a substantial reduction in % bias (column 8) (between 79 and 99%). Third, we also re-estimate the propensity score on the matched sample and compare the pseudo-R^2 before and after matching, which are actually 0.422 and 0.003, respectively. LR tests of joint significance of the regressors before and after the matching present values of 17061 and 5.41, respectively. All these tests suggest that matching is successful in balancing the sample.

At the end of the matching process, the new sample includes 34,449 blocks (80% of the initial sample). The treated and controls groups are made up of 6,186 and 28,263 blocks, respectively. This indicates that the original sample (with 35,293 and 7,700 blocks, respectively) considers blocks that are structurally different and that do not have a counterpart.

Table E.1: Propensity score matching: Selecting treated and control groups

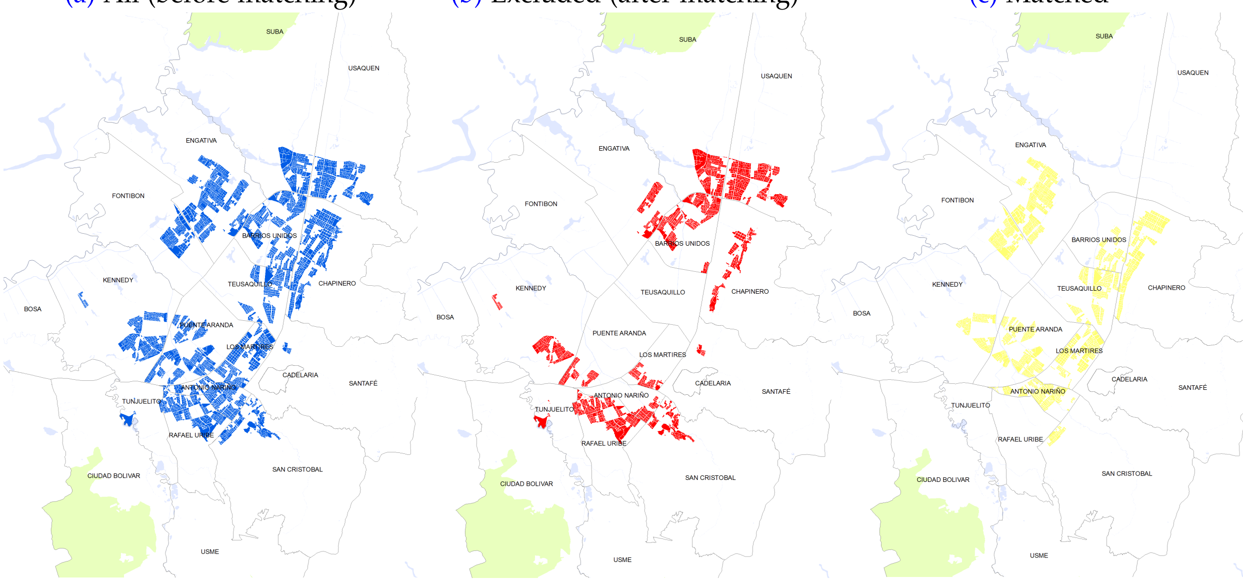
	Panel A	Panel B						
	Logit	Matched vs. unmatched samples						
			Mean		*t*-test			
		Sample	Treated	Control	t	$p-value$	% *bias*	$\%\nabla\ \lvert bias \rvert$
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
ln(Population per hectare)	-1.056^a	Unmatched	4.785	5.145	-22.24	0.00^a	-26.2	
	(0.038)	Matched	4.845	4.850	-0.20	0.85	-0.4	98.6
ln(Population per household)	-2.015^a	Unmatched	1.510	1.528	-15.12	0.00^a	-21.1	
	(0.161)	Matched	1.512	1.512	-0.80	0.43	-0.8	96.3
ln(km^2 of metropolitan parks)	-0.280^a	Unmatched	0.138	0.230	-11.88	0.00^a	-16.0	
	(0.034)	Matched	0.163	0.143	2.02	0.04^b	3.4	79.0
ln(km^2 of zonal parks)	0.609^a	Unmatched	0.566	0.200	69.42	0.00^a	74.1	
	(0.037)	Matched	0.564	0.589	-2.34	0.02^b	-5.1	93.1
Number of private institutions	-0.005^a	Unmatched	163.0	20.20	70.00	0.00^a	59.1	
	(0.001)	Matched	169.0	163.5	0.85	0.39	2.3	96.2
Number of facilities	0.004^a	Unmatched	88.4	51.5	55.2	0.00^a	79.6	
	(0.001)	Matched	91.9	91.9	-0.14	0.89	-0.2	99.8
Number of Transmilenio stations	0.501^a	Unmatched	2.1	0.5	100.53	0.00^a	101.2	
	(0.011)	Matched	1.9	1.9	-0.21	0.84	-0.5	99.5
ln(km^2 of approved projects)	0.294^a	Unmatched	9.579	5.491	72.31	0.00^a	107.8	
	(0.007)	Matched	9.449	9.427	0.47	0.64	0.6	99.5
Number of approved new buildings	-0.005^a	Unmatched	142.5	95.6	21.29	0.00^a	29.7	
	(0.001)	Matched	152.3	149.2	1.40	0.16	2.0	93.4
Strata dummies	✓							
Pseudo-R^2 0.439 LR-χ^2 17759		Unmatched	Pseudo-R^2 0.422	LR-χ^2 17061	Median bias 37.9			
		Matched	Pseudo-R^2 0.003	LR-χ^2 5.41	Median bias 1.7			

Notes: 42,993 observations. Standard errors in column 1 are in parenthesis. ^{a}, ^{b}, and ^{c} indicates significant at 1, 5, and 10 percent level, respectively.

Figure E.1 shows the stages followed by the matching process for the case of the treated group. Figure E.1a shows the location of all blocks affected by the Law of Heights. Figure E.1b shows the blocks that are excluded after the matching process. Although there are excluded blocks in several locations of the city, they appear to be concentrated mainly in two with different strata. On the one hand, blocks are excluded in the municipalities of Tunjuelito and Rafael Uribe with a predominance of low-strata properties (1 and 2). On the other hand, blocks are excluded in the municipality of Chapinero with a predominance of high-strata properties (4 and 6). Finally, Figure E.1c shows the selected treated block after the matching process.

Figure E.1: Stages of the matching process for treated blocks

(a) All (before matching) (b) Excluded (after matching) (c) Matched



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