PONTIFICIA UNIVERSIDAD CATÓLICA DE CHILE
ESCUELA DE GOBIERNO

The Stringency of Urban Regulation: Evidence from Chile

Thesis presented to obtain the academic degree of Master in Public Policy
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December 17, 2021

[1]I would like to thank Kenzo Asahi, Diego Gil, and Hugo Silva for their exceptional guidance, constant feedback, and confidence in my work. Also, to Andrea Herrera and Javier Peñafiel, for their support, help and comments. Finally, I want to thank my family and friends, especially my MPP's friends, with whom I shared in this process. All errors are of my responsibility. For any comments or questions, please address them to my email: laura.gonzalez@uc.cl

Abstract

This work explores the stringency of urban regulation in the Greater Santiago area, measured as the elasticity between property prices and two regulatory variables: maximum allowed FAR and height. A high stringency reveals that regulated levels are far below free-market levels, while a low stringency indicates that the two values are closer. I use a rich panel dataset that contains different regulatory variables over time, at a territorially disaggregated level for an important part of the city. I join this database to used housing transaction prices between 2007 and 2018. My results show that the strigency is not statistically different from zero in Santiago. This indicates that construction levels are probably close to what would have been in the absence of regulation. Additionally, when I study heterogeneities within the city, I do not find the stringency changes with accessibility. However, I find that high socioeconomic neighborhoods and those with stricter baseline regulatory variables have higher levels of stringency, although the last is small in magnitude. These results, however, must be interpreted with caution, considering that the analysis is centered on used housing prices –assuming that all could be regarded as land for densification–and not only in land transactions.

1 Introduction

Chile has a severe problem of housing affordability. The gap between housing prices and real wages has increased in the last years, mainly in Santiago, Chile's capital. In fact, according to Central Bank data,[2] housing prices increased 87 percent between 2010 and 2020, while real wages grew only 26 percent in the same period (Banco Central, 2020a; INE, 2020).[3]

This trend has led to a significant housing deficit that mainly affects medium and lower-income sectors. The quantitative housing deficit, which corresponds to the number of dwellings required to satisfy housing needs, reached almost 497 thousand homes in 2017 (Ministerio de Vivienda y Urbanismo, 2017). Of this figure, 72 percent corresponds to homes needed for the first three income quintiles (Ministerio de Vivienda y Urbanismo, 2017).

The housing deficit is highly reflected in the proportion of families living in urban settlements or sharing a dwelling with more than a family nucleus ("allegamiento"). The last Census of urban slums carried out by Techo and Fundación Vivienda[4] between 2020 and 2021 shows that more than 81 thousand families live in this type of settlement, representing about 1.4 percent of total households in Chile.[5] Although this figure is far from those in countries such as Brazil or India, which have 15.2 and 34.8 percent of their population living in urban slums (UN, 2021),[6] it is worrying considering that it has been at an all-time high since 1996. At the same time, the Chilean survey of socioeconomic characterization (CASEN), carried out in 2017, showed an increase in the number of families that share a dwelling with more than a family nucleus, from 2.8 percent in 2015 to 4.5 percent in 2017. The survey's responses support that the leading cause of "allegamiento" is higher prices. Indeed, 30 percent of respondents stated that they live in a shared dwelling because household income does not allow them to maintain an independent residence, 15 percent indicated that it is because they have to take care of children, elderly or sick people, and 13 percent stated that it is to generate savings (Ministerio de Desarrollo Social, 2018).

[2] The Central Bank of Chile is an autonomous body whose main function is to ensure the stability of the currency, that is, to keep inflation low and stable over time (Banco Central, nd).

[3] To calculate the housing prices growth, I used the Housing Price Index (IPV), a real indicator of housing prices with quarterly frequency elaborated by the Central Bank of Chile. The index is made using 2008 as the basis year. Regarding real wages, I used the General Remuneration Index, a real indicator of hourly wages with monthly frequency elaborated by the Central Bank of Chile using data from the National Statistics Institute (INE). The index is made using 2016 as the basis year.

[4] Techo is a Latin-American non-profit organization that works with communities living in urban settlements. Fundación Vivienda is a Chilean foundation that seeks to develop innovative housing solutions for groups in vulnerable situations (Fundación Vivienda, nd).

[5] To calculate the proportion of families living in urban slums, I used the total number of households from Censo 2017, elaborated by the National Statistics Institute (INE).

[6] Although these figures are not exactly comparable to those in Chile, since they represent the proportion of people living in urban slums and not the proportion of families, it is useful for a general comparison.

The trend of rising housing prices is an international phenomenon. There has been an average annual growth of housing prices in OECD countries of seven percent from the fourth quarter of 2019 to the fourth quarter of 2021, the fastest year-to-year growth in two decades (OECD, 2021). As in Chile, this increase has been more rapid than the increase in household income in most countries. The USA, for example, has experienced a steady rise in the price-to-income ratio, reaching a housing overvalue of about 18 percent (The Economist, 2021).

Although many factors affect housing prices, a growing literature studies urban regulation as a determinant (Molloy, 2020). These regulations can take multiple forms. Some of them, such as building codes and impact fees, increase the construction cost; by contrast, others limit the number of dwellings built on a particular area, like zoning, minimum lot sizes, height restrictions, open space requirements, and growth controls (Molloy, 2020). All the previously mentioned regulations limit housing supply and, at least theoretically, should increase nearby housing prices.

This thesis aims to analyze the relationship between land use regulation and property prices. In particular, I study the elasticity between the maximum floor-area ratio (FAR) and maximum height on used housing transaction prices per square meter of land in twelve municipalities in the Greater Santiago area. This method allows me to explore the stringency of land use regulation within the city, analyzing heterogeneities at different levels. These regulations are endogenous, that is, they probably correlate with property attributes that also affect prices. Hence, to mitigate bias, I include fixed effects at the municipality, Census district, Census tract, and block-level.

To apply these methods, I rely on two main datasets. First, a rich panel of municipal regulatory plan changes –the municipalities' primary urban regulatory norm– between January 1997 to April 2019 in twelve municipalities of the Greater Santiago area. The database explicitly contains the maximum height, density, floor-area ratio, and occupancy for each lot in the city, corresponding to the smallest geographic unit of analysis. Regarding prices, I use a database of housing transactions in the Greater Santiago area between 2007 and 2018, which contains the transaction price, the geographic location for each transaction, and a set of property characteristics, such as the year of construction, an index of quality, and the lot's built-up surface. I only use used home sales of this sample, assuming all constitute potential land for densification. Additionally, I use infrastructure and Census socioeconomic data to study heterogeneities within the city.

As previously stated, a large body of empirical literature studies the relationship between urban regulation and land and housing prices, but results tend to be mixed (Quigley and Rosenthal, 2005; Molloy, 2020). One of the most relevant studies in the area is that of Turner et al. (2014), who decompose the effect of regulation on land prices into three components. The first is the own lot effect, which refers to the impact of urban regulation on the cost of the regulated lot. This effect would be negative because regulation constrains how a landowner develops her land, thus reducing its value. The second is the external effect, which refers to the impact of urban regulation on the value of nearby locations. In this case, the sign of the effect is not so straightforward since it depends on the type of regulation and the incoming residents' preferences. For example, suppose a regulatory norm imposes a maximum building height. In that case, the external effect is expected to be positive, given that individuals tend to prefer lower elevations that provide better views. The third component is the supply effect, which reflects the impact of urban regulation on residential land supply. This effect would be positive, given that stricter regulations reduce the proportion of developable land, creating upward pressure on prices. The results show that the own lot effect is negative and robust to changes in specifications, controls, and samples. The external lot effect is negative, but non-significant at conventional levels. On the other side, the analysis of the supply effect shows a negative impact of urban regulation on the proportion of developable land.

However, all these effects depend on the level of stringency of land use regulation. If regulation imposes construction levels similar to those that would apply in a free market context, there would be no impact on land or housing prices. On the contrary, if regulation causes a divergence from market building levels, there would be a reduction in the price of the regulated lot and upward pressure on housing prices, as Turner et al. (2014) state. Few studies have analyzed this distinction. One measure of stringency addressed in the literature is the "zoning tax", defined as the gap between real estate prices and the marginal cost of producing one additional housing unit (Glaeser et al., 2005; Gyourko and Krimmel, 2021). Since home building is a highly competitive industry, the intuition is that gaps between prices and marginal costs indicate artificial barriers to construction. Nevertheless, this measure does not identify particular regulations that generate the tax (Brueckner and Singh, 2020).

Another measure of stringency is the elasticity between the value of vacant land and particular urban regulations, which can be obtained by regressing the (log of) land price per area on (the log of) a continuous regulatory land-use measure (Brueckner et al., 2017; Brueckner and Singh, 2020). In this case, the intuition is that relaxing a stringent regulation would raise the land value by more than relaxing a less stringent one. Thus, the stringency would be substantial when regulation outcomes are far below the free market outcomes and lower when the two values are closer (Brueckner and Singh, 2020).

This last measure has been applied in different contexts. Brueckner et al. (2017) analyze the stringency of land use regulation in Chinese cities, finding that log land price is positively correlated with log floor-area ratio (FAR). The average elasticity when cluster fixed effects are used is about 0.35; however, results are heterogeneous across cities. The authors also study the effects within Beijing, allowing the elasticity to vary with site characteristics, such as the distance to central business districts, nearest significant roads, schools, among other amenities. Brueckner and Singh (2020) use the same method to study the stringency of land use regulation in US cities. The results show that New York and Washington DC have stringent FAR regulations, while Chicago and San Francisco are less severe. They also analyze FAR stringency within cities, incorporating heterogeneities as the distance to central business districts and subways, the median income, and the white proportion of the population at the zip-code level.

I find that the elasticity between used housing prices and FAR or height regulation is, on average, not statistically different from zero in the Greater Santiago area. This result indicates a low level of stringency; that is, construction levels are probably close to what would have been in the absence of regulation. Additionally, I do not see the elasticity changes with distance to the central business districts or subways, but I find a slight effect with the distance to highways. Finally, I find that high socioeconomic neighborhoods and those with stricter baseline regulatory variables have higher levels of stringency, although for the last the effect is small in magnitude. These results, however, must be interpreted with caution. The main limitation of this work is that I do not have data on effective land transactions. Thus, as previously mentioned, I use the price per square meter of the land of used housing transactions, assuming that all constitute available land to densify.

The main contribution of this thesis is that it extends the analysis of the stringency of urban regulation, incorporating new regulatory variables. Unlike the previous literature, I rely on a rich database that contains georeferenced information for the maximum FAR, height, density, and occupancy coefficient of an essential part of the city for an extended period. This allows me to explore the particular stringency of each measure. Specifically, I analyze the maximum FAR and height since they are the variables that should significantly influence land prices.

The second contribution of this thesis is that it allows observing stringency heterogeneities within the city. This clarifies the areas where urban regulation reduces land value and restricts new housing development, thus pushing housing prices. Nevertheless, more research is needed to quantify the supply effect on housing prices.

The rest of this study is structured as follows. In section 2, I describe the background, explaining the urban regulatory context in Chile. Section 3 presents the empirical analysis, referring to the method, data sources, and descriptive statistics. In section 4, I present the results of the analysis. Finally, in section 5, I close with the discussion and a brief conclusion.

2 Background

As stated in the introduction, this thesis focuses on twelve municipalities of the Greater Santiago area (henceforth, Santiago). Santiago is the capital of Chile and the most significant economic and administrative center. Indeed, it concentrates 40.5 percent of the country's total population (INE, 2018), and in 2020, it represented 42 percent of the national GDP (Banco Central, 2020b).

Despite its positive economic indicators, Santiago is a highly segregated city. Residential income segregation levels are considerably higher than those in metropolitan areas in the US (Agostini et al., 2016). Furthermore, in the case of the wealthiest decile, residential income segregation reaches levels comparable to the average of racial residential segregation in the US cities (Agostini et al., 2016). As shown in the Appendix 1, the north-eastern sector of the capital is the most segregated area, concentrating the highest socioeconomic groups (ABC1). Thus, there are broad heterogeneities between municipalities.

Concerning urban regulation in Chile, there is academic consensus that it is dispersed and complex (Sierra, 2006; Ministerio de Vivienda y Urbanismo, 2013). Different titular bodies exercise their regulatory powers, within a particular area of competence and following a pre-established procedure (Sierra, 2006).

Regarding the legislative power, the central norm is the General Law of Urbanism and Construction (henceforth, LGUC), which regulates at the national level areas such as urban planning, urbanization and construction, affordable housing, and mitigations and contributions to the public space (BCN, nda). While this norm establishes the general framework, the General Ordinance of Urbanism and Construction (henceforth, OGUC) contains the regulatory provisions related to administrative procedures, urban planning, urbanization and construction processes, and the technical design and construction standards (BCN, ndb). Finally, Urban Development Division's Circulars (DDU) address matters not sufficiently specific within the OGUC.

There is also an autonomous power, understood as the authority of municipalities and regions in urban regulation (Sierra, 2006). These administrative units exercise their regulatory power through Territorial Planning Instruments (IPT). According to the provisions of the OGUC, these instruments, ordered by their scope of action, are the following: Regional Urban Development Plans, Metropolitan Regulatory Plans, Communal Regulatory Plans, Sectional Plans, and Urban Limits.

This thesis focuses on Communal Regulatory Plans (henceforth, PRCs) since these are the instruments that regulate the maximum floor-area ratio (FAR) and height allowed in an urban area. These instruments operate at the municipal level and establish urban limits, urban road networks, land intended for circulation and parks, historic conservation areas or buildings, plantation requirements, zoning rules, and other conditions. Until 2016, 236 of 346 municipalities in Chile had an approved PRC, while in the Santiago Metropolitan Region, this figure was 35 out of 52 municipalities (Cámara Chilena de la Construcción, 2017). Nevertheless, most PRCs face an obsolescence problem, which is reflected in the age of the plans. The average age of PRCs in municipalities of the Santiago Metropolitan Region with more than 50.000 inhabitants is 16.7 years (Cámara Chilena de la Construcción, 2017).

Approving a new PRC is, however, a very long process. According to a study elaborated by the Ministry of Housing and Urbanism (MINVU), from a sample of

45 municipalities, the average time of formulation of a PRC is six years (Ministerio de Vivienda y Urbanismo, 2013). Thus, the trend has been to make modifications to the original plans. These changes can be grouped into two types. In the first place, the municipality can make an amendment to alter the building and urbanization conditions of the PRC. Second, the municipality can create a structural or punctual modification to the PRC, following OGUC's provisions. Both amendments and punctual changes to the PRC have shorter average processing times than the approval of a new plan, so there are widely used to change FAR and maximum height. Finally, it is essential to state that sectional plans were also used to make changes to PRCs. However, a modification to the LGUC changed the purpose of sectional plans, as now they are directed to those municipalities that do not have a PRC.

My data source includes regulatory variables derived from the approval of new PRCs and their modifications made through the provisions of the OGUC. Thus, I count with maximum FAR and height of the smallest geographic units over time.

3 Empirical analysis

3.1 Research question

In line with previous research, specifically the framework described by Brueckner and Singh (2020), this work explores the stringency of urban regulation in Santiago de Chile. As a measure of stringency, I use the elasticity between property prices and two regulatory variables: maximum floor-area ratio (FAR) and height. Additionally, I search for heterogeneity on site characteristics, particularly, regarding the distance to central business districts, subways, and highways, between the block residents' socioeconomic quintile, and between differences in the baseline regulation.

3.2 Method

3.2.1 Theoretical model

To explore the stringency of urban regulation within Santiago, I follow the standard land-use model (Brueckner et al., 2017; Brueckner and Singh, 2020), which assumes that real estate companies' profits depend on the price per square meter of housing p, the price per square meter of land r, the housing output in square meters $h(S)$ –which depends on the structural density S–, and the cost per unit of capital i.

$$\pi = ph(S) - iS - r$$

Assuming that S^* is the value that satisfies the zero-profit condition, the free-market price of land would be given by:

$$r = ph(S^*) - iS^*$$

In a regulated market, regulation variables (as maximum FAR or height) impose a maximum value for the housing output, denoted as $\overline{h}$, resulting in a maximum value for structural density, indicated as $\overline{S}$. Thus, the land value, in this case, would be:

$$r = ph(\overline{S}) - i\overline{S}$$

The elasticity of the land price relative to $\overline{S}$ is given by:

$$E_{r,\overline{S}} = \frac{\partial r}{\partial \overline{S}} \frac{\overline{S}}{r} = \frac{[ph'(\overline{S}) - i]\overline{S}}{ph(\overline{S}) - i\overline{S}} = \frac{[h'(\overline{S}) - h'(S^*)\overline{S}]}{h(\overline{S}) - h'(S^*)\overline{S}}$$

As Brueckner et al. (2017) and Brueckner and Singh (2020) point, if the production function is assumed as a Cobb-Douglas, the elasticity of the land price relative to the regulated structural density is reduced to an expression that positively depends on the ratio $\frac{S^*}{\overline{S}}$. Thereby, there will be a higher elasticity when the regulated structural density lies far below the free-market structural density.

3.2.2 Empirical strategy

To measure the elasticity between used housing prices –as a proxy of land prices– and urban regulation, I use a fixed-effects regression model. The basic specifications are the following:

$$ln(P_{igty}) = \beta_0 + \beta_1 ln(FAR_{igty}) + \beta_2 X_i + \gamma_g + \delta_y + \epsilon_{igty} \quad (1)$$

$$ln(P_{igty}) = \beta_0 + \beta_1 ln(Height_{igty}) + \beta_2 X_i + \gamma_g + \delta_y + \epsilon_{igty} \quad (2)$$

Where i is the individual property, g is the geographical area, and t and y are the transaction month-year and year, respectively. The dependent variable $ln(P_{igty})$ represents the natural logarithm of the price per square meter of land of the property's transaction, measured in UF[7]. On the other side, $ln(FAR_{igty})$ and $ln(Height_{igty})$ are the natural logarithm of the floor-area ratio (FAR) and height of the lot where the property is located, at the moment of transaction. X_i is a vector of the property's characteristics, γ_g is a geographical area-level fixed-effect, δ_y is a year-level fixed-effect, and ϵ_{igty} is the error term. I use different levels of geographical areas as fixed effects to overcome possible endogeneity caused by unobservable variables that are common within each region. In particular, I use

[7] UF (Unidad de Fomento) corresponds to an inflation-adjusted measure authorized by the Central Bank. The 2021 monthly average UF value until October, was 29.611 CLP or 37,4 USD.

municipalities, Census districts, Census tracts,[8] and blocks.[9] I cluster the errors by municipality, given that, as stated in the background section, urban planning is done at the municipal level. The coefficient of interest is β_1, which indicates the elasticity between FAR or height and property prices, i.e., the percentage variation in prices due to a one percent increase in the FAR or height coefficient.

In a second specification, I interact the ln of FAR or height with a set of variables to allow the elasticity to vary with the site's characteristics (Z_i). In particular, I use the distance to the central business district (CBD), the nearest subway station, and the nearest highway entrance. Additionally, I use the socioeconomic quintile at the block level and the basal FAR and height quintile of the lot where the property is located. Except for the basal FAR and height quintile, in these last specifications, I only use fixed-effects at a more aggregated level –municipal, Census district, and Census tract level–, since blocks constitute a small territorial unit. Thus there should not be significant variability in the distance within each block. Regarding the socioeconomic quintile, the variable is measured at the block level, which prevents using fixed effects.

$$ln(P_{igty}) = \beta_0+\beta_1 ln(FAR_{igty})+\beta_2 Z_i+\beta_3 ln(FAR_{igty})*Z_i+\beta_4 X_i+\gamma_g+\delta_y+\epsilon_{igty} \quad (3)$$

$$ln(P_{igty}) = \beta_0+\beta_1 ln(Height_{igty})+\beta_2 Z_i+\beta_3 ln(Height_{igty})*Z_i+\beta_4 X_i+\gamma_g+\delta_y+\epsilon_{igty} \quad (4)$$

3.3 Data sources

3.3.1 Urban regulation database

The first data source is a panel of 107.514 lots in Santiago containing regulatory variables such as the maximum height, density, FAR, and occupancy coefficient between January 1997 and April 2019. It was elaborated by a research team of the Pontificia Universidad Católica de Chile: Kenzo Asahi, Diego Gil, Andrea Herrera, and Hugo Silva, based on information obtained through the transparency law in municipalities (decrees, municipal ordinances, and communal regulatory plans) (Asahi et al., 2021). As previously mentioned, the unit of analysis is the lot, which represents the smallest geographical unit assessed in regulation.

The database contains information for twelve municipalities in Santiago, in particular: Independencia, Quinta Normal, Pudahuel, Renca, Conchalí, Lo Prado, Cerro Navia, Estación Central, Providencia, Las Condes, Vitacura, and Lo Barnechea (Appendix 2). I only use the maximum allowed FAR and height as my regulatory variables, for data availability and because they significantly impact property

[8] Census tracts are geographical divisions formed by a conglomerate of blocks that have approximately 2000 houses (INE, 2015). I use Census tracts from the 2002 Census.

[9] I use two types of blocks ("manzanas"). One coded by the Internal Revenue Service (SII) and the other coded by the National Statistics Institute (INE).

prices. According to the Chilean normative, FAR constitutes a “number that multiplied by the property’s total area, discounting from the latter the areas of public utility, sets the maximum possible square meters of building on the land” (art. 1.1.2, OGUC). On the other side, height sets the maximum vertical distance of the building, expressed in meters.

3.3.2 Transactions database

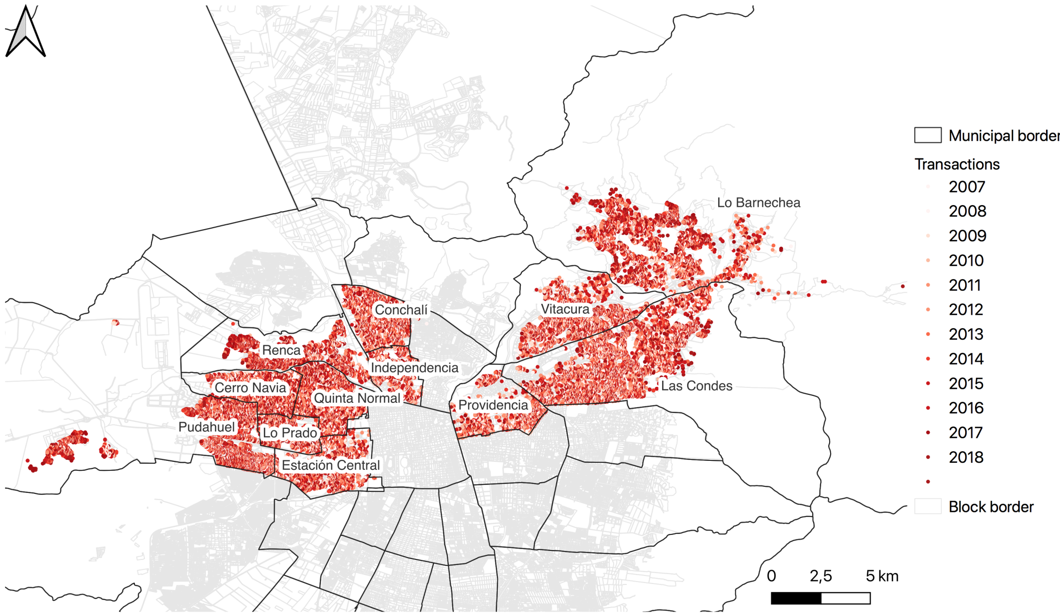
The second data source is a panel of housing transactions of 45 municipalities in the Santiago Metropolitan Region between 2007 and 2018. It was elaborated by TocToc, an association of real estate companies, based on information from Conservador de Bienes Raíces de Santiago (CBRS), one of the Chilean offices for property registries. This database was subsequently shared with researchers of the Pontificia Universidad Católica de Chile in the “Ciudad con Todos” project.

The main variables in the database are the sale’s date, the price measured in Unidad de Fomento (UF), and the geographic location for each transaction. Additionally, the database contains a set of property characteristics, specifically, the year of construction, a quality index, the lot’s and built-up surface’s size, the type of dwelling (house or apartment), and the property’s status (new or used).

The database includes 714.599 transactions of 628.400 georeferenced properties between 2007 and 2018. Nevertheless, it has 98 transactions repeated, so I reduced the sample to 714.501 observations. Given that I aim to analyze the impact of urban regulation on land prices –and not housing prices–, I restrict the sample to used housing transactions, assuming that these properties are all potential land for densification. Thus, my final sample consists of used housing transactions on the twelve municipalities on analysis, which leaves 54.764 observations.

I linked transactions with regulation data through a spatial join using GIS software. In particular, I join each transaction with a regulated polygon at the month and year of transaction. Of the final sample, 54.511 transactions were joined to a regulated polygon, which are widely distributed within the municipalities of the sample, as shown in Figure 1.

Figure 1: Used housing transactions 2007-2018



Notes: Own elaboration using TocToc transactions database.

3.3.3 Additional data: CBD, infrastructure, and socioeconomic data

Following Brueckner and Singh (2020), I also use CBD, infrastructure, and socioeconomic data to study the city's heterogeneities. First, I calculate the minimum distance from the property to the central business districts (CBD) using GIS software. Unlike the case of New York, where two specific points are considered –Times Square and Wall Street–the CBD in Santiago can be regarded as a line extending from the western to the northeast of the city, particularly from Santiago Centro to Las Condes (Appendix 3).

Second, I calculate the minimum distance from the property to the nearest subway station. Santiago has a metro network that covers an important part of the city. The first line, "Línea 1," was inaugurated in 1975 and, until 2019, there were six lines in operation (Appendix 4). I calculate the distance to the nearest available station, considering the inauguration year.

Third, I calculate the minimum distance from the property to the nearest highway entrance. I consider seven highways that were improved or inaugurated between 2006 and 2010: Vespucio Norte, Vespucio Sur Express, Autopista Central, Costanera Norte, Autopista Nororiente, Túnel San Cristóbal and Acceso Sur (Appendix 5).

Finally, I incorporate socioeconomic data at the block level. In particular, I use quintiles based on the mean decile of the household at the 2002 Census block level. Although it would be better to use the average household income per block –as Brueckner and Singh (2020) do–, since it provides greater variability, there are no data at such a disaggregated territorial level.

3.4 Descriptive statistics

Figure 2 shows the maximum allowed FAR from the first and the last period in the regulation database for the twelve municipalities in analysis. As can be seen, in 1997, municipalities of the north-eastern Santiago –those of high socioeconomic level– had a stricter regulation compared to western communes, as they set a lower maximum allowed FAR. Nevertheless, an essential change in regulation is observed towards 2019. The maximum FAR is reduced for an important part of the territory in western communes, particularly in Estación Central and Independencia. Only in the case of Conchalí and in a proportion of Quinta Normal, an increase in the maximum allowed FAR is observed. Height regulation followed a similar pattern; however, no communes have transitioned towards a laxer regulation (Figure 3).

Figure 4 shows the histogram of the maximum allowed FAR and height for the pooled sample of used housing transactions –as a proxy of land transactions– of the twelve municipalities in analysis that will be used on the following regressions. Regarding FAR, it is observed that values with the highest density range from 1 to 1,5. Furthermore, it is striking that there is a relevant concentration of values in the range between 12,5 and 13. On the other side, the maximum allowed height concentrates its values with the highest density in the range between 10 to 15 meters.

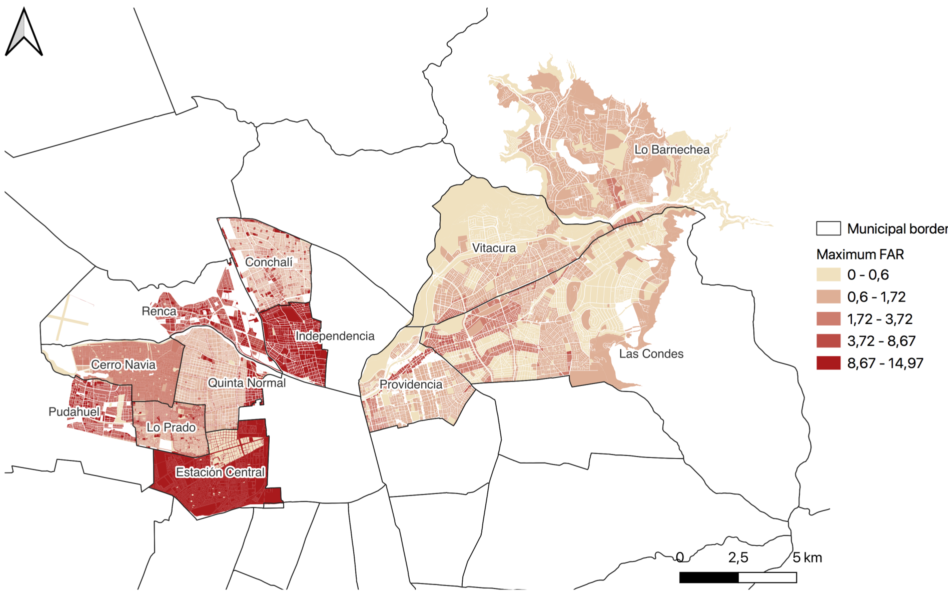
Finally, Table 1 presents the main statistics of the sample, separated by municipality. As the previous maps showed, urban regulation tends to be more restrictive in north-eastern communes. Las Condes, Vitacura, and Lo Barnechea have an average maximum allowed FAR lower than one. In addition, those municipalities have an average maximum permitted height lower than 15 meters. On the contrary, Independencia, Renca, and Estación Central present an average FAR between seven and nine, while its maximum allowed height reaches an average of 100, 8,2, and 68 meters, respectively. Despite being located west of the city, Quinta Normal, Conchalí, Lo Prado, and Cerro Navia have relatively strict regulations, but they are laxer than high-income communes.

Additionally, as expected, north-eastern municipalities experience higher value transactions. Average prices per square meter of land in north-eastern communes are double or even quadruple than those in western communes. Vitacura is the one with the highest average price, of 25,6 UF per square meter, equivalent to 957,44 USD. On the other side, Cerro Navia has the lowest value, of 6,36 UF or 237,86 USD.[10]

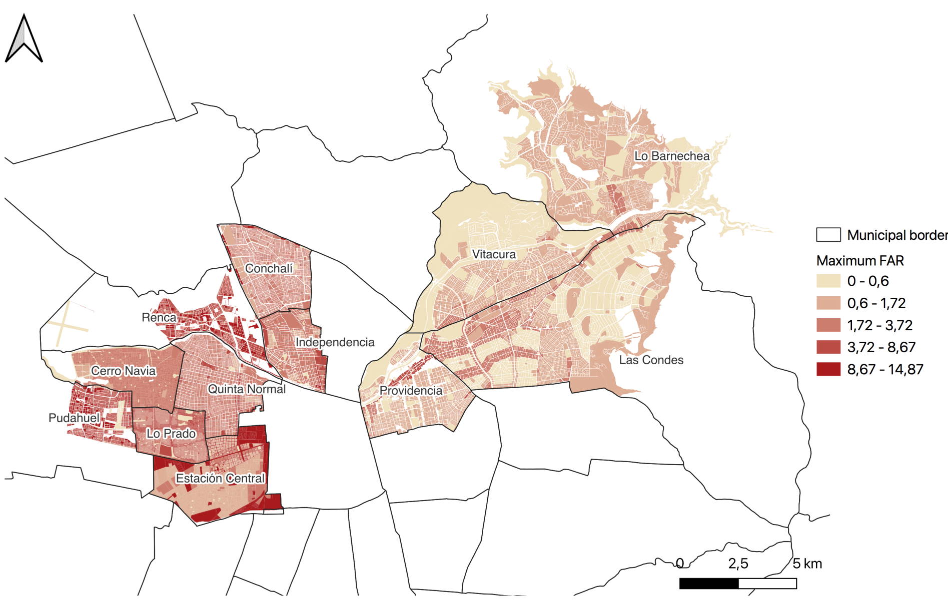
[10] Calculation based on the 2021 monthly average UF value until October, of 29.611 CLP or 37,4 USD.

Figure 2: Maximum allowed FAR 1997 - 2019

(a) FAR 1997



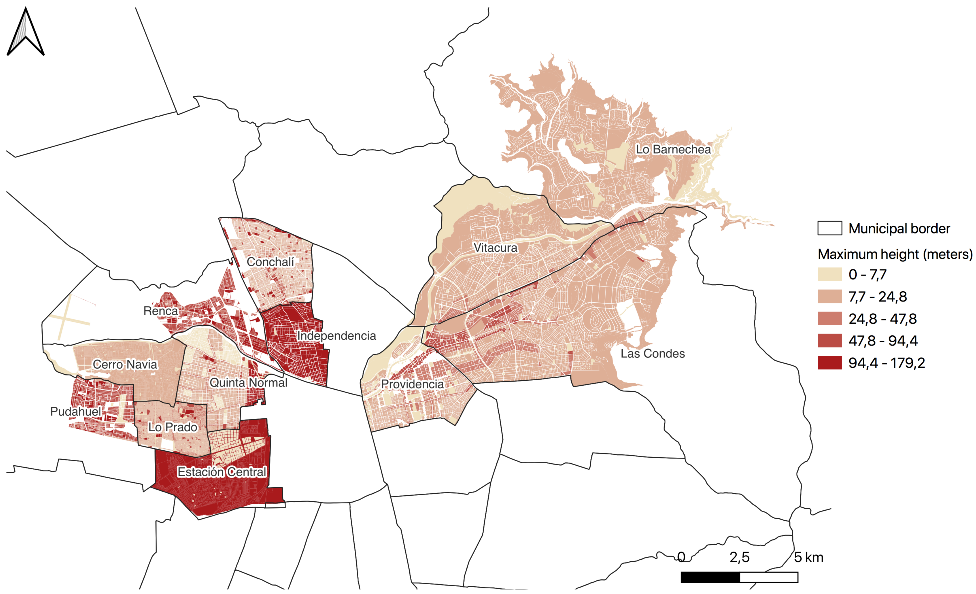
(b) FAR 2019



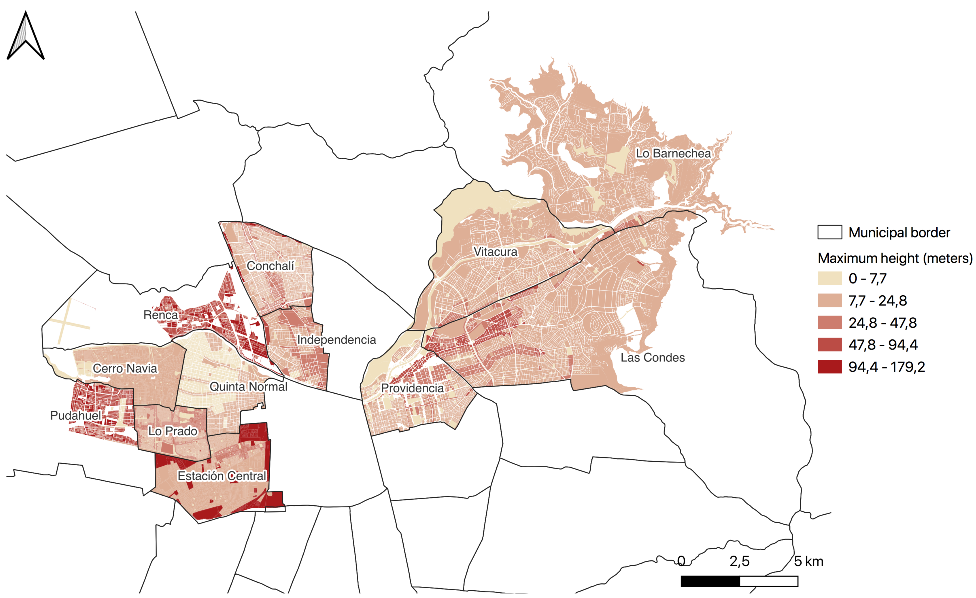
Notes: own elaboration using the regulation database. Only maximum FAR values lower than 15 are considered.

Figure 3: Maximum allowed height 1997 - 2019

(a) Height 1997



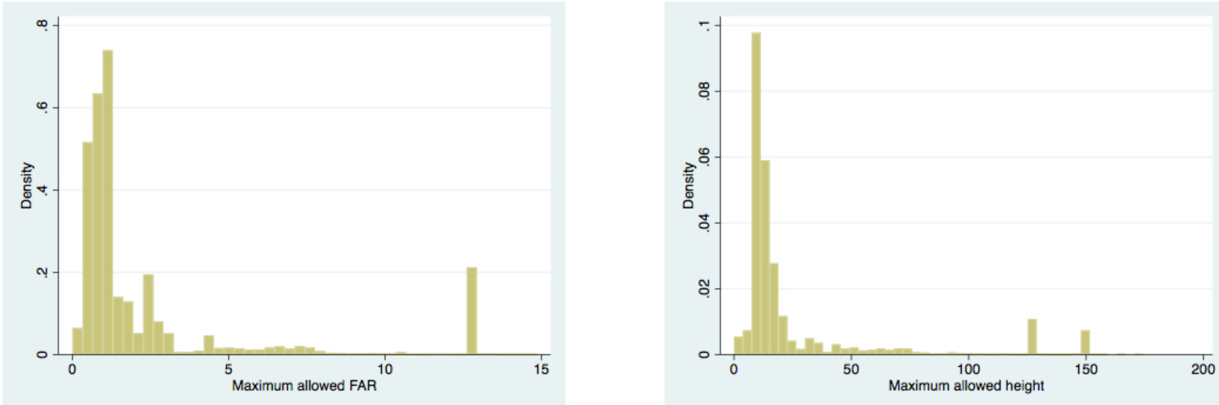
(b) Height 2019



Notes: own elaboration using the regulation database. Only maximum height values lower than 180 meters are considered.

Figure 4: Histogram of maximum FAR and height allowed

(a) FAR **(b)** Height



Notes: own elaboration.

Table 1: Descriptive statistics

Variable	Obs	Mean	Std Dev	Min	Max
Independencia					
Maximum FAR	1.993	8,79	5,31	1,00	12,92
Maximum Height (meters)	1.993	100,31	65,28	7,20	151,20
Transaction price (UF)	2.036	1.690,65	1.227,95	500,00	13.669,00
Land area (sq meters)	1.962	190,42	108,21	24,00	1.444,00
Price per sq meter (UF)	1.962	10,13	6,23	1,49	58,66
Quinta Normal					
Maximum FAR	2.667	1,46	1,28	0,00	10,63
Maximum Height (meters)	2.677	17,27	17,12	0,00	126,00
Transaction price	2.808	1.443,48	971,59	325,00	14.500,00
Land area (sq meters)	2.736	248,35	170,18	36,00	1.750,00
Price per sq meter (UF)	2.736	7,16	4,55	0,43	59,24
Pudahuel					
Maximum FAR	2.335	5,82	2,89	0,00	20,67
Maximum Height (meters)	2.335	57,07	28,34	0,00	202,68
Transaction price (UF)	7.986	1.473,03	1.170,25	325,00	16.750,00
Land area (sq meters)	7.491	191,64	2.001,70	8,00	100.000,00
Price per sq meter (UF)	7.491	10,79	8,77	0,02	296,88
Renca					
Maximum FAR	1.662	8,30	5,45	0,77	34,74
Maximum Height (meters)	1.662	82,35	51,81	7,31	356,24
Transaction price (UF)	3.702	1.077,84	599,08	418,00	9.675,00
Land area (sq meters)	3.529	150,67	136,23	33,00	4.521,00
Price per sq meter (UF)	3.529	8,92	5,22	0,45	45,19
Conchalí					
Maximum FAR	2.706	1,67	0,93	0,00	20,78
Maximum Height (meters)	2.706	16,11	9,46	0,00	196,98
Transaction price (UF)	3.331	1.218,42	667,95	325,00	8.800,00
Land area (sq meters)	3.301	194,45	87,92	42,00	1.600,00
Price per sq meter (UF)	3.301	6,70	3,50	0,79	43,21
Lo Prado					
Maximum FAR	1.936	2,90	1,28	0,00	12,92
Maximum Height (meters)	1.936	18,74	9,63	0,00	126,00
Transaction price (UF)	1.936	1.280,69	812,10	372,00	13.320,00
Land area (sq meters)	1.878	188,48	70,61	40,00	919,00
Price per sq meter (UF)	1.878	7,28	4,79	0,84	82,22
Cerro Navia					
Maximum FAR	2.766	2,50	0,36	0,00	5,00
Maximum Height (meters)	2.766	17,75	2,78	0,00	36,51
Transaction price (UF)	2.766	945,74	695,07	325,00	28.731,00
Land area (sq meters)	2.748	169,31	88,47	53,00	2.424,00

Price per sq meter (UF)	2.748	6,36	5,48	0,53	224,46
Estación Central					
Maximum FAR	3.400	7,15	6,13	0,00	24,07
Maximum Height (meters)	3.400	68,48	59,70	0,00	236,05
Transaction price (UF)	3.400	1.421,49	997,62	372,00	29.100,00
Land area (sq meters)	3.359	169,42	84,46	36,00	1.083,00
Price per sq meter (UF)	3.359	9,52	7,84	1,29	279,81
Providencia					
Maximum FAR	2.010	1,19	0,46	0,00	4,30
Maximum Height (meters)	2.010	16,71	7,78	0,00	53,63
Transaction price	2.085	6.511,47	4.003,08	512,00	29.940,00
Land area (sq meters)	1.984	312,82	175,90	44,00	2.879,00
Price per sq meter (UF)	1.984	23,78	13,78	0,73	83,61
Las Condes					
Maximum FAR	11.427	0,79	0,36	0,00	3,00
Maximum Height (meters)	11.247	12,49	6,70	0,00	52,50
Transaction price	12.103	8.532,65	7.183,63	404,00	269.573,00
Land area (sq meters)	11.517	462,65	626,71	50,00	25.242,00
Price per sq meter (UF)	11.517	21,78	19,28	0,13	1.489,35
Vitacura					
Maximum FAR	5.238	0,81	0,27	0,00	2,80
Maximum Height (meters)	5.238	10,52	4,95	0,00	53,08
Transaction price	5.238	10.989,50	8.489,65	405,00	150.000,00
Land area (sq meters)	5.050	552,03	766,70	84,00	10.806,00
Price per sq meter (UF)	5.050	25,56	13,96	0,08	169,04
Lo Barnechea					
Maximum FAR	6.407	0,97	0,19	0,00	2,00
Maximum Height (meters)	6.407	13,59	2,03	0,00	35,00
Transaction price	7.145	13.213,00	64.083,00	441,00	5.4e+06
Land area (sq meters)	6.028	946,78	2.332,05	42,00	108.197,00
Price per sq meter (UF)	6.028	23,52	238,10	0,04	18.464,71

4 Results

4.1 Main results

This section shows the main results for different specifications that account for the elasticity of property prices and urban regulatory variables. Tables 2 and 3 show the average stringency regressions for FAR and height, respectively, considering the twelve municipalities under analysis. The regression in column (1) in both tables constitutes the rough estimate, including fixed-effects at year and municipality-level. The regression in column (2) includes controls of the building on the land, particularly an index of quality and the year of construction. Both for the case of the FAR and height, I find coefficients near zero that are not statistically significant.

To mitigate the bias derived from unobservable variables that correlate with regulation and prices and that are common within certain geographic areas, in columns (3) to (6), I include fixed effects at the Census district, Census tract, and block level. Although the coefficients are reduced in magnitude, they are still not statistically different from zero. These results indicate that regulation, on average, is not binding on the twelve municipalities on analysis in the Greater Santiago area. That is, land-use characteristics do not diverge from free-market levels.

Table 2: FAR average stringency regressions

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
lnFAR	0.0607	0.0660	0.0248	0.00217	0.00348	0.00794
	(0.0527)	(0.0542)	(0.0396)	(0.0258)	(0.0254)	(0.0241)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes				
Census district FE			Yes			
Census tract FE				Yes		
Census block FE					Yes	
SII block FE						Yes
Housing controls		Yes	Yes	Yes	Yes	Yes
Number of fixed-effects groups	12	12	101	334	5,713	6,320
Observations	41,424	41,424	39,283	39,282	37,937	39,804
R-squared	0.143	0.176	0.176	0.187	0.205	0.211

Notes: The dependent variable is the ln of the price per square meter of land. All regressions include an intercept (not shown). Clustered standard errors by municipality in parentheses.***p<0.01, **p<0.05, *p<0.1.

Table 3: Height average stringency regressions

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
lnHeight	0.0264	0.0275	-0.00684	0.00225	0.00945	0.0145
	(0.0451)	(0.0410)	(0.0307)	(0.0219)	(0.0221)	(0.0204)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes				
Census district FE			Yes			
Census tract FE				Yes		
Census block FE					Yes	
SII block FE						Yes
Housing controls		Yes	Yes	Yes	Yes	Yes
Number of fixed-effects groups	12	12	101	334	5,713	6,320
Observations	41,424	41,424	39,283	39,282	37,937	39,804
R-squared	0.518	0.536	0.588	0.627	0.710	0.726

Notes: The dependent variable is the ln of the price per square meter of land. All regressions include an intercept (not shown). Clustered standard errors by municipality in parentheses.***p<0.01, **p<0.05, *p<0.1.

The next tables extend the analysis to account for elasticity heterogeneities within the city for FAR and height. Table 4 includes distance to central business districts (CBD). To define the CBD, I use twelve geographical points that concentrate an essential part of the commercial activity in Santiago, which are located between

Santiago Centro, Providencia, and Las Condes (Appendix 3). Columns (1) and (5) include the continuous variable of distance to CBD and the interaction between that variable and ln FAR, using municipality, Census district, Census tract, and block-level fixed-effects. As can be seen, neither the coefficient of ln FAR nor the interaction is statistically significant. Table 5 shows the same models but uses height as the regulatory variable of interest. As in the FAR case, neither the coefficient of ln height nor the interaction is statistically significant.

These results contrast those of the USA. As Brueckner and Singh (2020) show, in the case of New York, Chicago, and Boston, stringency declines with distance to the CBD. According to the authors, this could be interpreted as there is greater stringency in those areas where the buildings are already tall. On the other side, Washington D.C., has a distance-FAR interaction coefficient that is not statistically significant. This result is intuitive considering that the distribution of jobs is rather homogeneous within the city (Brueckner and Singh, 2020). Although the results in the case of Chile are similar to those in Washington D.C., they represent very different contexts. In fact, in the Greater Santiago area, firms are highly concentrated in the three communes where the CBD is located: Santiago, Providencia, and Las Condes (BCN, 2019), while public employment is mainly located in Santiago. In that sense, my results indicate that stringency is homogeneous regardless of the accessibility to jobs.

Table 4: FAR within city stringency regressions: distance to CBD

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5
lnFAR	-0.0669	-0.128	0.00727	-0.00412	-0.00233
	(0.106)	(0.116)	(0.0367)	(0.0276)	(0.0276)
Distance to CBD	-0.0369***	-0.0554**	0.0413	0.0332	0.0289
	(0.0101)	(0.0247)	(0.0250)	(0.0319)	(0.0173)
lnFAR * Distance to CBD	0.0230	0.0273	-0.000927	0.00145	0.00198
	(0.0219)	(0.0234)	(0.00788)	(0.00591)	(0.00590)
Year FE	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes				
Census district FE		Yes			
Census tract FE			Yes		
Census block FE				Yes	
SII block FE					Yes
Number of fixed-effects groups	12	101	334	5,713	6,320
Observations	41,424	39,283	39,282	37,937	39,804
R-squared	0.543	0.592	0.628	0.710	0.726

Notes: The dependent variable is the ln of the price per square meter of land. All regressions include an intercept (not shown) and housing controls. Clustered standard errors by municipality in parentheses.***p<0.01, **p<0.05, *p<0.1.

Table 5: Height within city stringency regressions: distance to CBD

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5
lnHeight	-0.0171	-0.0605	-0.00133	-0.00570	-0.0127
	(0.0880)	(0.0678)	(0.0318)	(0.0209)	(0.0217)
Distance to CBD	-0.0574	-0.0869**	0.0390	0.0259	0.0172
	(0.0478)	(0.0280)	(0.0307)	(0.0339)	(0.0226)
lnHeight * Distance to CBD	0.00734	0.0104	0.000842	0.00307	0.00558
	(0.0173)	(0.0139)	(0.00741)	(0.00512)	(0.00430)
Year FE	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes				
Census district FE		Yes			
Census tract FE			Yes		
Census block FE				Yes	
SII block FE					Yes
Number of fixed-effects groups	12	101	334	5,713	6,320
Observations	41,424	39,283	39,282	37,937	39,804
R-squared	0.541	0.590	0.628	0.710	0.726

Notes: The dependent variable is the ln of the price per square meter of land. All regressions include an intercept (not shown) and housing controls. Clustered standard errors by municipality in parentheses.***p<0.01, **p<0.05, *p<0.1.

Tables 6 and 7 include the distance to the nearest metro station and the closest entrance to a highway and the interaction between those variables with the regulatory variables, for the case of FAR and height, respectively. In both tables, the first three columns include distance to the nearest subway with different geographical levels as fixed-effects, and the last three columns include the distance to the nearest highway access.

Neither for the case of FAR or height, the interaction with the distance to the subway is statistically significant. When the distance to the highway is analyzed, results show that the interaction is positive and statistically significant when municipality and Census district-level fixed-effects are used (in the case of FAR, it loses the statistical significance with the inclusion of Census tract-level fixed-effects). Although small in magnitude, this result indicates that regulation is looser near highways, which is intuitive considering the better accessibility in those areas.

Table 6: FAR within city stringency regressions: subway and highway distance

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
lnFAR	-0.0114	-0.0777	-0.0202	-0.00408	-0.0543	-0.0204
	(0.0610)	(0.0577)	(0.0322)	(0.0443)	(0.0451)	(0.0301)
Distance to subway	-0.0329	-0.0257	0.00418			
	(0.0189)	(0.0216)	(0.0235)			
lnFAR * Distance to subway	0.0351	0.0517	0.0130			
	(0.0364)	(0.0320)	(0.0147)			
Distance to highway				-0.00335	-0.0228	0.0691
				(0.0204)	(0.0189)	(0.0455)
lnFAR * Distance to highway				0.0473*	0.0535	0.0153
				(0.0230)	(0.0326)	(0.0118)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes			Yes		
Census district FE		Yes			Yes	
Census tract FE			Yes			Yes
Number of fixed-effects groups	12	101	334	12	101	334
Observations	41,424	39,283	39,282	41,424	39,283	39,282
R-squared	0.542	0.592	0.627	0.539	0.589	0.628

Notes: The dependent variable is the ln of the price per square meter of land. All regressions include an intercept (not shown) and housing controls. Clustered standard errors by municipality in parentheses.***p<0.01, **p<0.05, *p<0.1.

Table 7: Height within city stringency regressions: subway and highway distance

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
lnHeight	0.00598	-0.0507	-0.00783	-0.0434	-0.0681	-0.0197
	(0.0782)	(0.0639)	(0.0326)	(0.0333)	(0.0421)	(0.0259)
Distance to subway	-0.0561	-0.0958	-0.0132			
	(0.103)	(0.0755)	(0.0397)			
lnHeight * Distance to subway	0.00701	0.0222	0.00594			
	(0.0416)	(0.0336)	(0.0168)			
Distance to highway				-0.143**	-0.144**	0.0284
				(0.0541)	(0.0518)	(0.0651)
lnHeight * Distance to highway				0.0535**	0.0458**	0.0154
				(0.0202)	(0.0196)	(0.0115)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes			Yes		
Census district FE		Yes			Yes	
Census tract FE			Yes			Yes
Number of fixed-effects groups	12	101	334	12	101	334
Observations	41,424	39,283	39,282	41,424	39,283	39,282
R-squared	0.539	0.589	0.627	0.538	0.589	0.628

Notes: The dependent variable is the ln of the price per square meter of land. All regressions include an intercept (not shown) and housing controls. Clustered standard errors by municipality in parentheses.***p<0.01, **p<0.05, *p<0.1.

Table 8 includes an interaction of the ln of FAR and height with socioeconomic variables, using municipality and district-level fixed-effects. Unlike the case of Brueckner and Singh (2020), who use the median income at the zip-code level, I use socioeconomic quintiles based on information from the 2002 Census. In particular, I generate quintiles based on the mean socioeconomic decile of the household per Census block, using the sample of used housing transactions of the 12 municipalities on analysis, as in the previous regressions. Although the ideal would be to use a socioeconomic variable with greater variability, such as Brueckner and Singh (2020) do, the Census does not provide income information. Additionally, other sources, such as the Casen survey, are not representative at a disaggregated territorial level.

As can be seen, only the interaction with the fifth socioeconomic quintile is statistically significant, both for the case of FAR and height. The positive coefficient indicates that regulation in those blocks is stringent compared to blocks of the third quintile, the omitted category. These results are contrary to those found by Brueckner and Singh (2020), which indicate that higher-income neighborhoods have FAR values closer to the free-market level. According to the authors, neighborhood income could be a proxy of the area's amenities, which results in high demand for such locations and a looser regulation. Nevertheless, a branch of literature has developed the "Homevoter Theory", which states that homeowners influence land-use decisions pushing for stricter regulation to maximize the value of their properties (Fischel, 2009; Been et al., 2014). In that sense, the higher stringency in higher-income blocks could be reflecting political pressures of residents that seek to maintain the amenities in the area.

Table 8: FAR and height within-city stringency regressions: block socioeconomic level 2002

VARIABLES	FAR		Height	
	(1)	(2)	(3)	(4)
	Model 1	Model 2	Model 3	Model 4
lnFAR/lnHeight	0.0301	0.0113	-0.00801	-0.0180
	(0.0411)	(0.0388)	(0.0303)	(0.0308)
lnFAR/lnHeight * Dummy for 1st quintile	-0.130	-0.131	-0.0705	-0.0839
	(0.0804)	(0.0835)	(0.0632)	(0.0664)
lnFAR/lnHeight * Dummy for 2nd quintile	-0.0380	-0.0212	-0.0155	-0.00381
	(0.0249)	(0.0262)	(0.0167)	(0.0179)
lnFAR/lnHeight * Dummy for 4th quintile	0.0527	0.0507	0.0361	0.0340
	(0.0644)	(0.0501)	(0.0405)	(0.0370)
lnFAR/lnHeight * Dummy for 5th quintile	0.192***	0.141**	0.189***	0.103*
	(0.0564)	(0.0457)	(0.0294)	(0.0527)
Dummies for quintiles	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Municipality FE	Yes		Yes	
Census district FE		Yes		Yes
Number of fixed-effects groups	12	101	12	101
Observations	39,285	39,283	39,285	39,283
R-squared	0.560	0.595	0.557	0.593

Notes: The dependent variable is the ln of the price per square meter of land. All regressions include an intercept (not shown) and housing controls. Clustered standard errors by municipality in parentheses.***p<0.01, **p<0.05, *p<0.1.

Finally, in Table 9 and 10, I include an interaction of the ln FAR and height with the basal FAR and height of the lot where the property is located. In particular, I generate a variable that shows the quintile of both variables in 1997, using the sample of used housing transactions of the 12 municipalities in analysis, as in the previous regressions. Table 9 shows the case of FAR. As can be observed, both the first and last interaction coefficients are statistically significant. Even so, the coefficient of the first quintile is much higher, except when SII block-level fixed-effects are used. The effect of the last quintile is near zero in most specifications. On the other hand, when basal height is analyzed (Table 10), I also find a higher effect of the first quintile, but only significant when block-level fixed-effects are used. This indicates that stringency is higher in those sectors where the regulatory variables were initially stricter, although the effect is small in magnitude.

Table 9: FAR within-city stringency regressions: basal FAR

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5
lnFAR	-0.101**	-0.146**	-0.137**	-0.191***	-0.178***
	(0.0358)	(0.0476)	(0.0556)	(0.0548)	(0.0515)
lnFAR * Dummy for 1st quintile	0.647***	0.664***	0.349***	0.304***	0.230*
	(0.188)	(0.0834)	(0.0868)	(0.0800)	(0.111)
lnFAR * Dummy for 2nd quintile	-0.0252	-0.0168	-0.0298	-0.0125	-0.0238
	(0.0647)	(0.0491)	(0.0471)	(0.0409)	(0.0476)
lnFAR * Dummy for 4th quintile	-0.112	-0.0310	-0.00321	-0.0377	-0.0550
	(0.0745)	(0.0683)	(0.0609)	(0.0340)	(0.0319)
lnFAR * Dummy for 5th quintile	0.103*	0.144*	0.142*	0.209**	0.205***
	(0.0550)	(0.0656)	(0.0702)	(0.0694)	(0.0643)
Dummies for quintiles	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes				
Census district FE		Yes			
Census tract FE			Yes		
Census block FE				Yes	
SII block FE					Yes
Number of fixed-effects groups	12	101	334	5,713	6,320
Observations	41,424	39,283	39,282	37,937	39,804
R-squared	0.549	0.595	0.629	0.711	0.727

Notes: The dependent variable is the ln of the price per square meter of land. All regressions include an intercept (not shown) and housing controls. Clustered standard errors by municipality in parentheses.***p<0.01, **p<0.05, *p<0.1.

Table 10: Height within-city stringency regressions: basal Height

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5
lnHeight	-0.351*	-0.221	-0.181	-0.169**	-0.134
	(0.178)	(0.138)	(0.131)	(0.0606)	(0.0762)
lnHeight * 1st quintile	0.0591	-0.0336	0.192	0.274**	0.238*
	(0.235)	(0.220)	(0.137)	(0.119)	(0.123)
lnHeight * 2nd quintile	0.225	0.114	0.117	-0.0140	-0.0196
	(0.167)	(0.128)	(0.112)	(0.0667)	(0.0704)
lnHeight * 4th quintile	0.517**	0.216	0.198	0.00556	-0.0139
	(0.233)	(0.190)	(0.149)	(0.0558)	(0.0728)
lnHeight * 5th quintile	0.357*	0.224	0.189	0.187**	0.160*
	(0.181)	(0.142)	(0.134)	(0.0653)	(0.0799)
Year FE	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes				
Census district FE		Yes			
Census tract FE			Yes		
Census block FE				Yes	
SII block FE					Yes
Number of fixed-effects groups	12	101	334	5,713	6,320
Observations	41,424	39,283	39,282	37,937	39,804
R-squared	0.542	0.589	0.628	0.710	0.727

Notes: The dependent variable is the ln of the price per square meter of land. All regressions include an intercept (not shown) and housing controls. Clustered standard errors by municipality in parentheses.***p<0.01, **p<0.05, *p<0.1.

4.2 Robustness

As a robustness check, I restrict the sample to municipalities with real estate interest. In particular, I select municipalities within the group of communes that in 2019 concentrated the 80 percent of units and the 87 percent of UF of total apartment sales (TocToc, 2020b). Thus, the municipalities in analysis are the following: Estación Central, Independencia, Las Condes, Lo Barnechea, Providencia, Quinta Normal, and Vitacura; which consists of 34,790 transactions linked to a regulated polygon. The intuition of restricting the sample to municipalities with real estate interest is that elasticity should better reflect stringency, since these lands are more valued for densification.

Tables A6.1 and A6.2 shows the results for the average elasticity of property prices and regulatory variables. As in the previous models, I use different geographical area fixed-effects, to account for possible endogeneity. The regression in column (1) in both tables constitutes the rough estimate, including fixed-effects at year and municipality-level. The FAR coefficient is 0,134, significant at 95 percent confidence level, which indicates that an increase in FAR–i.e., a looser regulation–leads to higher property prices. In particular, it means that a 10 percent increase in FAR leads to a 1,34 percent increase in prices. The regression in column (2) includes controls of the building on the land, particularly an index of quality and the year of construction, and the FAR coefficient is slightly higher. On the other hand, the height coefficient is near zero, only statistically significant when housing controls are included.

The last three columns include geographical area-level fixed-effects at a more disaggregated level to overcome possible endogeneity caused by unobservable variables that are common within regions. In the case of FAR, the coefficient is reduced and reaches a value closer to zero –statistically significant at conventional levels– when block fixed-effects are used. A similar pattern is observed for the case of height. The low magnitude of these coefficients indicates that the average regulation in municipalities with real estate interest in Santiago is looser. That is, land-use characteristics do not diverge from free-market levels, which confirms the previous results.

Tables A6.3 and A6.4 shows the interaction between ln FAR or height with the distance to the CBD. As in the previous models, different types of area-level fixed-effects are included. The interaction coefficient gains statistically significance when Census district and block-level fixed-effects are used. However, results are still very close to zero.

Tables A6.5 and A6.6 shows the interaction between ln FAR or height with the distance to the subway and highway. The interaction with the distance to the subway remains non-significant. Even so, in the FAR case, it gains significance when Census tract-level fixed-effects are included. Regarding the interaction with the distance to the highway, results are statistically significant when municipality-level fixed-effects are used. In the case of height, the coefficient is also significant when Census tract-level fixed-effects are included. Despite this, similarly to the CBD case, all interaction coefficients are near zero.

In that sense, the results of the previous analyzes are reinforced. The stringency tends to be homogeneous within the city, regardless of the accessibility to jobs, measured by the distance to the CBD, the subway and highways.

5 Discussion and conclusion

The excessive growth in housing prices is a public concern problem studied from various angles. A strand of literature points to urban regulation as one of the determinants. Theoretically, if there is a stricter regulation, the value of the regulated lot should be reduced since its potential for densification is shortened. Therefore, the supply of land available for densification is also reduced, which pressures housing prices to grow.

This work studies the stringency of urban regulation on property prices. In particular, I explore the elasticity of the maximum allowed floor-area ratio (FAR) and height on property prices, using the price per square meter of the land of used housing transactions, intending to have a sample similar to land transactions. I restrict the analysis to twelve municipalities in the Greater Santiago area.

A high stringency implies that regulation moves away from free-market levels. Thus, the measure of stringency accounts for which sectors have restrictions that could reduce new housing development, pushing housing prices up. Results show that the average stringency of the municipalities in the analysis is not statistically different from zero, both for the case of FAR and height. These results are maintained with other specifications that include various types of fixed-effects at the territorial level.

Additionally, I do not find the elasticity varies with the distance to the CBD or with the distance to the nearest subway, neither with the case of FAR nor height. This result implies that stringency is relatively homogeneous in areas regardless of accessibility to jobs. When the distance to the near highway entrance is analyzed, I find a positive and statistically significant coefficient that, although small in magnitude, represents a lower stringency near highways. Considering that a looser regulation is desirable in sectors with greater accessibility, these results are intuitive. In other specifications, I analyze the stringency heterogeneity given by the socioeconomic characteristics of the neighborhood, using socioeconomic quintiles at the block level. Results are not statistically significant for most quintiles, but a positive and significant coefficient is observed for the 5th quintile. This result indicates that there is a greater stringency in higher-income sectors, which could be attributed to political pressures. Finally, I analyze the stringency heterogeneity given by the baseline regulatory variables. I find a positive and statistically significant coefficient for the first quintile, i.e., for those whose regulation was initially stricter, but small in magnitude.

However, these results should be interpreted with caution. The main limitation of this work is the lack of data on land transaction prices. Instead, as previously stated, I use the price per square meter of the land of used housing transaction prices, assuming that these properties constitute potential lots for densification. It should be noted that there are other unobservable variables by which real estate companies select the land to be densified. Therefore, it is necessary to update this study using only transactions associated with densification projects, which represent a subsample of the actual data.

A second limitation is that the regulatory variables, as the maximum allowed FAR, height, density, and occupancy, act in an interrelated manner, also depending on the characteristics of the land. One way to study how strict the regulation is on a determined lot is to analyze the average surface per housing unit, which is calculated using the maximum allowed FAR and density established on the Communal Regulatory Plan (PRC). Thus, the same FAR coefficient could be more or less strict depending also on the regulated density in the respective zone.[11] Another index that can be used is the maximum projected volume, which depends on the maximum height, FAR, occupancy, and density, among other variables.[12] In that sense, a more significant variation in prices could be observed using an index that integrates all the regulatory parameters.

Finally, my regulation sample includes only twelve municipalities in the Greater Santiago area. Indeed, there are many communes of real estate interest that are not included in the selection. In particular, La Florida, La Reina, Macul, Ñuñoa, Recoleta, San Joaquin, San Miguel, and Santiago Centro.[13] It is essential to incorporate more municipalities into the analysis to obtain more accurate conclusions.

Despite this, some policy implications should be considered. In particular, my results show heterogeneities within the city since the stringency is higher in neighborhoods of high socioeconomic status. Thus, relaxing urban regulation in these sectors, which are those of higher amenities, could raise the value of the lot and lead to a greater availability of land for densification. However, this work does not study the externalities of densification, which must also be taken into account when planning looser regulations.

Finally, more research is needed to fully understand the impact of urban regulation on land prices and new housing supply within the city. Quantifying the effects proposed by Turner et al. (2014) is essential to determine if regulation is indeed one of the determinants of excessive price increases.

[11] It is important to mention, in addition, that many times the FAR established in the PRC does not adjust to the average surface that is demanded in a certain area. Therefore, in those cases, real estate companies tend to use a lower parameter than the established one, which could also bias the results.

[12] One methodology is the one proposed by "Ciudad con Todos," available at `https://politicaspublicas.uc.cl/wp-content//uploads/2020/10/Informe_construyetuciudad1.pdf`

[13] These municipalities are part of the group that concentrates the 87 percent of UF total sales on apartments in 2019 (TocToc, 2020a).

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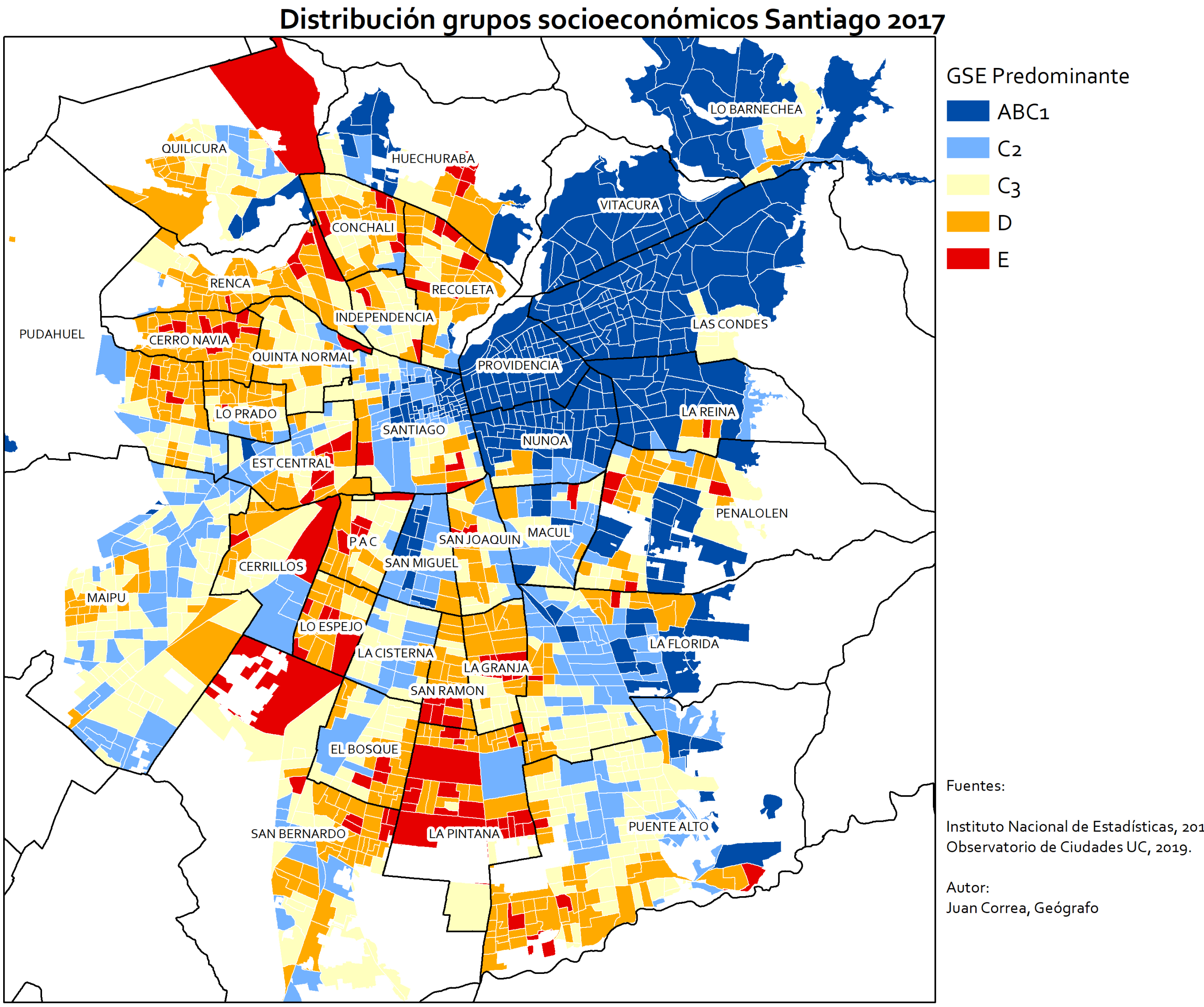
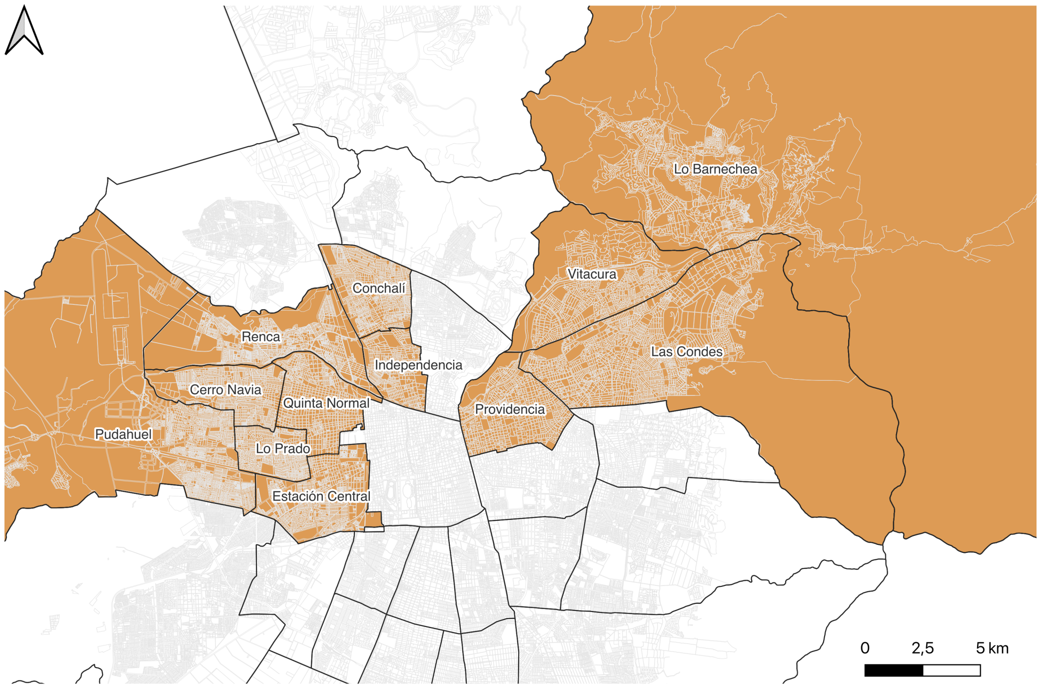
Appendix

Appendix 1: Socioeconomic distribution Santiago 2017



Source: Correa, 2019.

Appendix 2: Municipalities in the analysis



Source: own elaboration.

Appendix 3: Santiago's CBD

Source: own elaboration.

Appendix 4: Santiago's metro network

Source: own elaboration

Appendix 5: Santiago's highways

Source: own elaboration

Appendix 6: Robustness tables

Table A6.1: FAR average stringency regressions: municipalities with real estate interest

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
lnFAR	0.134**	0.139*	0.0888**	0.0498***	0.0432**	0.0394*
	(0.0540)	(0.0579)	(0.0359)	(0.0125)	(0.0154)	(0.0184)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes				
Census district FE			Yes			
Census tract FE				Yes		
Census block FE					Yes	
SII block FE						Yes
Housing controls		Yes	Yes	Yes	Yes	Yes
Observations	30,646	30,646	28,685	28,684	28,194	30,078
R-squared	0.418	0.444	0.505	0.550	0.635	0.653

Notes: The dependent variable is the ln of the price per square meter of land. All regressions include an intercept (not shown). Clustered standard errors by municipality in parentheses.***p<0.01, **p<0.05, *p<0.1.

Table A6.2: Height average stringency regressions: municipalities with real estate interest

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
lnHeight	0.0806	0.0774*	0.0376	0.0387**	0.0406*	0.0367
	(0.0421)	(0.0375)	(0.0219)	(0.0120)	(0.0168)	(0.0193)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes				
Census district FE			Yes			
Census tract FE				Yes		
Census block FE					Yes	
SII block FE						Yes
Housing controls		Yes	Yes	Yes	Yes	Yes
Observations	30,646	30,646	28,685	28,684	28,194	30,078
R-squared	0.413	0.438	0.503	0.550	0.635	0.653

Notes: The dependent variable is the ln of the price per square meter of land. All regressions include an intercept (not shown). Clustered standard errors by municipality in parentheses.***p<0.01, **p<0.05, *p<0.1.

Table A6.3: FAR within city stringency regressions: distance to CBD. Municipalities with real estate interest

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5
lnFAR	-0.0394	-0.124	0.00916	-0.00716	0.00378
	(0.114)	(0.118)	(0.0187)	(0.0224)	(0.0213)
Distance to CBD	-0.0364**	-0.0545	0.0422	0.0373	0.0450**
	(0.0102)	(0.0335)	(0.0277)	(0.0408)	(0.0125)
lnFAR * Distance to CBD	0.0330	0.0406	0.00823*	0.00968**	0.00698
	(0.0253)	(0.0266)	(0.00394)	(0.00358)	(0.00363)
Year FE	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes				
Census district FE		Yes			
Census tract FE			Yes		
Census block FE				Yes	
SII block FE					Yes
Observations	30,646	28,685	28,684	28,194	30,078
R-squared	0.455	0.513	0.551	0.636	0.653

Notes: The dependent variable is the ln of the price per square meter of land. All regressions include an intercept (not shown) and housing controls. Clustered standard errors by municipality in parentheses.***p<0.01, **p<0.05, *p<0.1.

Table A6.4: Height within city stringency regressions: distance to CBD. Municipalities with real estate interest

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5
lnHeight	-0.0188	-0.0710	-0.00465	-0.0162	-0.00421
	(0.0967)	(0.0760)	(0.0199)	(0.0202)	(0.0174)
Distance to CBD	-0.0920	-0.127***	0.0175	0.00600	0.0250
	(0.0542)	(0.0256)	(0.0311)	(0.0440)	(0.0183)
lnHeight * Distance to CBD	0.0185	0.0230	0.00934**	0.0117**	0.00854*
	(0.0186)	(0.0156)	(0.00361)	(0.00341)	(0.00357)
Year FE	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes				
Census district FE		Yes			
Census tract FE			Yes		
Census block FE				Yes	
SII block FE					Yes
Observations	30,646	28,685	28,684	28,194	30,078
R-squared	0.447	0.508	0.551	0.636	0.653

Notes: The dependent variable is the ln of the price per square meter of land. All regressions include an intercept (not shown) and housing controls. Clustered standard errors by municipality in parentheses.***p<0.01, **p<0.05, *p<0.1.

Table A6.5: FAR within city stringency regressions: subway and highway distance. Municipalities with real estate interest

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
lnFAR	0.0472	-0.0380	0.0276*	0.0453	0.0133	0.0337**
	(0.0570)	(0.0424)	(0.0139)	(0.0434)	(0.0288)	(0.0116)
Distance to subway	-0.0227	-0.00798	0.0264			
	(0.0293)	(0.0241)	(0.0230)			
lnFAR * Distance to subway	0.0433	0.0681*	0.0169			
	(0.0471)	(0.0300)	(0.0101)			
Distance to highway				0.00218	-0.0227	0.0645
				(0.0205)	(0.0212)	(0.0493)
lnFAR * Distance to highway				0.0617**	0.0496	0.0103
				(0.0231)	(0.0369)	(0.00860)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes			Yes		
Census district FE		Yes			Yes	
Census tract FE			Yes			Yes
Observations	30,646	28,685	28,684	30,646	28,685	28,684
R-squared	0.450	0.512	0.551	0.448	0.507	0.551

Notes: The dependent variable is the ln of the price per square meter of land. All regressions include an intercept (not shown) and housing controls. Clustered standard errors by municipality in parentheses.***p<0.01, **p<0.05, *p<0.1.

Table A6.6: Height within city stringency regressions: subway and highway distance. Municipalities with real estate interest

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5	(6) Model 6
lnHeight	0.0524	-0.0242	0.0279	-0.0149	-0.0168	0.0204
	(0.0991)	(0.0764)	(0.0224)	(0.0331)	(0.0304)	(0.0147)
Distance to subway	-0.0564	-0.117	-0.00158			
	(0.152)	(0.100)	(0.0252)			
lnHeight * Distance to subway	0.00761	0.0336	0.00941			
	(0.0633)	(0.0444)	(0.0101)			
Distance to highway				-0.184***	-0.136**	0.0311
				(0.0402)	(0.0451)	(0.0680)
lnHeight * Distance to highway				0.0700***	0.0409*	0.0125
				(0.0148)	(0.0179)	(0.0105)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes			Yes		
Census district FE		Yes			Yes	
Census tract FE			Yes			Yes
Observations	30,646	28,685	28,684	30,646	28,685	28,684
R-squared	0.442	0.505	0.550	0.442	0.504	0.551

Notes: The dependent variable is the ln of the price per square meter of land. All regressions include an intercept (not shown) and housing controls. Clustered standard errors by municipality in parentheses.***p<0.01, **p<0.05, *p<0.1.