The Role of Housing Supply in Shaping Affordability: A Quasi-experimental Approach*

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Abstract

Accurately estimating housing supply elasticity is crucial for evaluating the effectiveness of housing assistance programs in addressing the growing affordability crisis. However, the lack of quasi-experimental evidence has limited these estimates, hindering policy assessments. This paper addresses this gap by leveraging Chile's 2011 *Subsidio Habitacional* program and administrative data on property transactions from 1998 to 2020. The results imply a housing supply elasticity of 0.543, indicating low responsiveness of the housing supply. In particular, the response of new construction is twice as large as the conversion of rental units into owner-occupied housing, suggesting that supply constraints and low elasticity persist in non-CBD areas, where construction activity is relatively low. Finally, we estimate that the policy increased housing prices by an average of 8.87% in its first 10 years, with substantial variation across neighborhoods. We conclude that subsidizing housing for low- and middle-income households may not be an effective solution to the affordability crisis and may disproportionately benefit developers.

Keywords: Homeownership, affordability, property prices, housing supply.

JEL Classification: D31, H53, I38, R21, R23, R31, R38

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1 Introduction

Housing has become increasingly unaffordable in many cities around the world (UN, 2023).[1] Between 2010 and 2022, real housing prices increased by an average of 27% globally, with some of the highest growth rates observed in Iceland (103%), Estonia (97%), New Zealand (97%), Chile (95%), Turkey (91%), and Canada (90%) (BIS, 2024).[2] Several major cities now exhibit exceptionally high ratios of prices to household income, including Hong Kong (16.7), Sydney (13.8), Vancouver (12.3), San Jose (11.9), and Los Angeles (10.9), rendering them "impossibly unaffordable" for their residents (Cox et al., 2024).

To curb the recent global housing affordability crisis, governments have increasingly responded by subsidizing housing. Common approaches include tax incentives, subsidies that lower annual mortgage payments, homeownership vouchers, tenant-based vouchers, and project-based assistance.[3] Assessing the costs and benefits of these policies requires understanding housing fundamentals, particularly housing supply elasticity.

Measuring housing supply elasticity is challenging due to the difficulty in isolating supply-side from demand-side shifts. Additionally, there is significant variation in supply conditions across cities and neighborhoods, such as supply constraints, topography, and land availability. Recent literature has attempted to identify this elasticity by exploiting long-term labor demand shocks and geographical constraints as instruments for demand (Saiz, 2010; Baum-Snow et al., 2024). However, labor demand shocks may be influenced by local supply factors and supply constraints may correlate with demand, raising concerns about the validity of these instruments (Davidoff, 2016). Due to the lack of quasi=experimental evidence, the identification of housing supply elasticity remains unclear.

This paper addresses the aforementioned challenges of estimating housing supply elasticity by utilizing quasi-experimental variation in the case of Chile's *Subsidio Habitacional* program. Implemented in 2011, this policy was aimed at promoting homeownership among low- and middle-income households. The program enables eligible households to purchase properties up to a certain price cap, while the government provides a voucher to cover part

[1] The UN estimates that 96,000 new affordable homes must be built each day to accommodate the estimated 3 billion people requiring adequate housing by 2030.

[2] The UN reports that the pandemic, along with geopolitical conflicts, increasing land demand, and other factors, has led to a global rise in housing prices, evictions, and housing deficits, making it increasingly difficult for households to afford basic necessities like housing.

[3] Some examples include: for tax incentives, there is the U.S. mortgage interest deduction ($200 billion a year) and the Canadian tax credit for first-time home buyers; for mortgage subsidies, there is the Help-to-Buy program in the United Kingdom; for homeownership vouchers, there are *Mi Casa, Mi Vida* in Brazil (2009), *Subsidio Habitacional* in Chile (2011), and *Mi Casa Ya* in Colombia (2023); for tenant-based vouchers, there are Section 8 in the U.S. and the rental voucher in Chile (2014); and for project-based policies, there is the Low-Income Household Tax Credit in the U.S.

of these costs. Depending on their income, applicants can apply to three different type of vouchers, named Title 0, Title 1, and Title 2. The size of the subsidy is determined by the property price and the voucher type. Over its first 10 years the program allocated 249,163 vouchers, generating a significant demand shock in Chile's housing market. By leveraging detailed administrative data on property transactions and the allocation of the subsidy, this study offers an identification strategy to estimates the housing supply elasticity.

Thus, this paper seeks to answer a central question: what is the short-term response of the housing supply to demand shocks? Relatedly, the paper also explores: (1) how fast do new constructions respond to an increase in prices? (2) how fast do rental units convert to homeownership when there is an increase in demand for owner-occupied housing? and (3) what is the effect of the homeownership voucher program on Chilean housing prices?

To implement the empirical analysis, we linked detailed information on 1,026,123 applicants and recipients of the voucher with novel administrative data of property transactions in Santiago de Chile from 1998 to 2020. Both datasets are georeferenced, so we linked them at the Census Zone (CZ) level.[4] The resulting dataset provides comprehensive insights into the housing market in Santiago, including the residential location of voucher applicants and the evolution of prices and transactions at the local level over time. Figure B.1a shows a map with a random sample of geolocated property transactions and the number of voucher recipients by CZ. Figure B.1b shows the spatial correlation between transactions and the housing quality at the neighborhood level (measured by the ISMT index).[5] These figures suggest that housing supply has grown more in supply-constrained markets (such as the city's downtown) compared to suburban areas, indicating a positive correlation between supply constraints and demand growth.

The challenge in estimating housing supply elasticity is illustrated in Figure 1. Panel (a) shows that in Santiago transactions have been concentrated in the Central Business District (CBD) and high-income areas in the northwest neighborhoods of the city. However, the CZs with the largest price increases are more concentrated in suburban and intermediate regions. Panel (b), on the other hand, suggests that areas with significant price increases have experienced relatively small increases in housing stock, which is indicative of a low elasticity of supply. This leads to the question of how quickly the supply has responded to demand growth across neighborhoods, as well as why some suburban areas show a relatively high increase in prices.

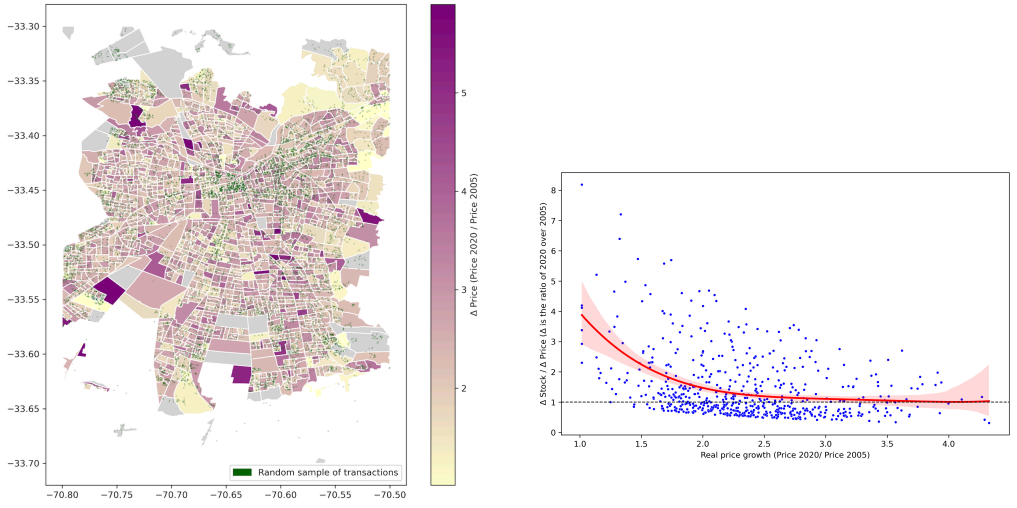
In Section 4, we analyze how the housing supply responds to demand shocks. Using historical transaction data for different types of properties in Santiago, we build an index

[4]The Metropolitan Region of Santiago is divided into 1,865 CZs, each with an average of 3,813 individuals.

[5]As explained in Section 2, the Socio-Territorial Index (ISMT) measures housing quality and socioeconomic conditions.

for local exposure to each voucher type. Additionally, using data on subsidy recipients from 2011 to 2019, we estimate the demand shock at the neighborhood level. These two metrics are then used to construct a shift-share instrument for housing demand. While OLS estimates appear to be biased by a combination of demand-side and supply-side effects, the 2SLS strategy estimates a housing supply elasticity of 0.543. This result is robust across other price measures, such as price per square foot and estimated appraisal value, with elasticities of 0.85 and 0.328, respectively. All measures are below 1, indicating a low supply response to demand shocks. Back-of-the-envelope calculations suggest an average price effect ranging from 6.29% to 10.13% as a consequence of the policy.

Figure 1: Growth in housing prices and stock across Santiago's CZ (2005-2020)



(a) Price growth across CZ

(b) Correlation between $\frac{\Delta \text{Stock}}{\Delta \text{Price}}$ and ΔPrice.

Note: This figure displays the growth in housing prices and stock by Census Zone (CZ) in Santiago from 2005 to 2020. Panel (a) shows the average housing prices in real terms for 2005 and 2020 across CZs, with missing information colored in gray. A sample of property transactions between 2005 and 2020 is plotted in green. Panel (b) illustrates the correlation between the ratio of stock growth to price growth ($\frac{\Delta \text{Stock}}{\Delta \text{Price}}$) and price growth ($\Delta$Price). The dashed line represents an elasticity of 1, indicating proportional growth between stock and price. These are long-term elasticities obtained through a simple ratio and should not be interpreted as causal relationships. The polynomial fit is of the 4th degree, but a negative correlation is observed also in a linear polynomial fit.

We also find that new constructions are more than twice as responsive to price increases compared to rental units transitioning to owner-occupied housing. This is particularly relevant for low- and middle-income suburban neighborhoods, where the share of new construction is relatively small compared to central areas. This lack of responsiveness suggests that developers are not converting enough rental properties into owner-occupied homes, restricting opportunities for families aiming to become homeowners. Consequently, the demand for new constructions intensifies, further driving up prices. we argue four mechanisms could explain why developers focus on new construction in more central areas:

higher profitability, significant variation in zoning policy in hyper-dense areas, better infrastructure closer to the CBD, and evidence of a high rate of redevelopment.

In Section 5, we slightly modify the main empirical strategy by implementing an Event Study of the vouchers' exposure to housing prices. This exercise has three objectives: (i) to validate the empirical strategy from the previous section by testing for parallel trends, (ii) to directly estimate the effect of the voucher on housing prices, providing a robustness check on the housing supply elasticity estimate, and (iii) to assess heterogeneous effects of the policy. First, we find that the parallel trends assumption is generally satisfied, suggesting that confounders do not seem to correlate with the treatment. Second, we find a positive and consistent effect on housing prices, with an average increase of 8.87% from 2011 to 2019. Coefficients of similar magnitude are found by Carozzi et al. (2024) in the context of homeownership subsidies in the United Kingdom. Furthermore, our estimates align with an average elasticity of 0.62, which is just slightly higher than the estimate in the previous section. These results suggest that a large share of the subsidies are capitalized into higher prices, benefiting previous owners and developers. Lastly, we find that neighborhoods with high population density, low share of new properties, and those farthest from CBD experience larger price effects. This aligns with the characteristics of neighborhoods more exposed to the policy and reflects the low elasticity of supply in low- and middle-income areas.

This study contributes to multiple strands of literature. Firstly, it adds to the body of work analyzing housing supply responses. Recent evidence in the U.S. shows that there is an important variation in the housing supply elasticity *between* and *within* cities (Saiz, 2010; Cosman et al., 2018; Blouri et al., 2023; Baum-Snow et al., 2024). Saiz (2010) finds elasticities ranging from 0.6 to 5.45, depending on a city's supply constraints, while Blouri et al. (2023) estimates elasticities between 0.39 and 2.25 across U.S. counties. On the other hand, Baum-Snow et al. (2024) find a housing price elasticity, in terms of new units, ranging from 0.2 to 0.9 in metropolitan areas. Understanding the spatial variation in housing supply elasticity is key to estimating the consequences of neighborhood-specific housing demand shocks (Calabrese et al., 2011; Couture et al., 2023). Our estimate for Santiago (0.543) is closer to the bottom range of previous estimates, suggesting a low elasticity of supply. Nevertheless, our analysis reflects a short-term supply response, while the literature analyzes long-term variation. Additionally, we argue that neighborhoods with low constraints can still have low-supply responses when developers do not have enough incentives to build new housing. Lastly, this research contributes to the literature by exploring the supply response in a middle-income country, where housing market dynamics and policy impacts may differ significantly.

Secondly, this study contributes to the literature evaluating the effects of housing policy. In the context of tax incentives, there is extensive evidence suggesting that mortgage interest deductions (MID) in the U.S. disproportionately benefit high-income individuals and developers (Sinai et al., 2004; Poterba et al., 2008; Hilber et al., 2014; Rappoport, 2016; Davis, 2019). On the side of owner-occupied subsidies, policies aimed at reducing mortgage payments (such as Help-to-Buy in the U.K.) seem ineffective in unaffordable areas where the housing supply is inelastic, leading to increased housing prices and higher profits for developers without stimulating new construction (Carozzi et al., 2024). The evidence we provide is consistent with this result, while in our case we directly estimate the housing elasticity of supply. On the other hand, rental vouchers (e.g., Section 8 and MTO) have been shown to be valuable tools for reducing housing costs and providing long-term benefits for recipients (Kling et al., 2007; Ludwig et al., 2013; Chetty et al., 2016). While rental vouchers do not appear to have a significant impact on housing prices on average, Eriksen et al., 2015 find the largest price increase in cities with inelastic housing supply. Finally, project-based policies like the Low-Income Housing Tax Credit (LIHTC) have been criticized for their cost-effectiveness, with around half of the subsidies captured by developers and a quarter dissipated in fixed costs (Soltas, 2024).

This study also contributes to ongoing policy debates. Our results suggest that housing subsidies may not be an efficient solution to address the housing affordability crisis and could even exacerbate the problem for unsubsidized households. The effectiveness of housing assistance largely depends on the responsiveness of the housing supply to demand shocks. Therefore, complementary measures, such as supply-side incentives for new construction in low- and middle-income areas, should be considered.

This paper is organized as follows. Section 2 describes the Chilean homeownership voucher. Section 3 presents the data used in the study. Section 4 outlines the empirical strategy and estimates the housing supply elasticity. Section 5 estimates an Event Study to validate the identification strategy and to directly estimate the effect of the policy on housing prices. Finally, Section 6 presents the main conclusions of the study.

2 The Chilean homeownership voucher

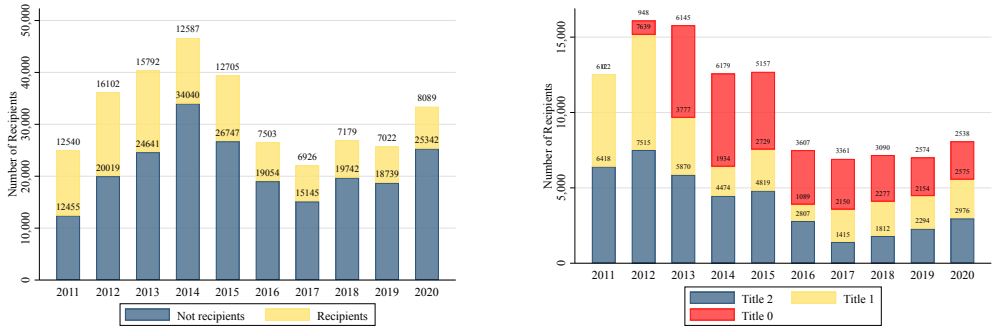
This section provides an overview of the Chilean housing subsidy program, detailing its structure and evolution over time, which are essential for understanding the paper's empirical strategy.

2.1 General context

In 2011, the Chilean government established a homeownership voucher program titled *Subsidio Habitacional* (SH or DS01). This housing subsidy was designed to finance the acquisition of new or used homes, either in urban or rural areas, to be used as housing for recipient and their family.[6] The government covers a percentage of the property's value up to a certain price cap, but households are required to have savings before applying to the program.

The homeownership voucher was introduced as a housing subsidy targeted at the "middle class." In Chile, the homeownership rate stands at 66%, which is lower than the average of the OECD (71%) and the European Union (75%).[7] As in many other countries, there is a strong correlation between homeownership and income. During the first ten years of the program, the government spent nearly $526 million annually (0.2% of current GDP), distributing 249,163 vouchers. Assuming an average household size of four, this implies that 5.5% of the Chilean population was directly impacted by the policy. Figure 2 shows the voucher allocation over time. Panel (a) shows number of applicants and recipients, while panel (b) indicates the recipients of each voucher type over time.

Figure 2: Voucher allocation over time



(a) Voucher applicants and recipients

(b) Voucher recipients by type

Note: The figure presents the distribution of voucher applicants and recipients over time, from 2011 to 2020. Panel (a) displays the number of voucher applicants, differentiating between those who received a voucher ("recipients") and those who did not ("not recipients"). Panel (b) breaks down the recipients by the type of voucher received.

2.2 Voucher structure

Initially, the subsidy was divided into two tiers (Title 1 and Title 2), but at the end of 2012, the government introduced a new tier focused on low-income individuals, called "Title 0".

[6] Supreme Decree 01 (DS01), available at: https://www.bcn.cl/leychile/navegar?idNorma=1026260

[7] According to the Housing Tenures Report (2024) by the OECD, this figure is comparable to those observed in countries such as Mexico, Canada, the United Kingdom, the United States, France, the Netherlands, Sweden, and Korea, which range between 58% and 70%. The report is available at https://www.oecd.org/els/family/HM1-3-Housing-tenures.pdf.

While there were no significant changes in the voucher structure over time, subsidies and property caps were increased for each voucher type in 2015. Table 1 outlines the main characteristics of the vouchers. We present the information for year 2015 to easy the explanation of each component.

The first tier, called Title 0, focuses on low-income individuals with a maximum monthly income of $938. This voucher enables the purchase of properties up to $37,500, providing a subsidy of up to $18,750, while requires savings of at least $1,125. For Title 1, the maximum income requirement is $1,500. This voucher allows the purchase of properties up to $52,500, with a maximum subsidy set at $19,350, and requires savings of $1,500. Lastly, for Title 2 applicants the maximum income requirement is $2,250. They can purchase a property worth up to $82,500, and the subsidy cap is set at $13,125. The saving requirement for this group is set at $3,000. Additionally, it is worth noting that Title 1 and Title 2 require mortgage credit pre-approval from a financial entity, while Title 0 does not.

Table 1: Vouchers eligibility criteria and structure from 2015 (in US dollars)

	Title 0	Title 1	Title 2
Maximum income	$938	$1,500	$2,250
Saving requirements	$1,125	$1,500	$3,000
Credit requirement	No	Yes	Yes
Subsidy rule	min{P; $18,750}	$27,188-0.375×P	$27,188-0.375×P
Maximum subsidy	$18,750	$19,350	$13,125
Minimum subsidy	-	$7,500	$4,500
Cap in property value	$37,500	$52,500	$82,500

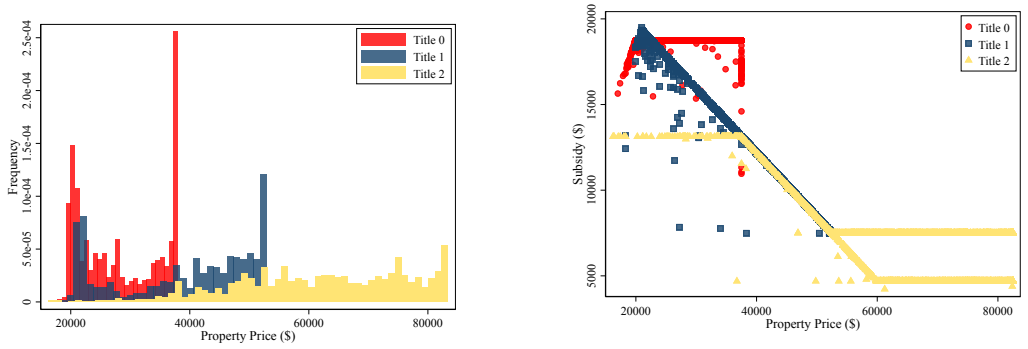
Note: The table outlines the eligibility criteria and subsidy rules for three voucher tiers based on income, savings, credit requirements, and property value caps. The subsidy rule indicates the relationship between subsidies and property prices, which can be visually examined in Figure 3b.

On top of that, the program stipulates that properties purchased in "priority" areas would receive a minimum subsidy of $7,500.[8] Figure 3 provides a clearer understanding of the subsidy structure. Panel (a) shows the distribution of property prices for each voucher type, while panel (b) illustrates the empirical relationship between subsidies and prices. For all three voucher types, there is significant bunching at the property price cap. It can be observed that subsidies are the largest for Title 0 and the lowest for Title 2, with a common minimum of $7,500 for all vouchers (priority areas), and a specific minimum of $4,500 for Title 2 when the property price exceeds $60,000.

[8]In Chile, priority areas of development are defined based on factors such as poverty levels, income disparities, economic productivity, infrastructure needs, and social equity. Regions with lower income, insufficient infrastructure, or potential for economic growth are targeted, with a focus on improving living standards, addressing inequality, and promoting sustainable development.

Thus, the monetary amount of each voucher was designed as a function of the value of the purchased property and the voucher type.[9] The subsidy amount for Title 0 is the largest compared to the other voucher types, but it also restricts purchases to very low-priced homes. When the policy was implemented, property prices in Santiago averaged around $70,000, meaning only recipients of Title 2 vouchers were able to purchase an "average-priced" property in Santiago.

Figure 3: Prices of purchased properties by voucher type and price-subsidy function



(a) Distribution of property prices

(b) Relationship between property prices and subsidies

Note: This figure visualizes the structure of the subsidy. Panel (a) shows the distribution of prices of purchased properties by each voucher type. The right panel depicts the empirical relationship between prices and subsidies.

2.3 Application process and the use of the subsidy

To apply for the subsidy, households must be registered in the *Ficha de Protección Social* (FPS), which helps the Chilean Ministry of Social Development (MDS) identify eligible households for subsidies and social programs. Households are required to be below the 90th percentile of the FPS vulnerability score to be eligible to apply.[10] Applicants must also demonstrate some borrowing capacity, as described in Table 1.

After the application process, the Chilean Housing Department (MINVU) rations vouchers through two main mechanisms. First, applicants are ranked according to a vulnerability score that considers factors such as household size, single-parent status, the presence of children or elderly individuals, the people-to-bedrooms ratio, and savings. Second, the central government allocates a budget to each of Chile's 16 administrative regions. Then,

[9]This structure was consistent across all regions of the country, with the exception of a few isolated areas (e.g., Chiloé Island, Easter Island, Juan Fernández Island, and the Regions of Aysén and Magallanes), where the subsidies and property caps were relatively higher. For simplicity, we do not analyze these areas, which also represent less than 2% of the Chilean population.

[10]The FPS score is based on household members' income-generating capacity and economic needs. The household is defined as those who share a home and a food budget.

when demand for vouchers exceeds supply—which has occurred in every application call since the program's inception—each region distributes its budget based on the vulnerability ranking system until the funds are exhausted. As a result, in each application call and region, a threshold in the vulnerability index determines who receives a voucher.

When applicants receive the voucher, they take an average of two years in purchasing a property. After getting it, recipients must reside in the property and retain ownership for at least five years (Clause Nr. 39 of the law). The prohibition against selling or renting the property is highly enforced. The property title is registered with the Conservador de Bienes Raíces (Chilean Property Registrar), and any violation of the law could result in the government reclaiming the subsidy or the property.[11]

2.4 Chile's 2014 rental voucher

In 2014, Chile introduced a rental voucher program named *Subsidio al Arriendo*, which was smaller in scale than the homeownership voucher. Over five years, the government spent $350 million, 87% less than the annual spending on homeownership subsidies. The rental voucher is targeted at low-income individuals and provides $7,500, which is 60% lower than the homeownership voucher for comparable individuals (nearly $18,750 for Title 0). Selman (2022) found that the rental voucher did not affect applications for the homeownership voucher.

3 Data

To study the urban response to homeownership vouchers, we work with two main datasets. First, we use the administrative dataset of the applicants and users of the subsidy (MINVU, 2024), which allows us to understand the characteristics of the applicants and their residential addresses before and after using the subsidy. Secondly, we employ data on property transactions in Chile from 1998 to 2020, which gives information on the housing market before and after the implementation of the SH (TocToc, 2024).

The administrative data of the subsidy is administered by the MINVU. This dataset provides detailed information on all the applicants and users of the homeownership subsidy program from June 2011 to December 2020. The database includes 1,026,123 applicants in Chile's 16 regions, where 322,369 (31,4%) belong to Santiago's Metropolitan Region. From

[11] However, this is rare, as banks review property titles before issuing mortgages. Additionally, MINVU enforces compliance through random inspections and local community reports of misuse. In 2019, the government launched the "Te cache" program to identify misused subsidized properties. Reports mainly concerned illegal rentals or commercial use of subsidized homes (MINVU, 2019). Between 2014 and 2018, there were 2,309 reports of improper use, affecting 2% of voucher recipients.

the applicants in Santiago, 106,445 individuals (33%) have been awarded with the home-ownership subsidy, representing $1,511 million of monetary transfers through vouchers and 62,542 individuals that have used the voucher to purchase a properties in 10 years.[12]

The database has an ID for each applicant, and provides detailed information about them and their family at the moment of the application, such as gender, nationality, family's vulnerability index, number of people living in their current home, residential address, important financial information (declared income, savings, credits, among others), among others. It also includes the date of the application, the type of the subsidy (Title 0, 1 or 2), their score in each application, their results (win or lose), and if they used the voucher. In the case they have purchased a property with the voucher, the dataset reports the residential address of the new home, the property value, and the subsidy amount, among others.

The information on transactions was obtained by an agreement with the Chilean private company TocToc.[13] This database, includes all the property transactions in the Santiago's Metropolitan Region from 1998 to 2020. This information was digitized from the original titles registered at the Chilean Property Registrar. This database contains 3,012,082 transactions, where 1,782,304 correspond to houses and apartments, which are the focus of this paper. The data includes detailed information on property characteristics, such as location (address), transaction value, square footage, and year of construction, among others. This structure enables us to match these transactions with the residential location of subsidy applicants at the CZ level. Furthermore, the time span of this data allows us to test housing dynamics before and after the policy, such as changes in prices and transactions by neighborhood.

We complement these databases with information from other sources. Firstly, we add appraisal information from the Chilean Revenue Agency (SII) which is matched with TocToc data at the transaction level. This database also includes CZ-level information on property valuation, size of land, price by square meter of land, and number of units, among others. Secondly, we incorporate information from the Chilean censuses of 2002 and 2017 [14]. These censuses gathered a wide array of variables, including age, gender, educational attainment, employment status, household size, and type of dwelling, among others. This

[12]Some reasons that can explain why there is no full use of the subsidy are the following. Firstly, individuals have three years to decide where to purchase a property, which can generate a lag in its use. Secondly, they may apply for more than one type of subsidy in different years, so if they receive more than one, they can only use one. Finally, individuals may not have enough savings to purchase properties even though they receive the voucher, so they may decide not to purchase.

[13]TocToc is one of the largest housing consultant companies in Chile. To the best of our knowledge, this is the only company that manages a database of all the property transactions in the Metropolitan Region of Santiago from 1998 to 2020.

[14]Chilean census provides detailed information of the country's demographic, social, and economic characteristics. They are administered by the National Institute of Statistics (INE), covering all 16 regions and 346 municipalities of Chile. The 2017 Census collected information from 17.5 million residents

information can be used to identify demographic characteristics and neighborhood amenities at a census tract level. They also include shapefiles that are needed to aggregate or collapse the databases at a CZ level and other administrative regions.

To get a perspective on tenure choice at the neighborhood level, we add information from 2017's CASEN survey(MDS, 2017).[15] This survey includes detailed information on households' socioeconomic characteristics. Additionally, it includes valuable housing information such as homeownership status, housing cost, and use of subsidies, among others.

Lastly, to measure the housing quality of neighborhoods, we use the *Socio-Material Territorial Index* (ISMT) built by Observatorio-de-Ciudades-UC (2022).[16]. This index summarizes in one variable socioeconomic and housing information that comes from the Census of 2017, such as educational level from the head of the household, housing overcrowding, and housing construction quality. This variable is used therefore as a metric of neighborhood quality.

4 Housing supply elasticity

What is the supply response to demand shocks? Do we expect to see higher prices after the implementation of a housing subsidy? In this section, we provide quasi-experimental evidence of the housing supply elasticity in the context of Santiago de Chile. To do so, we exploit the demand shock generated by the Chilean homeownership voucher (SH). We estimate a 2SLS panel regression with fixed effects, with a shift-share instrument to isolate supply-side and demand-side variation. The analysis relies on Santiago's transaction data for 1,779 CZs from 1998 to 2019, along with information on the number of voucher recipients by neighborhood and year.

4.1 Identification strategy

The housing supply elasticity is the change in housing stock when there is an increase in prices ($\eta = \frac{dQ}{dP}\frac{P}{Q}$). Identifying η requires isolating changes in supply from changes in demand, since equilibrium prices combine both demand-side and supply-side effects. Recent literature (Saiz, 2010; Blouri et al., 2023; Baum-Snow et al., 2024) has leveraged long-term

[15] Encuesta de Caracterización Socioeconómica Nacional (CASEN) is a comprehensive household survey conducted in Chile to assess the socioeconomic conditions of the population. This survey runs every 3 years and obtains detailed information on income, education, and housing, among other variables at the municipal level.

[16] Observatorio de Ciudades UC is an academic center at the Pontificia Universidad Católica de Chile that focuses on generating, collecting, and analyzing data related to various social, economic, and political phenomena in Chile. The observatory aims to provide valuable insights and information to support public policy, academic research, and public understanding of current issues.

labor demand shocks, also known as "Bartik shocks" (Bartik, 1991), to isolate these effects. However, some evidence has pointed out that Bartik shocks may not be good instruments for housing demand as they are highly correlated with supply constraints (Davidoff, 2016). The identification strategy of this paper, in contrast, relies on short-term housing demand shocks caused by the introduction of the Chilean homeownership voucher. Therefore, this paper seeks to provide one of the first quasi-experimental evidence of the housing supply elasticity.

Based on the previous literature, the inverse of the housing supply can be written as Equation 1:

$$\ln P = \frac{1}{\eta} \ln Q^s + \mathbf{X}'\gamma + \epsilon \tag{1}$$

where P the housing price index, Q^s is the supply quantity (measured as housing stock), $\mathbf{X}$ are observable characteristics, and ϵ includes all the unobservables. Since $Q^s = Q^d$ in equilibrium, the goal is to find an instrument that captures only demand-side variation, so that η can accurately identify the response of housing stock to an increase in prices.

The approach in this paper is to use the structure of the subsidy to define the neighborhood's exposure to each type of voucher. By interacting these measures of exposure with the allocation of vouchers in each neighborhood, we estimate a shift-share instrument for the local demand for owner-occupied housing. This instrument enables us to isolate supply responses and therefore to estimate the short-term housing supply elasticity.

The main identification assumptions of the instrumental variable approach are the standard ones: (a) the instrument is relevant, and (b) it affects prices only through its impact on housing demand. In this section, we provide evidence supporting both assumptions. A potential threat to the identification is that the instrument may not be valid if the demand shift is correlated with unobserved factors that also affect supply. We partially deal with this by including neighborhood and time fixed effects in the main specification. These variables control, for example, for supply constraints that do not vary over time. In Section 5, We provide additional evidence of the exogeneity of the shock. By structuring the analysis into an Event Study framework, we test the existence of parallel trends between groups of different intensity of the treatment before the implementation of the policy.

We begin by describing the shift-share instrument, followed by an emphasis on the estimation and the results of the empirical strategy. Finally, we briefly explore the mechanisms that could explain the primary findings.

4.1.1 *Shift-share instrument*

To implement a shift-share framework, it is necessary to define which are the measures of exposure (also known as "shares") and the shifts of housing demand.

To define neighborhoods' exposure to the policy, we use the fact that each of the vouchers specifies a set of properties that can be purchased based on their prices (see Table 1). This allows us to calculate the mass of properties in each neighborhood that are eligible for purchase with each voucher type. To achieve this, we construct an index of property prices at the neighborhood level just before the policy was introduced in 2011. This approach also prevents the issue of using the outcome variable to determine treatment exposure. We use transactions data from 1998 to 2010 to identify prices in each residential location. Leveraging transaction-level data, we run a regression of prices on housing characteristics and year fixed effects. Using these estimates, we predict the property price of all properties for the year 2010. In simple terms, this methodology adjusts all prices to be comparable at 2010 levels, accounting for housing market characteristics such as local real price growth. Figure B.4 plots the evolution of average prices over time, and the estimated indicator for prices at 2010. Intuitively, the 2010-price index should be relatively constant over time. Additionally, Figure B.5 reports the distribution of property prices in 2010 in Santiago's CZs and the average price at that moment (nearly $70,000).

With the price index established, we calculate the number of properties eligible for purchase under each type of voucher in each CZ. The eligibility range is set as follows: $18,750 to $37,500 for Title 0, $37,500 to $52,500 for Title 1, and $52,500 to $82,500 for Title 2.[17] Then, we estimate the shares (exposure) by dividing the number of eligible properties of type k by the total number of properties in each CZ. Equation 2 indicates the formula for estimating the shares for voucher-eligibility type k in each CZ i:

$$\omega_{ik}^{2010} = \frac{\sum_{n=1}^{N_i} \mathbb{1}\{\underline{P}^k < \hat{P}_n^{2010} < \overline{P}^k, i \in I\}}{\sum_{n=1}^{N_i} \mathbb{1}\{i \in I\}} \tag{2}$$

where the numerator sums all properties in neighborhood i whose adjusted 2010 prices fall within the bounds of eligibility for voucher k. The denominator sums all properties in the specific CZ. Figure B.6 shows the CZ exposure to each voucher type (panel a) and the total exposure to the policy (panel b), which are a visual representation of the previous formula.

The next stage is defining the housing demand shocks. To do this, we use the admin-

[17] Even though Title 1 and Title 2 allow the purchase of properties starting from $18,750, Figure 3 Panel (a) shows a strong correlation between voucher use and property prices. As a result, very few properties under $52,500 are purchased with Title 2, and similarly, few properties below $37,500 are bought with Title 1.

istrative dataset of the subsidy allocation from 2010 to 2019. We calculate the number of voucher recipients living in each neighborhood k and year t.

We opt to use the original residential locations of voucher recipients rather than their new residences for multiple reasons. First, the number of recipients in each neighborhood-year is influenced by the quasi-random nature of the application process, particularly around the household vulnerability threshold (see rationing process in Section 2). In contrast, the use of the voucher is endogenous to market conditions, as individuals can choose *when* and *where* to purchase, which could bias the instrument. Second, housing demand shocks are not solely a reflection of current purchases but also encompass potential future demand. In other words, we assume the market responds in year t based on the exposure to the policy, which includes future potential buyers. Moreover, approximately 19% of voucher recipients purchase a property in the same Census Zone (CZ) where they previously resided, and nearly 51% remain within the same municipality. This strong correlation between origin and destination residential locations suggests the use of voucher allocation data is preferable, as it provides a larger sample size than voucher usage data.

Having established the housing demand shifts, we can now calculate the shift-share instrument. The instrument is a weighted summation of the housing demand shocks, where the weights are the exposures to each type of voucher. Equation 3 illustrates how the shift-share instrument is calculated.

$$\mathrm{S}_{it} = \sum_{k=1}^{3} \omega_{ik}^{2010} \times \mathrm{s}_{kt} \tag{3}$$

where s_{kt} represents the number of vouchers type k allocated in year t, ω_{ik}^{2010} is the share of eligible properties for voucher k in CZ i, and the summation goes over the three type of vouchers (Tile 0, 1 and 2).

The structure of the instrument suggests that when a neighborhood has a large share of eligible properties for voucher type k and experiences a demand shock for those properties, we should observe a corresponding shock in housing demand. For example, if a CZ has a large share of properties priced below $37,500, we would expect a greater demand shock only if there is a significant number of recipients of Title 0 vouchers. In contrast, a comparable neighborhood with few or no Title 0 recipients should not experience a demand shock. Similarly, a neighborhood with many Title 0 voucher recipients but with property prices typically exceeding the $37,500 cap would not see a housing demand shock either. The same logic applies to Title 1 and Title 2.

For the validity of the shift-share approach, we test relevance and exogeneity assumptions through different regressions and exercises. Related to the relevance condition, Table

A.3 (columns 4 and 5) and Figure B.7 (panels d and e) show the correlation between the instrument and the logarithm of housing stock and property transactions. Those correlations are positive and significant at 10% and 1% of statistical significance, respectively. Additionally, the instrument reports a positive and significant correlation with different measures of prices, which represents the reduced form regressions. Regarding the exogeneity assumption, in this section we only deal with it by including fixed effects at both the neighborhood and year levels. This strategy helps to control for differences in supply constraints, local amenities, productivity, and other factors, thereby reducing omitted variable bias. We assume throughout that any fundamental differences in supply constraints across neighborhoods are time-invariant and are therefore captured by the neighborhood fixed effects. In Section 5, we provide a more robust test by checking for pre-trends to support the exogeneity assumption.

4.2 Estimation and main results

To estimate the housing supply elasticity, we slightly modify Equation 1 into the following two-stage (2SLS) model:

$$\ln P_{i,t} = \beta \ln \widehat{Q}_{i,t} + \mathbf{X}'_{i,t}\gamma + \mu_i + \lambda_t + \varepsilon_{i,t} \tag{4}$$

$$\ln Q_{i,t} = \theta \ln S_{i,t} + \mathbf{X}'_{i,t}\pi + \phi_i + \psi_t + \upsilon_{i,t} \tag{5}$$

where $\ln P_{i,t}$ denotes the logarithm of prices in CZ i at time t, and $\ln \widehat{Q}_{i,t}$ is the predicted logarithm of the housing stock, instrumented using a shift-share variable. The model includes control variables $\mathbf{X}_{i,t}$ to account for other factors influencing prices, μ_i neighborhood fixed effects and λ_t time fixed effects. The error term $\varepsilon_{i,t}$ captures the unexplained variation in prices and it is clustered at the neighborhood level. The coefficient β provides an estimate of the inverse of the elasticity of supply, so $\eta = \frac{1}{\beta}$.

Regarding the first stage, $\ln Q_{i,t}$ is regressed on the shift-share instrument $\ln S_{i,t}$. The coefficient θ measures the strength of the relationship between the instrument and the endogenous variable. The equation also includes control variables $\mathbf{X}_{i,t}$, neighborhood fixed effects, ϕ_i, and time fixed effects, ψ_t. $\upsilon_{i,t}$ indicates the error which is also clustered at the neighborhood level.

We start by showing the OLS results to get a sense of effects when both demand and supply-side variation are present. This helps to understand the relevance of the instrument on our main estimation. Results are reported in Table A.1. Columns (1) to (3) focus on the relationship between housing stock and prices (both in logarithm). The coefficients are positive and statistically significant across all specifications, ranging from 0.18 to 0.255. The

inclusion of fixed effects and controls affects the magnitude of the coefficients and increases the R^2. However, these estimates imply housing supply elasticities that are completely out of range (from 3.9 to 5.6). The explanation is that, as the supply effects are present, the coefficients are biased towards more negative values, which increase the estimated supply elasticity.

Columns (4) to (6) shift the focus from housing stock to transaction volumes. This variable helps to understand how different segments of the housing supply respond to rising prices, as we can distinguish between overall transactions, transactions for new constructions, and rental properties being sold ("rent-to-own" transactions).[18] The high implied elasticities (ranging from 9.7 to 18.8) suggest a significant responsiveness of transaction volumes to price changes. These results will be contrasted with IV estimates to further refine the analysis. As expected, supply-side shifts are likely to be more pronounced for transactions than for stock, due to the greater variation in transaction activity across periods and census tracts. Figure A.2 reports OLS estimates for other measure of prices, such as price per square foot and property's appraisal value. Results are consistent in terms of magnitude and significance.

Now we turn the attention to the instrumental variable approach. Results are reported in Table 2. Columns (1) through (3) focus on the relationship between the housing stock and various measures of prices: overall prices (column 1), price per square foot (column 2), and appraisal value (column 3). The IV estimates yield much larger coefficients for the effect of housing stock on prices compared to the OLS results, suggesting the presence of substantial bias in the OLS estimates. Specifically, in column (1), the coefficient of 1.843 indicates that a 1% increase in housing stock (driven by demand) leads to approximately a 1.84% increase in prices. The coefficients in columns (2) and (3) also demonstrate significant positive relationships, with magnitudes of 1.18 and 3.05, respectively. These results imply a very inelastic housing supply (ranging from 0.328 to 0.850), meaning that the market does not respond as strongly to changes in prices. Therefore, this supports the notion that supply constraints are binding in the housing market.

Regarding the relevance of the first stage, the *K-P F-statistic* consistently shows values above 20 across all estimations, indicating a reasonably strong instrument.

Columns (4) to (6) turn to analyse transactions: all, new constructions and rent-to-own transactions. The results indicate a significant positive relationship between the number

[18]We currently do not have specific data on traded properties that were previously rented, but we expect to obtain it soon. For now, to identify the likelihood of a property having been rented, we use tenure choice data at the municipality level from the CASEN survey (MDS, 2017). We then run a tenure choice model based on housing characteristics (e.g., size, apartment or house, price) and fixed effects. Using these estimates, we predict tenure status at the property level. Within each municipality, we classify properties as 'rented' if their predicted likelihood exceeds the municipality's average.

of transactions and prices, with the coefficient on overall transactions in column (4) being 0.574, indicating that a 1% increase in the number of transactions is associated with a 0.57% increase in prices. This implies an overall transaction-elasticity of 1.742. For transactions of new properties (column 5), the coefficient is 0.78, not far from the overall transactions estimation (implying an elasticity of nearly 1.3). Finally, the coefficient on rent-to-own transactions in column (6) is the largest at 1.946, which implies a rent-to-own transaction-elasticity of 0.515.

Table 2: IV estimates for housing supply

	(1) ln(Price)	(2) ln(Price sqft)	(3) ln(AV)	(4) ln(Price)	(5) ln(Price)	(6) ln(Price)
ln(Stock)	1.843*	1.176*	3.046*			
	(0.962)	(0.634)	(1.637)			
ln(Transactions)				0.574***		
				(0.142)		
ln(NP Transactions)					0.780***	
					(0.200)	
ln(RtO Transactions)						1.946**
						(0.855)
Implied Elasticity	0.543	0.850	0.328	1.742	1.282	0.514
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	15,831	15,831	15,834	15,831	15,831	15,831
K-P F-Stat	21.78	21.78	20.61	352.4	46.87	20.85

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Each cell corresponds to the estimate from a 2SLS regression, where the dependent variables are the logarithms of price (in columns 1, 4, 5 and 6), price per square meter (column 2), and appraisal value (column 3). The main explanatory variables include the logarithms of stock, transaction volume, transactions of new properties, and rent-to-own transactions. Controls at the neighborhood level include the share of different property types, the average year of construction and total population. The regressions incorporate both year and neighborhood fixed effects to account for time and location-specific shocks. The table reports Kleibergen-Paap F-statistics (K-P F-stat) to assess the strength of the instruments used in the 2SLS estimation. Standard errors are clustered at the neighborhood level are reported in parentheses.

The low implied transaction elasticity for rent-to-own properties suggests that the market primarily responds to increasing demand for owner-occupied housing through new construction rather than by offering existing rental properties for purchase. The lack of response in rent-to-own transactions may mean that developers are converting little rental units into owner-occupied housing. This highlights a key supply-side limitation, especially in areas where there is little construction activity of low price properties. To put this in context, Table 3 suggests that new constructions in Santiago tend to be concentrated on more

central areas, leading to a geographic mismatch in housing availability. As a result, intermediate regions and suburban neighborhoods, where new construction is relatively scarce, may experience high pressure on housing prices and reduced opportunities for renters to transition into homeownership.

Table 3: Share of new constructions and CBD distance – Low price properties

Distance group (quintiles)	1	2	3	4	5
Share of new constructions (%)	58.0%	43.9%	21.6%	27.1%	31.1%
New constructions (normalized)	1	0.76	0.37	0.46	0.53
CBD distance (km)	2.03	5.51	9.31	12.81	17.13

Note: This table is constructed for low-price properties, defined as those valued at less than $56,000 in 2010. It considers all new transactions from 2005 to 2019. The table shows the share of new constructions, the ratio of the new constructions in each group respect to first group (normalized to 1), and their corresponding distance to downtown across five distance groups.

This result challenges findings from the literature in developed countries, which show that housing supply tends to respond more strongly in neighborhoods that are further from the CBD (Saiz, 2010; Carozzi et al., 2024; Baum-Snow et al., 2024). These papers suggest that suburban development plays a key role in accommodating increased housing demand as they have more available land for new construction. In contrast, our results suggest that suburban areas may also exhibit low elasticity of supply, particularly when developers concentrate construction efforts in more affluent areas and when there are rigidities in the conversion of rental units to homeownership. This highlights the importance of studying housing supply elasticities in middle- and low-income countries to better understand how the affordability crisis can be addressed in various contexts. In the next section, we present several mechanisms that could explain the misallocation of new constructions and the supply of owner-occupied housing.

4.3 Potential mechanisms

There are at least four key factors that could explain why housing supply may respond slowly even in areas without significant constraints. First, heterogeneity in zoning policies across neighborhoods can influence the pace of new developments (Glaeser, Gyourko, and Saks, 2005; Ihlanfeldt, 2007). Second, higher profit margins for developers may concentrate new construction in more lucrative areas. Additionally, competition for land between real estate developers and farmers or agricultural users could limit the spatial size of the city (Brueckner, 2000; Thisse et al., 2002). Third, better infrastructure—such as transportation networks, utilities, and public services—can facilitate new housing developments with

minimal additional investment (Duranton et al., 2004; Asahi et al., 2023). Finally, the rate of redevelopment of underutilized land can also contribute to faster supply responses (Glaeser and Gyourko, 2005; Baum-Snow et al., 2024). We will explore each of these mechanisms in the following paragraphs.

Zoning. Santiago de Chile has a zoning-by-neighborhood system[19]. Santiago's downtown area, for example, has a zoning policy in place since 1990, which has been modified 29 times. Even with these restrictions in place, the population in the CBD has doubled between the 2002 and 2017 censuses (Valenzuela, 2023), which is consistent with a relatively fast response of the housing supply. In fact, recent evidence suggests that developers have managed to circumvent these constraints through vertical expansion of buildings (Sheehan, 2024; Martinez et al., 2018), a phenomenon increasingly relevant in Asia, Latin America, Oceania and Europe (World Bank, 2023).

Profitability of new constructions. While we do not have direct information on developer profits from new constructions, we do have data on new builds across the city, which can serve as an indicator of profitability. Developers tend to build more when they expect higher returns. Given that zoning policies are often more stringent in downtown areas and suburban regions typically have greater land availability, this indicator can be seen as a lower bound for differences in profitability. Table 3 shows that suburban neighborhoods experience 47% less new construction compared to CZs closer to the CBD. Intermediate areas, located around 9.31 km from the CBD, witness an even lower rate of new construction (-67%). To support these estimates, using the subsidy data we find that only 4.9% of Title 0 voucher recipients purchase new properties, whereas this figure rises to 29.2% for Title 1 recipients and 66.1% for Title 2 recipients. These pieces of evidence imply that developers are not creating many relevant options for low-income individuals in low-income neighborhoods.

Redevelopment. To test this hypothesis, we follow Baum-Snow et al. (2024) in building an indicator of the number of new properties developed on previously developed land. To do that, we use historical transaction data at the block level (smaller than the CZ level). Table 4 presents the results by CBD distance. The findings show that nearly 57% of new construction in the city's downtown occurs on blocks that already had properties, while the share of redevelopment decreases to 44% for blocks located 5.51 kilometers from downtown, and to around 30% for blocks more than 10 kilometers from the CBD (groups 3, 4 and 5). This evidence suggests a relatively high rate of redevelopment in center areas compared to the rest of the city, and is consistent with the vertical growth in the CBD. That being

[19]Each municipality establishes its own regulations, which include restrictions on the extensive margin (such as prohibiting certain types of infrastructure), the intensive margin (such as maximum building heights), and the type of land use (residential or commercial).

said, a more accurate method would involve using satellite imagery to capture developed land at the pixel level, which would provide a finer measure of redevelopment. We leave this exercise for future iterations of this research, so our current indicator likely represents an upper bound on the true extent of redevelopment.

Table 4: Share of redevelopment and CBD distance

Distance group (quintiles)	1	2	3	4	5
Share of redevelopment (%)	56.91%	43.79%	31.00%	26.76%	31.57%
CBD distance (km)	2.03	5.51	9.31	12.81	17.13

Note: This table reports the share of redevelopment (new properties built on previously developed blocks) across different distance quintiles from the CBD. The share of redevelopment decreases as the distance from the CBD increases, indicating higher redevelopment activity in areas closer to the city center.

Current infrastructure. Lastly, recent evidence from Chile (Asahi et al., 2023) underscores the significant role of highways and subway lines in increasing housing supply by stimulating demand. This implies that census zones (CZs) near the CBD can more easily respond to demand shocks, while areas farther from the city center face greater challenges in doing so.

Overall, these four mechanisms suggest that supply elasticity may be low not only in the CBD, but also in more distant areas. Therefore, housing assistance programs should consider how to encourage supply to respond to demand shocks beyond policy-restricted zones. Additionally, studying supply responses in different countries is crucial for understanding the broader impacts of housing assistance programs in various contexts.

4.4 Back-of-the-Envelope Calculation of Price Increases Induced by the Chilean Homeownership Voucher Program

To end this section, we use a simple supply-demand framework to estimate the effects on prices. The equation that enables us to estimate these effects is the following:

$$\Delta\%P = \frac{\Delta\%D}{\eta}$$

where $\Delta\%P$ is the percentage change in price, $\Delta\%D$ is the percentage change in demand, and η is the housing supply elasticity. As supply becomes less elastic (lower η), prices must rise more to accommodate the additional demand. When supply is perfectly elastic, η is infinite, and prices remain stable despite the demand increase. To estimate the equation, we need to make an assumption about the increase in demand, which is not

included in the previously mentioned results. We assume a 5.5% increase in demand for owner-occupied housing, which represents the percentage of Santiago's population that received the homeownership voucher from 2011 to 2019. As a second metric, we also use 3.4%, which represents the effective use of the subsidy[20].

Based on the IV estimates of the housing supply elasticity, a 5.5% increase in demand for owner-occupied housing would imply an increase of 10.13% in average prices, 6.47% in prices per square foot and 16.77% in appraisal values. On the other hand, a 3.4% increase in demand would imply a 6.29% increase in average prices, 3.95% increase in prices per square foot and 10.41% increase in appraisal value.

The implications of these calculations are significant for understanding the impact of housing assistance in different contexts. In areas with tight housing supply, such programs may exacerbate affordability issues by driving up prices, reducing the intended benefit of the program. Conversely, in markets with more elastic supply, the program's price impact would be smaller, allowing for a more effective expansion of homeownership without significant inflationary pressures. This underscores the importance of local housing market conditions when designing and implementing demand-side interventions like homeownership vouchers.

Table 5: Implied effect on real prices (2011-2019)

ΔDemand	Δ Price	Δ Price per sq ft	Δ Appraisal value
5.5%	10.13%	6.37%	16.77%
3.4%	6.29%	3.95%	10.41%

Note: The table shows the estimated effect of a demand increase for owner-occupied housing on real prices, prices per square foot, and appraisal values, based on IV estimates of housing supply elasticity. A 5.5% increase in demand corresponds to the percentage of Santiago's population that received homeownership vouchers during this period, while 3.4% represents the population that actually use them in the period.

In Section 5, we directly estimate the effects of the policy on housing prices in an Event Study framework. Results are of similar magnitude.

[20]We consider 62,542 recipients that have used the subsidy, which represents 250,168 individuals if we consider their families. This number divided by nearly 7,3 million people in Santiago is 3.4%.

5 Validation of the methodology and effects on housing prices: an Event Study approach

The previous section estimates Santiago's housing supply elasticity. The identification strategy relies on the assumptions of relevance and exogeneity. While the exogeneity assumption cannot be directly verified as the relevance, some robustness tests can be conducted to support its validity. In this section, we slightly modify the empirical strategy to explore the potential presence of unobserved factors that may differentially affect the different treatments and control groups over time. Specifically, in this section we implement an Event Study with a continuous treatment based on neighborhood exposure to different voucher types. This strategy enables us to test for parallel trends, check for the existence of anticipation effects prior to the policy, and estimate the impact of the policy (i.e., the implementation of the voucher system) on local housing prices. Thus, this section serves three main purposes: first, to validate the exogeneity assumption of the methodology proposed in Section 4; second, to provide a robust causal estimate of the policy's effect on housing prices; and third, to provide an analysis on the heterogeneous effect of the policy, which was not possible to implement in the instrumental variable approach.

5.1 Empirical strategy

The main strategy we follow in this section is the Event Study represented in Equation 6.

$$y_{i,t} = \alpha + \sum_{k=1}^{3} \sum_{t \neq 2010} \beta_t^k D_t^k \times \text{Exp}_i^k + \sum_{k=1}^{3} \sum_{t \neq 2010} \gamma_t^k D_t^k + \delta_k \text{Exp}_i^k + \mathbf{X}'_{i,t}\gamma + \lambda_i + \theta_t + \epsilon_{i,t} \quad (6)$$

where $y_{i,t}$ represents the outcome variable of interest, such as housing prices, for neighborhood i at year t. The coefficients β_k capture the interaction between the indicator of exposure (Exp_i^k) and the time binary variable for each time (D_t^k). We also include the binary variables and the exposure measure as a control. The vector $\mathbf{X}'_{i,t}$ includes control variables that vary by neighborhood and time, such as population, share of property typ,e and average year of construction of properties. The model also includes neighborhood fixed effects, λ_i, and year fixed effects, θ_t. The error term $\epsilon_{i,t}$ captures unobserved factors that affect the outcome variable. Standard errors are clustered at the neighborhood level.

The treatment indicator, Exp_i^k, is defined in the same way as the "shares" in Section 4 (see Equation 2). Thus, it can be described by Figures B.5 and B.6.

The identification strategy relies on three main assumptions. First, there must be par-

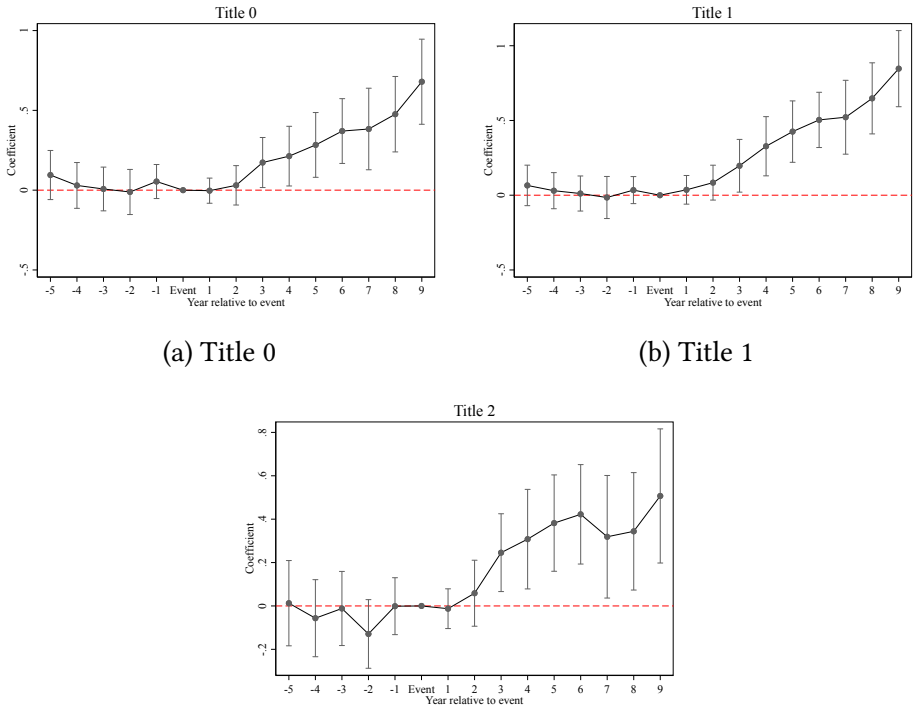
allel trends in housing prices, meaning that, prior to the implementation of the policy, neighborhoods with different levels of exposure to each voucher type followed similar price trends. Second, the policy change must be exogenous, implying that the reform was not implemented in response to unobserved characteristics of the housing market that differ across treatment groups. Third, it is assumed that households and the housing market did not anticipate the reform before its implementation in 2011.

In general, the assumptions can be tested using the Event Study by examining the coefficients for periods prior to the reform. Additionally, We control for time fixed effects that capture annual shocks common to all neighborhoods. Therefore, part of the potential endogeneity is addressed through these variables. Furthermore, our measure of exposure to each voucher provides quasi-random variation around the property price caps that define eligibility for each voucher. For instance, a property priced at US$37,500 is eligible for voucher Title 0, while a property priced at US$38,000 is not. Thus, when we measure treatment exposure, some neighborhoods have more exposure than others for reasons based solely on the policy structure and not on housing market conditions. Lastly, we restrict the control group to neighborhoods with average property prices up to US$150,000, meaning that very high-income neighborhoods are not included as part of the control group. Different thresholds for the support of the control group do not significantly change the results.

5.2 Results

The result of the estimation of Equation 6 is reported in Figure B.9. The first important finding is the absence of pre-trends for the exposure to vouchers of type Title 0 and Title 1. However, there is evidence of linear pre-trends for Title 2. While the existence of pre-event trends for voucher Title 2 can be seen as evidence against the identifying assumptions, Freyaldenhoven et al. (2021) suggest that a pre-adoption trend in the outcome can be used to learn the slope of the trend in the error. Extrapolating this slope into the post-adoption periods then permits accounting for the confound factors. We applied this method to make the necessary corrections, which is also reported in Figure B.9 to show the change between the "raw" estimates and the adjusted ones. Figure 4 reports the results of the Event Study with pre-trend adjustment.

Figure 4: Event Study on Local Prices



(a) Title 0

(b) Title 1

(c) Title 2

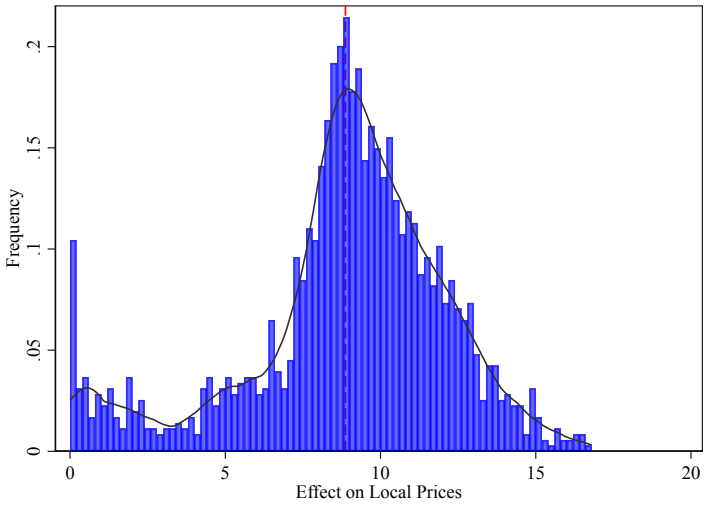
Note: This figure presents the results of an event study analyzing local property prices. The analysis is performed for three voucher types: Title 0, Title 1, and Title 2. Panel (a) shows the impact on prices for Title 0, Panel (b) for Title 1, and Panel (c) for Title 2. We make adjustments for pre-trends, following Freyaldenhoven et al. (2019).

Figure 4 indicates a strong and consistent effect of the exposure to the vouchers on the increase in housing prices. The Y-axis shows the percentage change in prices, while the bars represent 95 percent confidence intervals. Panel (a) indicates that in the first two years of the policy, there was no sizable impact of the eligibility to voucher Title 0 on prices. This is logical because Title 0 was implemented at the end of 2012, and individuals usually take an average of two years to purchase a property. From the third year, there is a positive and significant effect of the exposure to vouchers. Overall, we calculate an average effect of 0.36% per year for voucher Title 0. Panel (b) shows the effects of exposure to vouchers of the Title 1 type. The figure shows a larger effect in year 2 compared to Title 0, but still insignificant. After year 2, we find an increasing effect on prices (an average of 0.39%), which is consistent with the fact that more individuals use the voucher to purchase properties over time, as they decide where to buy. Lastly, for Title 2, we observe a smaller but still significant effect from year 3 after the event.

To put the results in context, the estimated effect on prices of each voucher type enables

us to estimate an overall effect of vouchers on housing prices in Santiago. To do so, we need to calculate the cumulative effect (between 2011 and 2019) for each voucher type and multiply them for the exposure share at each neighborhood ($\sum_{k=1}^{3}$ C.E.$_k$ $\times$ Exp$_i^k$). The resulting cumulative effects (C.E.) for each voucher type were 7.72% (Title 0), 16.64% (Title 1), and 7.55% (Title 2). Then, after summing the effects of all vouchers in each CZ, we end up with an average price effect of 8.87%. However, we find an important heterogeneous effect across neighborhoods. Figure 5 reports the distribution of price effects across Census Zones.

Figure 5: Distribution of Price Effects (2011-2019)



Note: This figure illustrates the distribution of the estimated price effects (in percentage) at the local level based on the share of eligible properties for each vouchers type. The effects are calculated using cumulative impacts for each voucher type across neighborhoods between 2011 and 2019 ($\sum_{k=1}^{3}$ C.E.$_k$ $\times$ Exp$_i^k$). The average price effect (8.87%) is highlighted in red dashed line.

Figure 5 suggests a bimodal distribution of price effects, with one concentration around very low increases and another around a 9% increase. Additionally, it is noteworthy that some CZs, particularly in areas with greater exposure to Title 1, exhibit increases of up to 15%. Conversely, CZs with low exposure to all three voucher types experienced minimal local effects, with price changes close to zero.

These findings helps in validating the estimated supply elasticity presented in the previous section. As shown in Table 5, the implied elasticities were consistent with price increases of between 6.29% and 10.13% (column 1). The average estimate in this section (8.87%) falls between those estimates. If we assume an increase in the demand of 5.5%, an increase of prices of 8.87% would be consistent with a housing supply elasticity of 0.62, which is just slightly larger than the main estimate of Table 2 (0.543).

Therefore, the event study supports the empirical strategy followed in the previous sec-

tion and provides robustness in the calculation of the housing supply elasticity.

5.3 Heterogeneous effects

Taking advantage of this empirical framework, we provide some evidence of the heterogeneous response of housing prices to housing market characteristics. We show evidence of three different variables: CBD distance, population density, and share of new construction per CZ. Results are reported in Figure B.9.

The top row of the figure breaks down the effects by distance from the CBD. It shows that property prices increased more in areas located farther than 10 km from the CBD compared to those closer to it. Panel (a), which presents the results for Title 0, indicates a positive and significant effect on prices in distant areas, while the effect in areas near the CBD is not significant. Panel (b) shows similar results for Title 1, though the differential effect across distance groups is smaller. Panel (c) reports the effects of Title 2, suggesting positive price effects but also some evidence of pre-trends. Overall, we cannot conclude that housing supply elasticity is larger downtown, as there is a correlation between CBD distance and exposure to the treatment. However, we can conclude that suburban areas do not exhibit high housing supply elasticity.

The middle row of Figure B.9 presents the heterogeneous analysis by population density. We observe larger price effects in CZs with higher population density. This pattern holds across all voucher types, but is particularly pronounced for Title 0 and Title 1. Additionally, we do not observe any pre-trends in this analysis for any of the voucher types.

In the bottom row, the focus shifts to the share of new properties in each neighborhood. The price effects are most pronounced in areas with a higher share of new construction (Panels g, h, and i) with respect to the average. This is consistent with the greater responsiveness of supply in places that traditionally allow for new constructions or where developers are investing in new buildings.

These heterogeneous effects align with the previously estimated elasticities, particularly the differences between rent-to-own and new construction elasticities that suggest a low elasticity of supply in neighborhoods that are distant from the CBD. This evidence is valuable for designing housing assistance programs for low- and middle-income families. Both the overall supply response and its geographic variation across housing markets provide critical insights into the effects of subsidies for owner-occupied housing and other policies directed at vulnerable households.

6 Conclusions

This paper estimates housing supply elasticity, a crucial factor in understanding how housing markets respond to assistance policies. Using quasi-experimental variation from Chile's *Subsidio Habitacional* program and detailed administrative data on property transactions, we find that Santiago's short-term housing supply elasticity is 0.543. This implies that subsidizing owner-occupied housing will likely be capitalized into higher prices, rather than directly improving housing affordability for low- and middle-income households.

To examine the policy's differential impacts across housing markets, we estimate the elasticities of new-property (NP) and rent-to-own (RtO) transactions. The results indicate that the responsiveness of new properties to price increases is more than double that of rental properties transitioning to owner-occupied housing. This is particularly relevant for low- and middle-income neighborhoods in suburban areas, where the share of new constructions is relatively low compared to downtown areas. This rigidity suggests that developers may be converting too few rental units into owner-occupied housing, limiting opportunities for families seeking to transition to homeownership. Additionally, we argue that the low elasticity observed in suburban areas may be a combination of lack of infrastructure, low profitability for developers, and a relatively high rate of redevelopment in central areas.

Using these elasticity estimates, we assess the impact of the homeownership voucher on housing prices. The findings indicate that real prices rose by between 6.29% and 10.13% due to the policy. To validate our empirical strategy and strengthen the evidence on price effects, we conduct an event study that exploits the timing of the introduction of the program. We find a consistent positive effect across all vouchers, with an overall increase of 8.87%. Notably, there is significant heterogeneity across neighborhoods, which depends on the exposure overall exposure to the three vouchers. We notice that higher price effects are observed in Census Zones with higher population density, fewer new properties, and greater distance from the city's downtown.

Should governments subsidize owner-occupied housing? This study suggests that policymakers must account for the responsiveness of housing supply when designing assistance programs, especially in the neighborhoods that are more exposed to the program. Future research could explore the benefits of implementing complementary measures that stimulate supply, such as promoting new construction in low- and middle-income neighborhoods.

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Appendix

A Tables

Table A.1: OLS results for housing supply

	(1) lnPrice	(2) lnPrice	(3) lnPrice	(4) lnPrice	(5) lnPrice	(6) lnPrice
ln(Stock)	0.255***	0.275***	0.180***			
	(0.00383)	(0.00615)	(0.0121)			
ln(Transactions)				0.103***		
				(0.0157)		
ln(NP Transactions)					0.0802***	
					(0.00580)	
ln(RtO Transactions)						0.0531**
						(0.0185)
Implied elasticity ($\frac{1}{\beta}$)	3.921	3.636	5.556	9.701	12.469	18.832
Observations	15,857	15,857	15,857	15,858	15,858	15,858
R-squared	0.189	0.207	0.661	0.631	0.641	0.626
Fixed Effects	No	No	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	Yes	Yes	Yes

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Each cell corresponds to the estimate from running an OLS regression of housing stock or transactions on housing prices (both in logarithm). The regressions include controls at the neighborhood level, such as the share of different property types, the average construction year of properties, and total population. Year and neighborhood fixed effects are also included. "NP transactions" refers to new builds, while "RtO transactions" refers to the conversion of rental units to owner-occupied housing. Standard errors are clustered at the neighborhood level. Additionally, implied housing supply elasticities are calculated.

Table A.2: OLS results for other measures of prices

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Effects on Price per sq ft (in log)						
ln(Stock)	0.229***	0.148***	0.0736***			
	(0.00284)	(0.00444)	(0.00702)			
ln(Transactions)				0.0477***		
				(0.00801)		
ln(NP Transactions)					0.0362***	
					(0.00344)	
ln(RtO Transactions)						0.0260**
						(0.00962)
Implied Elasticity ($\frac{1}{\beta}$)	4.366	6.757	13.583	20.964	27.624	38.461
Observations	15,857	15,857	15,857	15,858	15,858	15,858
R-squared	0.276	0.333	0.670	0.660	0.663	0.658
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	Yes	Yes	Yes
	(7)	(8)	(9)	(10)	(11)	(12)
Panel B: Effects on SII's Property Appraisal Value (in log)						
ln(Stock)	0.406***	0.348***	0.223***			
	(0.00422)	(0.00742)	(0.0165)			
ln(Transactions)				0.234***		
				(0.0207)		
ln(NP Transactions)					0.203***	
					(0.00774)	
ln(RtO Transactions)						0.00102
						(0.0226)
Implied Elasticity ($\frac{1}{\beta}$)	2.463	2.874	4.484	4.273	4.926	N.R.
Observations	15,862	15,862	15,862	15,863	15,863	15,863
R-squared	0.330	0.364	0.663	0.654	0.702	0.630
Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	Yes	Yes	Yes

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Each cell corresponds to the estimate from running an OLS regression of housing stock or transactions on a measure of housing prices (all are log-transformed). Panel A shows results on price per square foot, while Panel B shows results on the appraisal value estimated by the Chilean Revenue Service (SII). The regressions include controls at the neighborhood level, such as the share of different property types, the average construction year of properties, and total population. Year and neighborhood fixed effects are also included. "NP transactions" refer to new builds, while "RtO transactions" refers to the conversion of rental units to owner-occupied housing. Standard errors are clustered at the neighborhood level. Additionally, implied housing supply elasticities are calculated. For non-significant coefficients the elasticity is not reported.

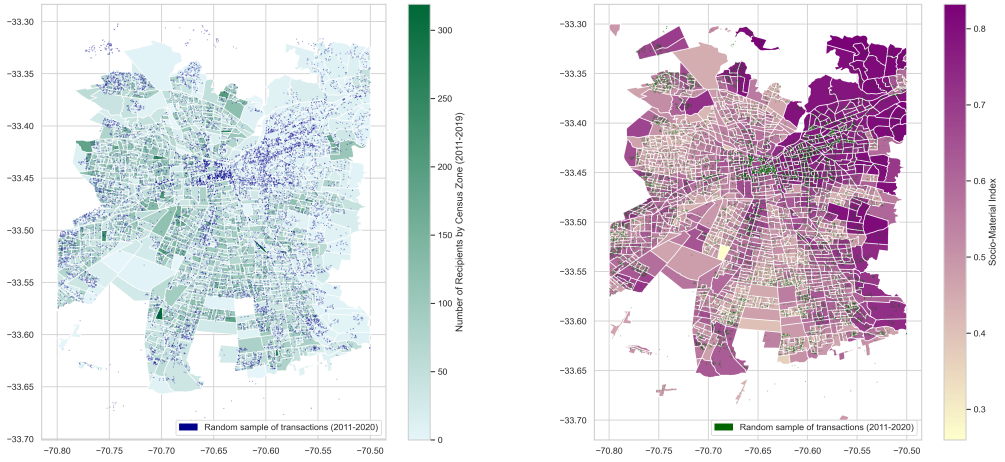
Table A.3: Reduced forms and first stages

	(1) ln(Price)	(2) ln(Price sqft)	(3) ln(AV)	(4) ln(Stock)	(5) ln(Trans.)
Shift-share instrument	0.0534***	0.0404***	0.0634***	0.0271*	0.0833***
	(0.00894)	(0.00437)	(0.0108)	(0.0118)	(0.00946)
Fixed Effects	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
Observations	15,831	15,831	15,834	15,834	15,834
R-squared	0.637	0.667	0.639	0.666	0.569

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Each cell corresponds to the estimate of an OLS regression of a variable on the shift-share instrument. Columns (1), (2), and (3) present the reduced form regressions on logarithm of price, price per square foot, and appraisal value, respectively. Columns (4) and (5) show the first stage results for housing stock and transactions (in logarithm). The regressions include controls at the neighborhood level, such as the share of different property types, the average construction year of properties, and total population. Year and neighborhood fixed effects are also included. Standard errors are clustered at the neighborhood level.

B Figures

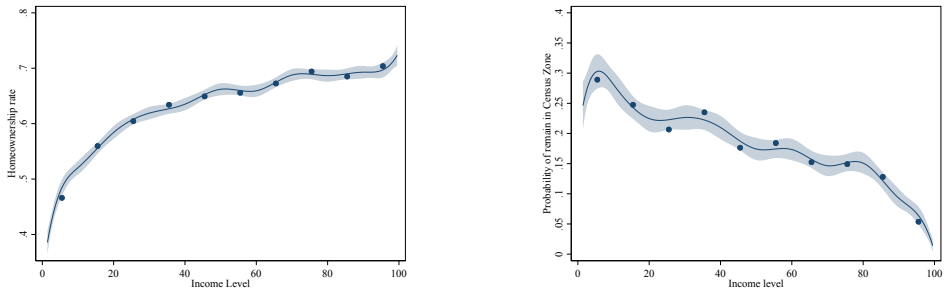
Figure B.1: Transactions, voucher recipients and neighborhood quality by CZ



(a) Voucher Recipients & Transactions (b) Socio-Territorial Index & Transactions

Note: This figure shows the spatial relationship between transactions, number of vouchers and housing quality at the neighborhood level. Panel (a) shows the number of voucher recipients at the Census Zone (CZ) level from 2011 to 2019 and a random sample of transactions. The number of recipients includes the sum of vouchers classified under Title 0, Title 1, and Title 2. Panel (b) displays the Socio-Territorial Index (ISMT), which measures housing quality and socioeconomic conditions, alongside the corresponding transactions aggregated at the CZ level for the same period.

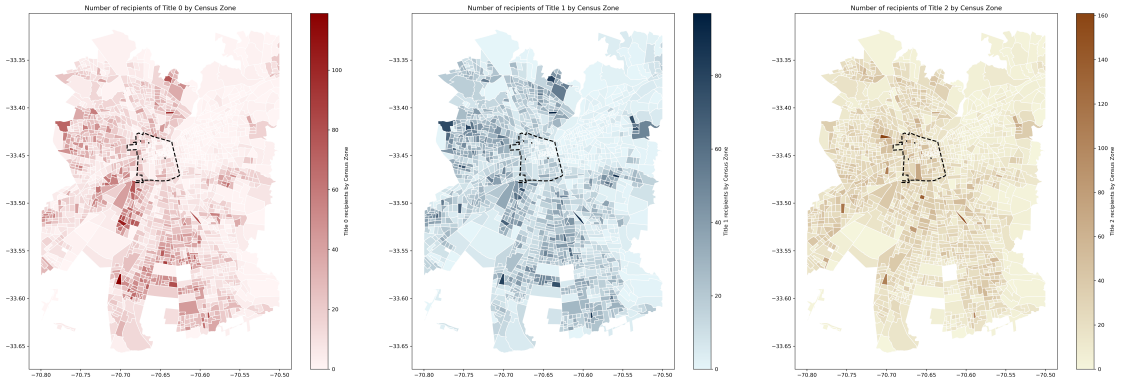
Figure B.2: Homeownership and moving probability by income level



(a) Homeownership by income (b) Probability to remain in nhbd by income

Note: The bin-scatter plots illustrate the homeownership rate and the probability of remaining in the Census Zone, both as functions of income level. In panel (a), we use data from the CASEN 2017 survey, which reports the tenure choices of individuals. In panel (b), we use voucher data, aggregated at the municipality level. Each bin represents deciles based on the average income of individuals in each municipality. The plots also include 95% confidence intervals. To make the plots, we use the method of Cattaneo et al. (2023) under the command *binsreg*, with a polynomial of degree 3 and 3 smoothness constraints.

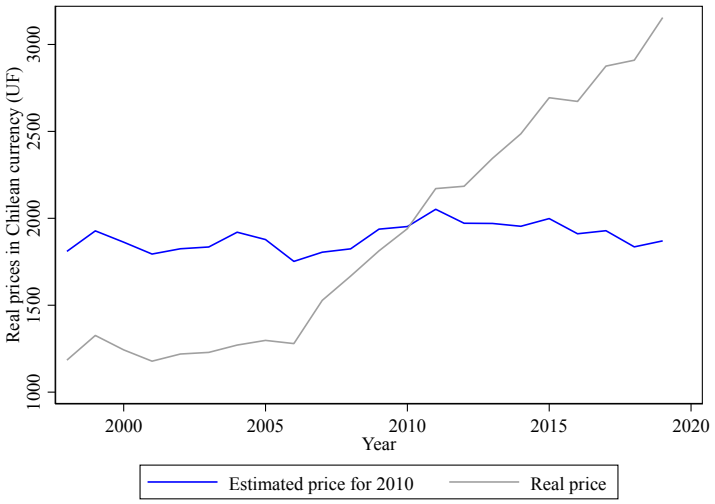
Figure B.3: Neighborhood choice by voucher recipients



(a) Title 0 (b) Title 1 (c) Title 2

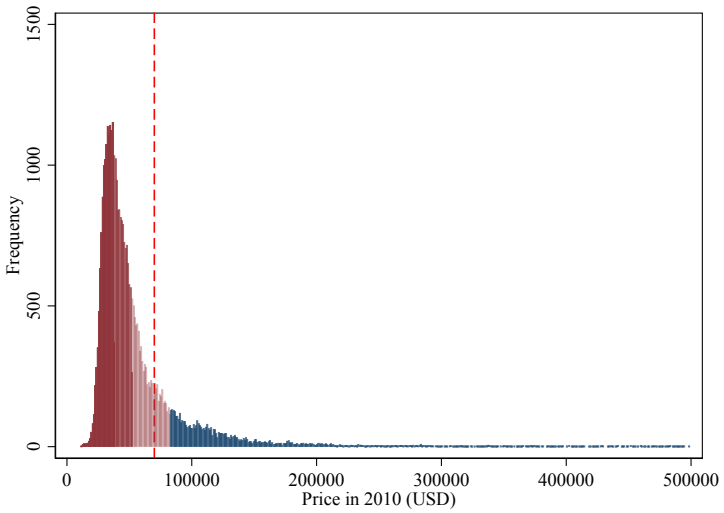
Note: This figure illustrates the residential location of voucher recipients at the Census Zone (CZ) level. The dashed line highlights the borders of the City's downtown, which we define as the municipality of Santiago. Panel (a) displays the neighborhoods of Title 0 voucher recipients, while Panels (b) and (c) show the same for recipients of Title 1 and Title 2 vouchers, respectively. Title 0 and Title 1 recipients tend to reside in the northern, western, and southern suburban areas, whereas Title 2 recipients are more widely distributed throughout the city, with a higher likelihood of residing in or around the downtown area.

Figure B.4: Evolution of prices



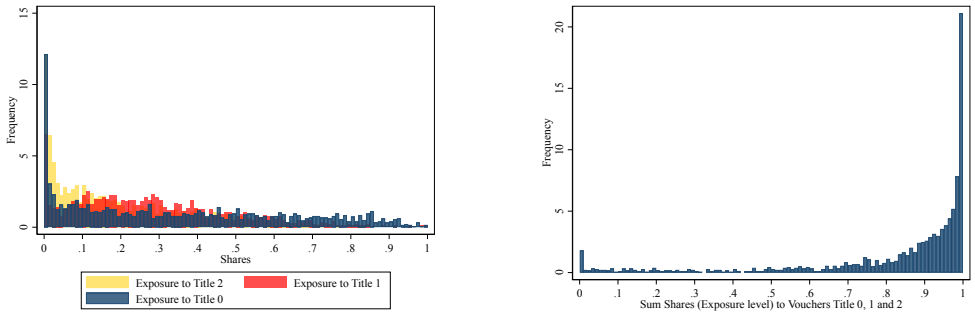
Note: This figure shows the evolution of average property prices over the years (in real terms) alongside the predicted prices for properties traded in all years, estimated at 2010 levels. The predicted prices are based on a regression of property prices on home characteristics such as size, age, type, and construction year. We include neighborhood, monthly and yearly fixed effects. The prediction is made using the estimated coefficients from the year 2010. As expected, estimated 2010-adjusted values are relatively constant for properties traded in different years. To build the indicator of exposure to the policy we only use data from before of 2011.

Figure B.5: Distribution of prices



Note: This figure shows the distribution of average Census Zone property prices in the year 2010, which serves as the basis for defining exposure to each voucher treatment. Properties eligible for Title 0 vouchers are highlighted in strong red, Title 1 eligible properties are in intermediate red, and Title 2 eligible properties are shown in light red. Areas that are not exposed to the voucher policy are depicted in blue. In the red dashed line, the figure shows the average price in Santiago de Chile in 2010, which is nearly USD70,000.

Figure B.6: Histogram of Census Zone's exposure to each voucher type

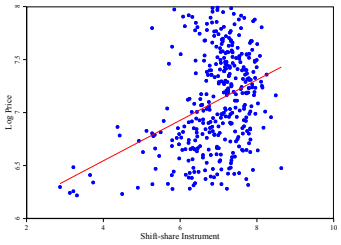


(a) Exposure to each voucher type

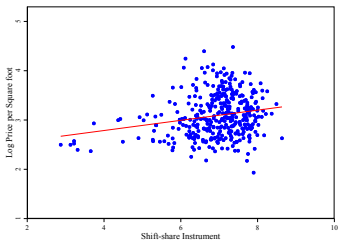
(b) Exposure to all vouchers

Note: This figure presents histograms depicting the distribution of Census Zones' exposure to the program. To create the exposure indicator we count all the properties in each Census Zone that in 2010 would have had a price eligible to be purchased by each voucher. Panel (a) illustrates the exposure to each voucher type separately. Panel (b) shows the aggregate exposure of Census Zones to all vouchers, highlighting the overall level of exposure across neighborhoods. See Section 4 for more explanation about the methodology to define exposure levels.

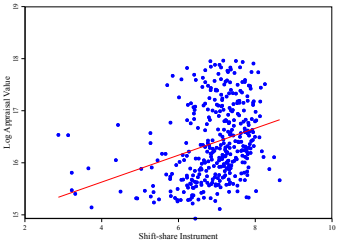
Figure B.7: Reduced forms and first stages scatter-plots



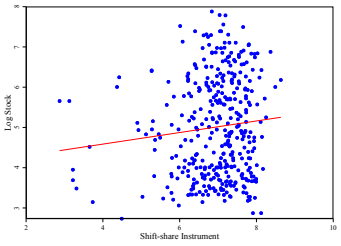
(a) Log Price



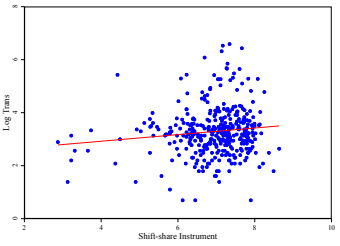
(b) Log Price per Square Foot



(c) Log Appraisal Value



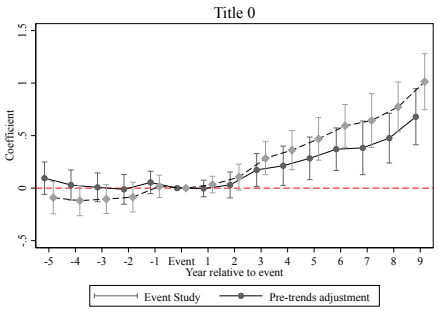
(d) Log Stock



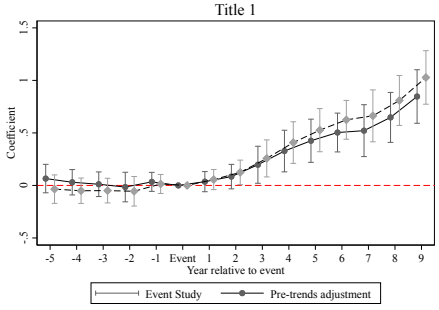
(e) Log Transactions

Note: This figure presents the reduced form and first stage results from the analysis. We present a random sample of 5% of the observations. Panels (a) to (c) display the reduced form relationships between the instrument and (a) Log Price, (b) Log Price per Square Foot, and (c) Log Appraisal Value. Panels (d) and (e) present the first stage results, where the instrument is used to predict (d) Log Stock and (e) Log Transactions. The significance of these relationships is detailed in Table A.3.

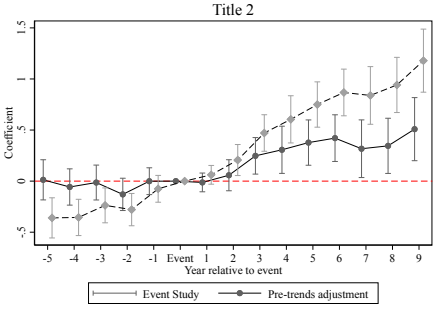
Figure B.8: Event Study on Local Prices with and without Pre-trends Adjustment



(a) Title 0



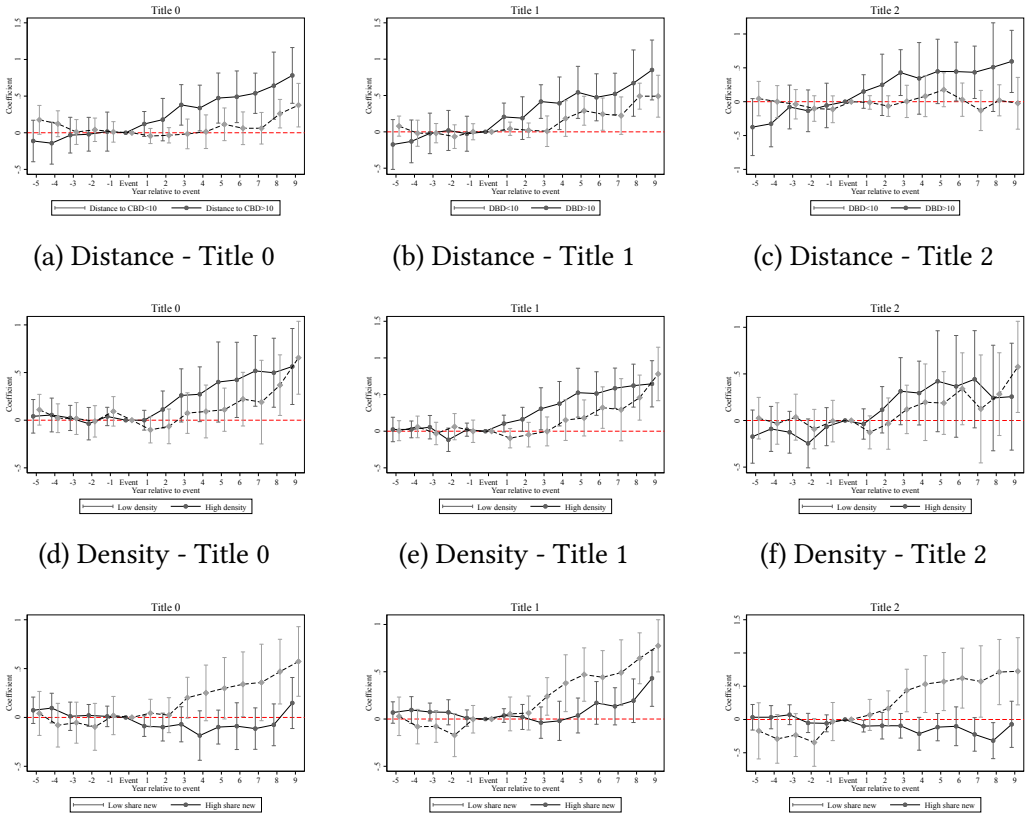
(b) Title 1



(c) Title 2

Note: This figure presents the results of an event study analyzing changes in property prices. Panel (a) shows the impact on prices for Title 0, Panel (b) for Title 1, and Panel (c) for Title 2. We make adjustments for pre-trends, following Freyaldenhoven et al. (2021). Bars represent 95 percent confidence intervals.

Figure B.9: Heterogeneous effects in an Event Study framework



(a) Distance - Title 0 (b) Distance - Title 1 (c) Distance - Title 2

(d) Density - Title 0 (e) Density - Title 1 (f) Density - Title 2

(g) Share new - Title 0 (h) Share new - Title 1 (i) Share new - Title 2

Note: The figure presents the results of an event study analyzing the heterogeneous effects of the voucher program on local property prices, broken down by three voucher types: Title 0, Title 1, and Title 2. The study examines three dimensions of heterogeneity: distance, density, and share of new properties. The top row shows the effect of the voucher program on property prices based on distance from the city center or a relevant focal point, with Panels (a), (b), and (c) corresponding to Title 0, Title 1, and Title 2, respectively, highlighting how prices respond differently depending on proximity to central areas. The middle row explores the effects based on neighborhood density, where Panels (d), (e), and (f) display the price impacts in lower- and higher-density areas for each voucher type, revealing the sensitivity of property prices to population density. The bottom row focuses on the price effects in neighborhoods with a higher share of new properties, with Panels (g), (h), and (i) showing the impact of each voucher type, illustrating how the presence of new constructions moderates the policy's impact. Bars represent 95 percent confidence intervals.