Essays on housing economics: the impacts of land use and voucher policies on affordable housing

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Declaration

I certify that the thesis I have presented for examination for the MPhil/Ph.D. degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it). The copyright of this thesis rests with the author. Quotation from it is permitted, provided that full acknowledgment is made. This thesis may not be reproduced without my prior written consent. I warrant that this authorization does not, to the best of my belief, infringe the rights of any third party.

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To my father,
Only those who are forgotten truly die
My education is a part of your lasting legacy.

*"Proa al norte. Aguante a toda máquina.
A puerto de recalada."*

ZULU
Salud y viento a un largo
Pedro Aravena Sánchez (1939-2024)

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This journey has been a gift that I will always be grateful for.

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Abstract

Housing affordability is a global policy challenge, particularly severe in large cities with long-term supply constraints and rising demand. This issue affects mainly the lowest income quintiles and arguably is increasing to middle-income familes, who face higher rent burdens and limited affordable options. Policymakers have attempted to address this through different policies, such as land use reforms and housing demand vouchers, but their impacts remain unclear. I use quasi-experimental shocks to estimate the causal effects of zoning policies in Los Angeles and New York, and a demand voucher in Chile.

In Los Angeles, incentivizing land use benefits targeting affordable units (inclusionary zoning) produces positive local results on the development probability and the number of units. However, these results are primarily in low-income and densely populated central neighbourhoods. Conversely, single-family districts show no significant effects on social housing outcomes, which acts as a disamenity that negatively impacts sales and face neighbors resistance.

In New York, I study the effects of a major land use reform applied to roughly 20% of the city. I leverage spatial heterogeneity to test if relaxing zoning constraints lowers housing prices. Results indicate contrasting effects: peripheral districts experience neighbourhood revitalizations that increase housing prices, driven by amenities that outweigh supply effects, whereas consolidated central districts show the opposite pattern.

Lastly, the voucher policy in Chile reveals that affordable housing developments in peripheral areas can promote social integration through attracting more educated families. These projects build better houses, increase green spaces, and build gathed communities that face less crimes. As predicted by theory, this leads to a modest increase in local housing prices in metropolitan areas with greater supply constraints.

In all cases the results are heterogenous: between central and peripheral areas (New York), socioeconomic status of neighborhoods (Los Angeles), and Metropolitan and smaller cities (Chile). This highlights the importance of causal evaluation, geography and that there are no silver bullets in housing policy.

Table of Contents

List of Figures

List of Tables

Chapter 1

Introduction

This thesis is at the intersection of urban planning and urban economics. It uses quasi-experimental methods to evaluate the causal effects of three urban policies on affordable housing, development trends, and social integration. The first two chapters focus on zoning changes in Los Angeles and New York, being the first about affordable housing production and the second on its impacts on housing prices; the third examines a nationwide Chilean demand voucher targeting prospective buyers in socially integrated developments.

This introduction is about the relationship between both fields and outlines the thesis contributions. First, I discuss the main aspects of policy evaluation in land use planning and housing policy, presenting my motivation for selecting the subject. Second, I provide an overview of each chapter, summarizing the research questions, methodologies, main results, contributions, and limitations.

It is worth noting that each chapter can be read as a standalone academic paper. While they are framed within the same broader subject, each section includes more in-depth introductions, literature reviews, and conclusions.

Overall, this thesis aims to understand how housing policy, through land use and demand vouchers, impacts the built environment. As a novelty, it underscores the importance of geography and its spatial heterogeneity in informing how local conditions influence policy outcomes; consequently, it shows that there are no silver bullets in this field. The dissertation shows in all chapters that there are heterogeneous effects between central and peripheral areas (New York), the socioeconomic status of the neighborhoods (Los Angeles), and the size of the city (Chile). This highlights the importance of proper design and understanding the local context to implement a successful housing policy.

1.1 Urban Planning and Urban Economics

Urbanization has brought various benefits to society - but housing affordability doesn't appear to be one of them. According to the United Nations, over 55% of the world's population lived in urban areas as of 2018, a figure projected to rise to nearly 68% by 2050 (UN, 2019). While urban settlements offer advantages such as increased economic activity (Glaeser, 2011), improved health outcomes (Shucksmith et al., 2009; Yusuf et al., 2007), and better access to education and human capital formation (Van Maarseveen, 2021), there are also remaining challenges, including segregation (Massey, 1993) and a shortage of affordable housing (Hilber & Schöni, 2022). By 2023, 2.8 billion people were affected by inadequate housing, and 1.1 billion still lived in slums (UN-HABITAT, 2023).

These issues have become major policy concerns as housing costs—whether measured through rent or mortgage payments—continue to outpace income growth, particularly in metropolitan areas. In many OECD countries, housing burden[1] affects a significant proportion of households (OECD, 2021a), especially those in the lowest income quintiles (Gabriel & Painter, 2020), who face the lack of affordable options (Collinson et al., 2019; Ellen et al., 2021) - these issues are arguably extending also to middle-income households. This strain is primarily driven by a combination of labor demand shocks and long-term supply constraints (Hilber & Mense, 2021), sparking debates among policymakers, economists, and urban planners on the most effective strategies to address the housing crisis. Paradoxically, this has led to the enactment of popular yet ineffective and costly policies, while potentially more effective solutions struggle to gain political support (Hilber & Schöni, 2022).

A motivation for this thesis is that although urban planning and urban economics intersect in various ways, perspectives on these topics often diverge. Urban planners primarily focus on designing and setting policy goals for the future of cities, while economists aim to understand how cities function and how previous policies impact different aspects of society (Makovsky, 2023). Under a scenario of growing planning policies to tackle societal challenges, the economics toolkit can provide valuable insights to planners and policymakers, especially when policies are replicated across different regions and social contexts, making it crucial to understand the drivers of success.

[1] Rent burden is typically defined as when a household pays more than 30% of their income on rent; severe rent burden is usually defined as exceeding 50%.

An ongoing debate centers around how zoning[2] affects housing affordability[3]. Historically, zoning has been used to regulate urban growth, preserve neighborhood characteristics, separate incompatible land uses, and ensure sanitary standards, such as adequate light and ventilation (Babcock, 1966). From a political perspective, it has also been a tool for controlling social trends. In the first half of the last century, zoning was used to segregate social classes and races by controlling neighborhood development, leading to the exclusion of many communities in American cities (Rothstein, 2018), with different long-term negative effects widely documented in the academic literature (Ananat, 2011; Bischoff & Reardon, 2014; Chetty et al., 2016; Jeffrey Kling et al., 2007; Lichter et al., 2015; Massey, 1995; Watson, 2009).

Conversely, in recent decades, there have been efforts to reverse exclusionary patterns by using zoning as an inclusionary tool to integrate low-income families into more affluent neighborhoods by setting aside affordable housing in private developments (Mukhija et al., 2015). The rationale is that allowing higher-density development can alleviate the supply constraints that drive up housing prices. Indeed, some scholars have noted that regions with more flexible zoning tend to experience lower housing costs (Glaeser & Gyourko, 2005; Manville et al., 2022). Motivated by the potential for local governments to actively complement federal programs to enhance affordability, supply-led solutions have become widely popular in countries like the United States (Nzau & Trillo, 2020).

While the case for zoning reforms is compelling, it is not without criticism. Detractors argue that allowing higher-density developments does not automatically improve affordability, particularly in high-demanded markets where the benefits of increased supply can be offset by the new amenities added (Rodriguez-Pose & Storper, 2020). Been et al. (2019) echo this concern, arguing that this mechanism alone does not solve the affordability challenge without considering other factors, such as tenant protections and thoughtful policy design. Furthermore, poorly designed policies can inadvertently raise housing costs and reduce overall housing production, highlighting the complexity of implementing zoning reforms (Freeman & Schuetz, 2017).

The complexity of zoning and the presence of counteracting forces underscore the need

[2]Zoning is part of the urban planning toolkit, alongside development control, transportation, and community engagement, among others. It refers to the process of designating land in a city, town, or borough for specific purposes, such as residential or commercial use. This thesis focuses specifically on land use planning, and unless otherwise specified, these terms are used interchangeably.

[3]Affordable housing refers to housing accessible to low-income families. While definitions vary globally, they focus on producing units that would not be affordable in the market, using tools like subsidies, rent control, or zoning. In the U.S., where I focus the first two chapters, policies often include demand vouchers, tax abatements, and land use planning; I focus solely on the latter. In Chile, affordable housing is linked to buyers. Each chapter will expand on these definitions.

for empirical research to inform policy design, particularly in understanding the nuanced impacts of zoning changes on different housing markets and socioeconomic contexts. For example, some case studies show a positive correlation with increased housing units (Dong, 2021; Greenaway-McGrevy & Phillips, 2023; Liao, 2023; Peng, 2023), while others report negative (Krimmel & Wang, 2023) or non-significant results (Freemark, 2020). Moreover, the effects on prices are even more volatile and less studied. These mixed results suggest that zoning's effectiveness depends on factors such as pre-existing market conditions, the scale of changes, and the socio-economic characteristics of the affected areas (Freeman & Schuetz, 2017).

Similarly, the effects of neighborhood improvements, whether through new or improved housing supply, have also been less studied in a causal context, and the empirical evidence remains mixed. As highlighted before, new developments can alter neighborhoods, with affluent families often having a higher willingness to pay for renovated projects and enhanced neighborhood amenities (Bayer et al., 2007; Diamond, 2016; Diamond & Mcquade, 2019; Handbury, 2021). This can help explain patterns of endogenous segregation driven by affluent families moving into low-income neighborhoods (Guerrieri et al., 2013). Also, public initiatives aimed at reducing segregation may not always trigger this effect, as seen in a large urban renewal process in Barcelona (González-Pampillón et al., 2020).

The debate around housing policies highlights the complexity of urban planning in contemporary cities and the challenges of policymaking. In both cases —whether rezoning or improving neighborhoods— there are unresolved questions about which factors derive into succeeding on policy goals, forming the overarching motivation of this thesis.

The ongoing debate over the efficacy of different policies reflects a deeper issue: the lack of a one-size-fits-all solution and the need for local context and robust techniques to inform these discussions. Although we often focus on general effects, housing markets inherently have local conditions, meaning that urban planning policies[4] must be carefully designed to avoid unintended consequences such as gentrification and displacement. Furthermore,

Economic theory and robust estimations can help to inform these discussions (Cheshire, 2007) and guide the urban planning process, which is critical not only for academics and policymakers but also for the millions of people affected by housing affordability issues worldwide.

[4] These are mostly local as they intervene on specific neighborhoods rather than on entire cities, which are less frequent

1.2 Thesis overview

The thesis is structured into two thematic blocks, each exploring different aspects of urban planning and housing economics. The first two papers examine the effects of land use changes on the production of affordable housing, their location patterns, and their impacts on local markets. The third paper investigates how a large-scale subsidy triggers urban renewal and its effects on population dynamics, specifically whether it can attract more affluent families to treated low-income areas.

A common attribute across all chapters is the use of empirical methods to study the causal impacts of each policy. I rely on Difference-in-Differences (DiD) methods and policy-specific features to exploit various quasi-experimental variations in space or time. This approach involves using techniques such as boundary discontinuities, matching, event studies, and machine learning algorithms. Additionally, in each chapter, I present different mechanisms to align the empirical findings with theoretical conjectures.

By assembling spatial datasets, I also study how geography plays a determinant role in the spatial heterogeneity of each policy. For example, this approach helps to understand how developers react to zoning incentives and where they choose to build affordable housing within a supply-constrained city like Los Angeles, California. Similarly, when dividing upzoning in New York, the effects are heterogeneous, as prices tend to increase in peripheral districts, while the opposite occurs in central tracts.

Due to the nature of quasi-experimental designs, it is crucial to recognize the limitations of these methods, which I detail in each paper. Despite the specifics of each policy and method, DiD methods rely on several assumptions: common trends before the policy intervention, no simultaneous policies affecting the outcome, no spillover effects between treated and untreated units, and no anticipatory behaviors in the treated group. Violations of these assumptions can lead to potential biases from unobserved confounders not controlled for in the baseline models. These threats to validity are common when randomization is not achieved. Nonetheless, considerable effort was made to control for, avoid, and report potential sources of bias and confounding shocks. Furthermore, the methods used in this research don't reflect the general equilibrium of a city, meaning that the studied effects are local.

Although general equilibrium is not studied in this thesis, understanding local effects is also important. For example, if a policy drives up local prices, it impacts on housing affordability issues that may lead to the displacement of disadvantaged community groups.

Research has shown that the local effects on prices can negatively affects displacement and evictions (Raymond et al., 2021), lead to losses in low-skilled jobs (Meltzer & Ghorbani, 2017), disrupt social networks (Du et al., 2023), and even reduces political influence for long-term neighbors (Martin, 2007). As previously highlighted, even the same policy does not yield consistent outcomes in local prices, which are the primary mechanism explaining displacement. Therefore, a better understanding of these impacts can help to inform urban policy design.

Additionally, concerns about external validity are always relevant when interpreting the results of this research. As discussed in each chapter, the same policy can have different impacts based on baseline market and socioeconomic conditions, leading to heterogeneous responses. Thus, the applicability of these findings to other contexts is constrained by similarities in time and space to the specific cases studied. For example, the first two chapters focus on zoning changes in large metropolitan areas with established land use codes; applying these results to smaller cities or regions without such codes may lead to biased interpretations. On a similar note, the Chilean case study focuses on would-be-buyers vouchers, which incentives might be difficult to replace on rental policies.

Finally, due to data limitations, this thesis focuses primarily on the short- and medium-term effects of each policy, which is common in a field where most programs are continuously evolving. For example, I evaluate a density bonus policy in Los Angeles, California, enacted in 2017, although similar policies have existed in the city since the 1980s.

In the next subsections, I provide an overview of each chapter, describing the policy, data and methods, results, main interpretations, and contributions to the literature.

1.2.1 Overall contributions

Overall, the thesis makes contributions to housing policy and planning by providing causal estimates of how land use changes and new affordable housing developments operate in peripheral areas, along with their local (un)intended consequences. Both initiatives can impact the built environment, but these effects are heterogeneous across different geographic areas, a dimension that is not commonly taken into consideration when designing policy incentives.

First, when designing incentives targeting affordable housing through land use benefits, developers are likely to respond by focusing on low-income areas. However, this does not change the demographic composition or development trends of these neighborhoods. More importantly, affluent local communities are not indifferent to these projects, as they are perceived as disamenities. Hence, inclusionary zoning can help to boost the local housing supply in constrained cities like Los Angeles, but it seems that it can't change developments patterns.

Second, upzoning can help boost the local housing supply, but it can also trigger other counteracting effects, such as enhancing the local amenity value of a neighborhood. Paradoxically, this occurs in peripheral areas where housing is more affordable, suggesting that low-income communities might be negatively affected by these policies.

Third, building affordable housing in peripheral areas yields similar results to upzoning. When the existing housing stock remains unchanged beyond the new developments, the increased amenity value attracts more educated residents. While this is important for social integration, it is important to track long-term effects to assess the potential displacement of low-income communities.

1.2.2 Chapters overview

Chapter 1: Inclusive but Concentrated: The impacts of Voluntary Inclusionary Zoning

In this chapter, I study the impacts of a Voluntary Inclusionary Zoning (VIZ) policy adopted in Los Angeles, California, aimed at addressing the housing shortage and the city's affordability problems while promoting social inclusion in well-connected transportation hubs. Specifically, I focus on the Transit Oriented Communities (TOC) program by leveraging the policy's boundary through a Difference-in-Differences approach that compares treated areas with their adjacent districts.

The policy offers a generous density bonus in exchange for affordable housing when developments are near transportation hubs, as defined by the Los Angeles Planning Department. The treatment buffers are scattered heterogeneously across the city, providing an opportunity to assess not only the overall effectiveness of the program but also the location patterns and their underlying drivers. These questions are crucial, as more than 30 of the top 100 metropolitan areas in the US have enacted similar policies (Soltas, 2022), a trend also observed in Europe and emerging in metropolitan areas of Latin America.

The findings indicate that the policy increases the likelihood of developing affordable housing by 2.8% to 3.3%, resulting in more affordable units compared to adjacent untreated areas. However, these effects are significant only in proximity to low-income neighborhoods where market rents are similar to subsidized units, with the probability increasing by up to

4.0% without substantially affecting nearby transactions and rents. In contrast, in affluent areas, the policy does not lead to an increase in subsidized units and is associated with a decrease in housing prices when new projects are introduced in single-family neighborhoods that are resistant to large-scale development. This effect is particularly observed within the first 250 meters of new affordable projects. Additionally, the average rent in multifamily developments that include affordable housing shows a negative premium in this group.

In this chapter, I argue that two factors can explain these effects. On the one hand, affordable housing is perceived as a disamenity in affluent neighborhoods, as evidenced by decreases in rents and lawsuits from neighbors against such developments. On the other hand, developers enhance their profits when building in low-income neighborhoods, which is associated with lower costs compared to wealthier areas (assuming they maintain the overall quality of each neighborhood), and there are no negative premiums in these areas. Consequently, the zoning bonus can enhance their profits.

The local average treatment effects suggest that in the first group of neighborhoods, building permits show an increase in market-rate units but not in the number of developments, implying a substitution between purely market-rate and mixed-income projects. In contrast, no significant change is observed in other areas. The study highlights that zoning incentives can promote affordable housing without reducing market-rate units. Still, the benefits are concentrated in areas that proxy to low-income neighborhoods and where market rents are similar to affordable housing vouchers. This indicates that the policy may fall short of its goal to deconcentrate poverty and foster social inclusion across the city.

The varying effectiveness of TOC across different neighborhoods suggests that the success of such policies depends heavily on the local economic context and the specific characteristics of the targeted areas. This underscores the need for flexible policy designs that can adapt to the unique conditions of different urban environments.

Lastly, this paper adds a methodological contribution by using spatially constrained machine learning algorithms to define functional areas. Thanks to these, the heterogeneity analysis is not only more robust but also reduces the use of discretionary groups when subsampling, allowing for a more granular and accurate assessment of how local characteristics influence the effectiveness of housing policies.

Chapter 2: Upzoning New York. The economic impact of public rezoning

The second chapter examines a substantial upzoning reform process initiated by Mayor Bloomberg's administration in various parts of New York City. I exploit the heterogeneous locations of these policies, implemented between 2007 and 2013, to compare the impacts of relaxing constraints (local supply effects) against the amenity effects that new construction can trigger—effects that may ultimately outweigh the benefits of these policies if neighborhood renewal processes occur.

I conduct hedonic event studies of housing prices and housing supply to assess the local impacts of the policy. While a substantial body of literature explores citywide land-use effects on housing supply (Glaeser & Gyourko, 2005; Glaeser & Gyourko, 2002; Hilber & Vermeulen, 2016), few studies investigate the local effects on neighborhood changes following the implementation of such policies, some of which present counteracting results. By working within the city, I test for location heterogeneities and provide disaggregated results for different neighborhoods, using adjacent areas as a control to evaluate the aggregate shock over the timeframe.

The overall local effects show a decline in housing prices in treated areas. Unlike previous studies that often focus only on the overall results, this paper adds a geographic dimension by exploiting spatial heterogeneity within a single city. By focusing on intra-city variations, the study captures differences in neighborhood changes that previous studies don't. Interestingly, the results diverge when comparing rezoning in peripheral and central. In peripheral areas, upzoning leads to a local increase in housing prices four to five years after implementation. In central areas, however, housing prices decrease post-implementation.

By identifying the factors that drive these heterogeneous effects—namely, location and development potential—the paper reconciles countervailing results from previous studies. It shows that while some studies found that new construction reduces housing prices in central developed areas, others observed price increases in peripheral areas. This nuanced understanding adds depth to the existing literature on the impacts of housing policies.

To understand the mechanisms driving these outcomes, I explore how upzoning correlates with different build environment variables such as new units, developments, commercial areas and height. Furthermore, I also separate sales by the median to test if older units increase their option value after upzoning. Results show, on overall, that the policy increases the local housing supply. Moreover, local amenity effects are larger than local supply effects in peripheral areas, while the opposite happens in central districts.

Finally, in both peripheral and central areas, there is an initial surge in new affordable housing projects following the enactment of the new zoning code. However, this trend reverses in subsequent years, with significantly fewer developments than in adjacent areas. By spatially disaggregating the policy effects, this paper demonstrates how location and the built environment must be considered in decision-making, as policy outcomes can vary significantly even within a single city.

The mixed outcomes of upzoning in New York underscore the importance of considering spatial heterogeneity when designing and evaluating urban policies. The success of such policies may depend not only on the scale of the zoning changes but also on the specific characteristics of the neighborhoods in which they are implemented and how neighborhood change is a crucial factor in predicting policy success.

Chapter 3: Paying for integration. The impacts of a mixed-income housing demand voucher in Chile

The last chapter examines the impact of a significant demand-side voucher program in Chile (DS-19) on social integration through a financial incentive targeting middle-income families willing to live in mixed-income developments. These developments are primarily located on the outskirts and are incentivized by larger subsidies than usual grants, along with new infrastructure that enhances neighborhood amenities and construction quality.

I evaluate the impacts and spillovers on neighborhood demographics using a difference-in-differences strategy to separately identify the causal effects of the policy on (i) the treated areas and (ii) the surrounding neighborhoods. To address non-random assignment, the absence of a defined control group, and neighborhood heterogeneity, I employ propensity score matching. I first analyze the effects of the policy on household heads with low and high educational attainment and then examine built-environment dynamics such as new construction, amenities, and sales.

The paper extends the understanding of spillover effects by demonstrating that new housing projects in impoverished areas can have positive impacts not only within the target neighborhoods but also in adjacent regions. This contrasts with previous research that has primarily focused on direct effects within the neighborhoods receiving the intervention.

The overall results indicate that the policy encourages more educated families to move into the treated areas, with a small spillover effect on adjacent neighborhoods. These effects are more pronounced in metropolitan areas, where land scarcity and housing shortages are more severe, making spillover effects significant, particularly for college degree.

As potential mechanisms, I find that DS-19 projects primarily drive neighborhood changes, as they add significantly more units in the treated blocks, while there is limited new construction in adjacent blocks. The new developments provide increased amenities, such as gatted communities that translate into lower crimes rates, green spaces, and higher housing quality.

The new amenities lead to higher housing prices in metropolitan areas; however, this effect is constrained by the subsidy, which imposes a price ceiling that limits the extent of the increase. This impact is likely concentrated in partially subsidized houses, as units predominantly funded by the government tend to drive prices down mechanically due to the significant subsidies applied to them. These units are typically reserved for very low-income families.

The findings suggest that a financial incentive can catalyze social integration through neighborhood revitalization, particularly in larger cities, even when the projects are located in peripheral areas.

Chapter 2

Inclusive but Concentrated: The impacts of Voluntary Inclusionary Zoning

2.1 Introduction

Housing affordability has increasingly become a global policy challenge, especially in large cities facing constant demand increases and long-term supply constraints (Hilber & Schöni, 2022). While this issue exacerbates in the lowest income quintiles (Gabriel & Painter, 2020) due to a higher rent burden and the lack of affordable options (Collinson et al., 2019; Ellen et al., 2021; OECD, 2021b), the rates of evictions and the income-to-housing ratio continues to climb (Desmond, 2018).

In the US, Inclusionary Zoning[1] (IZ) is one of the most prominent supply-led policies implemented by local governments since they can actively complement federal programs to enhance affordability (Nzau & Trillo, 2020). To illustrate, as of 2020, 33 of the top 100 U.S. cities by population had adopted a form of inclusionary housing (Soltas, 2022). These policies rely on designing land use incentives in exchange for affordable units in market-rate developments. The underlying rationale is to release supply constraints while helping to revert the current patterns of segregation (Hamilton, 2021), which outcomes are associated with better opportunities and welfare (Chetty et al., 2016). Similarly, these policies have also been used to increase the subsidized stock in specific locations like near transit stations, as they also help to reduce transportation costs in areas that usually lack affordable options (Singer, 2021).

[1]Inclusionary Zoning -sometimes called Inclusionary Housing- is a set of land use policies that grant extra benefits when new developments set aside a percentage for affordable units. If the zoning code is mandatory, it's called mandatory; if it's not, then it's voluntary.

This chapter examines how an inclusionary zoning policy increases the affordable housing stock in a supply-constrained city like Los Angeles, California. Despite IZ's popularity and success in creating more affordable units than federal policies (Freeman & Schuetz, 2017; Mukhija et al., 2010), its impacts remain unclear. While the existing literature has extensively documented the effects of relaxing land use on the overall housing supply and prices (Glaeser & Gyourko, 2005; Glaeser & Gyourko, 2018; Hilber & Vermeulen, 2010, 2016), the relationship between zoning and its local outcomes remain unclear, imposing empirical questions due to its heterogeneity on policy implementation, design, and population targets (Schuetz et al., 2009; Wang & Fu, 2022). Furthermore, the lack of clarity on the causal mechanisms impose questions on what are the drivers that trigger changes as, in many cases, they are also costly, ineffective, and lead to fiscal losses (Hilber & Schöni, 2022; Soltas, 2022).

An unexplored question regards how developers react to these benefits when the land use benefits are voluntary instead of mandatory, being the latest associated to a tax on developments that pose adverse outcomes on the market (Krimmel & Wang, 2023; Saiz, 2023; Schuetz & Meltzer, 2012).

To inform this discussion, I assess the impacts of a zoning bonus in Los Angeles, California, called Transit Oriented Communities (TOC). At the end of 2017, the program implemented a non-mandatory zoning bonus near major transit stations for developers willing to add affordable housing in mixed-income developments, which can be through new construction or the acquisition and rehabilitation of existing buildings. The policy also aims to reduce approval times, which are triggered after recording a 55-year covenant, starting since the issuing of the Certificate of Occupancy.

By studying the spatial and temporal discontinuities in a balanced panel across 500 meters of the boundary[2], I aim to answer the following questions:

1. Can inclusionary zoning increase the affordable housing stock?
2. If so, are developers' responses heterogeneous across the city?
3. Do inclusionary zoning impact housing prices and overall development trends?

If the overarching goal of relaxing land-use restrictions is to increase the housing supply, the effects on local markets are relevant to understanding how this policy can influence development decisions. On the one hand, developers are expected to react favorably to the incentives in areas where market rents are similar to city-wide subsidies. Nevertheless, this might vanish when affordable housing doesn't reflect development trends, as profits can be

[2] I run models with different bandwidths and test the robustness of the results in later sections.

lower than the baseline scenario. When price ceilings and development costs differ from market trends, profits should vary and influence on development decisions. On the other hand, single-family communities can be reluctant to increase density in their neighborhoods when these developments are perceived as a disamenity that impacts on quality of life or housing prices. As seen in Los Angeles, there have been lawsuits against TOC due to its impacts on the built environment, which supports this hypothesis.

Based on these theoretical predictions, I evaluate if TOC stimulates the production of affordable housing in the targeted areas. Secondly, I test if developments concentrate in areas with lower opportunity costs between market and affordable rents as well as their mechanisms. For this purpose, I group neighborhoods by rent, and use a machine learning algorithm to cluster them spatially based on density, type of residential developments, and socioeconomic characteristics. Finally, I study the policy externalities regarding housing prices and new market-rate developments.

I compile a panel dataset of Census Tracts on affordable housing and building permits as well as cross-sectional data on listings, sales, and construction quality. I exploit the policy boundary discontinuity -shown in Figure 2.1 in Section 2.2.1- by using a Difference-in-Difference design that leverages similarities between treated tracts near the boundary and their adjacent areas to test for the impacts of TOC. Notwithstanding the treatment allocation is not random and might impact developers' self-selection, I provide evidence that suggests parallel trends and a balanced sample in the first 500-meter bandwidth[3]. I also test for potential displacement effects across the boundary to check my model robustness to isolate the causal effects of the policy in question.

The main results indicate that the policy significantly increases the probability of developing affordable housing near the boundary between 2.8% to 3.3%, also translating into more buildings and units in the treated areas. These results are consistent for different bandwidths within a one-kilometer buffer on both sides of the boundary. The estimations also show that the increase is due to TOC rather than previous zoning policies.

I propose a simple framework that assumes profit-seeker developers and how they decide on whether to take the voluntary incentives of TOC. As shown in Section 2.2.1 there are three forces. First, there are supply forces that can make this option attractive, especially in high-density areas where initial density amplifies the impact. Second, if the development is located in areas where affordable housing is perceived as a dismanenity, the impacts on

[3]It's worth mentioning that this bandwidth is equivalent to 2-3 blocks on each side of the boundary. I test for different distances in the empirical section.

rents and prices should be negative, which decreases profits. Third, in a context where housing vouchers are constant across the city, the opportunity costs for developers increase in areas with high amenity value, negatively impacting profits. I propose that, when dividing between low- and high-end neighborhoods, these forces can be clearly understood to derive relevant policy conclusions about TOC.

When studying the model heterogeneities, the results are consistent with the theoretical predictions, indicating that affordable housing is more likely to occur in tracts below median rents, increasing its chances to 4% as well as to more extra units and developments. Conversely, there are no significant changes in affluent areas. To reduce potential biases when grouping tracts, I use machine learning algorithms to cluster by rent and throughout space. Furthermore, by developing functional areas, I also show that the effects concentrate in central areas with higher densities and lots zoned for multifamily purposes.

I explore two potential mechanisms to explain my results. First, I study the impact of affordable housing on residential sales. The findings indicate a decline of approximately 7.7% in neighborhoods with above-median rents following the construction of these developments; similarly, property values declined 5.6% in single-family areas after building mixed-income housing. This suggests a pattern of opposition that is further validated by different lawsuits against TOC. Second, I run a cross-sectional analysis of build-to-rent developments that reveals how affordable housing is negatively correlated with rents in above-median and single-family neighborhoods. Additionally, these areas tend to incur higher construction costs, which also negatively affect profitability and reduce developers' propensity to invest in these neighborhoods.

Lastly, I use propensity score matching (PSM) to pair treated tracts based on different affordable housing determinants to test how TOC impacts building permits. The results are aligned with the first set of regressions, indicating positive effects on developing affordable housing in below-median rent tracts for both affordable and market-rate units. Specifically, for each subsidized unit, five market-rents units are built, suggesting development trends aligned with TOC, which typically feature a proportion of affordable units fluctuating between 10% and 20%. Finally, I use this approach to examine the policy's impact in areas further away from the initial bandwidth, finding similar patterns, too.

Overall, the results suggest that TOC increases the affordable housing and market-rent stock in the treated area, meaning that the policy might be a suitable catalyst for increasing the subsidized stock in Los Angeles. Nonetheless, the program fails to comply with the ethos of inclusionary zoning, as it doesn't change the location patterns of these projects.

Due to the empirical strategy, there are caveats in the interpretation of the results. Firstly, the results are local and do not represent a general equilibrium of the Los Angeles housing market. Although I demonstrate that there are no displacement effects within the 500-meter bandwidth, I cannot rule out the possibility that local effects may trigger changes in other neighborhoods within the conurbation. Additionally, there may be specific affluent neighborhoods where affordable housing is not perceived as a disamenity that negatively impacts rents and sales. Similarly, I cannot dismiss the possibility of spillover effects beyond the distances studied[4]. Secondly, although I use PSM to analyze city-wide results, these findings should be interpreted with caution, as places like central tracts within the heart of Los Angeles CBD don't have a perfect counterfactual.

Los Angeles offers an interesting case study as it has one of the more inelastic markets in the US[5] (Saiz, 2010) while it currently ranks first in homelessness and second in overcrowding, unaffordability, vacancy rates, and the ratio between new construction and new jobs (Zhu et al., 2021). Moreover, as Hilber and Schöni (2022) mention, affordability issues tend to exacerbate in super-star cities and tourist destinations that suffer from high demand and binding supply constraints. Consequently, the lessons derived from this study can enlighten other metropolitan areas aiming to implement similar policies.

The paper relates to the previous literature on affordable housing and land use policies in the US. Numerous empirical studies highlight how stringent land use policies impact housing prices (Glaeser & Gyourko, 2003; Quigley et al., 2005; Saks, 2008), affordability (Molloy, 2020), and its production (Gyourko & Molloy, 2015), which effects exacerbate in large cities (Gyourko et al., 2013). At the local level, different authors have found that increasing the supply stock can bolster housing affordability through rent reductions (Asquith et al., 2019; X. Li, 2019; Pennington, 2021). Regarding the stock of affordable housing, inclusionary zoning can help to increase its production depending on market conditions (Freeman & Schuetz, 2017; Levy et al., 2012; Schuetz & Meltzer, 2012), zoning stringency (Bento et al., 2009; Schuetz et al., 2009) and the benefits and restrictions of its design (Mock et al., 2023; Mukhija et al., 2015; Schuetz & Meltzer, 2012; Wang & Fu, 2022).

Notwithstanding the large number of papers on IZ, most of the literature relies on descriptive statistics, financial analyses, or non-robust econometrics to derive conclusions.

[4]To address this concern, I examine price and quantity spillovers over larger distances in my robustness checks

[5]According to Saiz (2010), Los Angeles is a supply-constrained area with a supply price elasticity of 0.63, ranking two among the metropolitan areas with a population over 500,000 inhabitants.

More importantly, none of the studies address the mechanisms and the effects on market developments, something that, to the author's knowledge, is a gap in the IZ literature.

Regarding TOC, there have been few exploratory studies and policy reports indicating positive impacts on affordable housing following its implementation. The Terner Center (2019) published a policy report on how TOC has helped to increase the number of affordable units in Los Angeles, for which relies on Los Angeles' Department of City Planning data. Phillips (2024) simulates how changes in rent growth and density premiums can disincentivize developing under TOC. Lastly, the closest work to this paper was written by Zhu et al. (2021), who focus on financial calculations by neighborhoods to compare the internal rate of return (IRR) between as-of-right and mixed-income developments. They conclude that moderate markets are likely the most advantageous locations to capitalize on the policy benefits, which align with the locations of many developments. Additionally, they suggest that developers might benefit from building in affluent neighborhoods due to the increase in structural density.

Besides the lack of causal inference, these papers do not account for different market, social and political forces acting at the same time that can also influence financial outcomes when building affordable housing. On the one hand, there might be neighborhood resistance to these projects, which can influence housing prices and push away developers, avoiding community conflicts. On the other hand, affordable housing can impose different opportunity costs, even if a developer can produce more units, as they may negatively impact housing rents and production costs across locations. Both of these forces are empirically explored in Section 5.

The paper is structured as follows. Section 2 describes the policy and the theoretical predictions to guide the empirical analysis. Section 3 presents the data and its summary statistics. Section 4 develops the empirical strategy and presents the main results of TOC on producing affordable housing and their location patterns. Section 5 describes two mechanisms regarding the impacts of social housing on residential sales and in development profits. Section 6 presents the impacts of TOC on the overall housing market and city-wide. Section 7 provides different robustness checks. Finally, Section 8 concludes the work and discusses the policy implications of inclusionary zoning.

2.2 Policy Background and Theoretical Predictions

2.2.1 Policy Background: The Transit Oriented Communities

Under the voter-approved *Measure JJJ* of November 2016, the City Planning Department of Los Angeles adopted in September 2017 the Transit Oriented Communities (TOC) incentives program to increase the city's subsidized housing stock. The overarching goal is to grant land-use benefits that promote the construction of affordable units in mixed-income developments near major public transport stations[6].

The policy is based on a tiered structure that grants zoning incentives based on the distance to different transit infrastructures, which incentives are shown in Table 2.1. The first tier relates to a buffer between 750 to 2,640 ft to bus stops and rail lines. The second and third groups define lower distances. The last category covers a 750 ft buffer from metro rail stations that intersects with rail lines and buses. As shown in Figure 2.1, many of the buffers overlap, generating a large mass of land potentially benefited by the policy, including the city center and some peripheral areas.

TOC operates through generous zoning benefits such as FAR, density, and heights to increase the units per development, in exchange for a fraction of affordable dwellings. For this purpose, it increases the incentives and requirements of the still existing Density Bonus (DB) introduced in 2008. On the one hand, the new policy offers extra FAR between 50% to 80% instead of the 20% to 35% from the previous version. On the other hand, the affordability obligations almost double the rates of the preceding requirements[7]. Additionally, TOC also includes very low-income (VLI)[8] households in exchange for larger zoning incentives than when subsidizing less modest households[9], something that the previous DB don't offer.

As summarized in Table 2.1, the affordability requirements are stable across tiers for each socioeconomic group, while they differ between income groups, but a larger percentage of

[6] More details about the rationale in the Los Angeles City Planning website.

[7] To illustrate, TOC requires between 20% to 25% of Low-Income units, while DB asked for 10% to 20%. Similarly, the first policy requests 11% to 15% of Very Low-Income units instead of the previous 5% to 11%.

[8] The Policy defines three groups: (1) Extremely Low Income (ELI), (2) Very Low Income (VLI), and (3) Low Income (LI) which are based on city-wide Average Median Income (AMI) definitions which are 30%, 50%, and 80%, respectively.

[9] For instance, a developer can obtain a 50% density and 40% FAR increase in exchange for including 20% of low-income or 8% of extremely low-income dwellings. The benefits and requirements vary per AMI, as shown in Section 2.1.

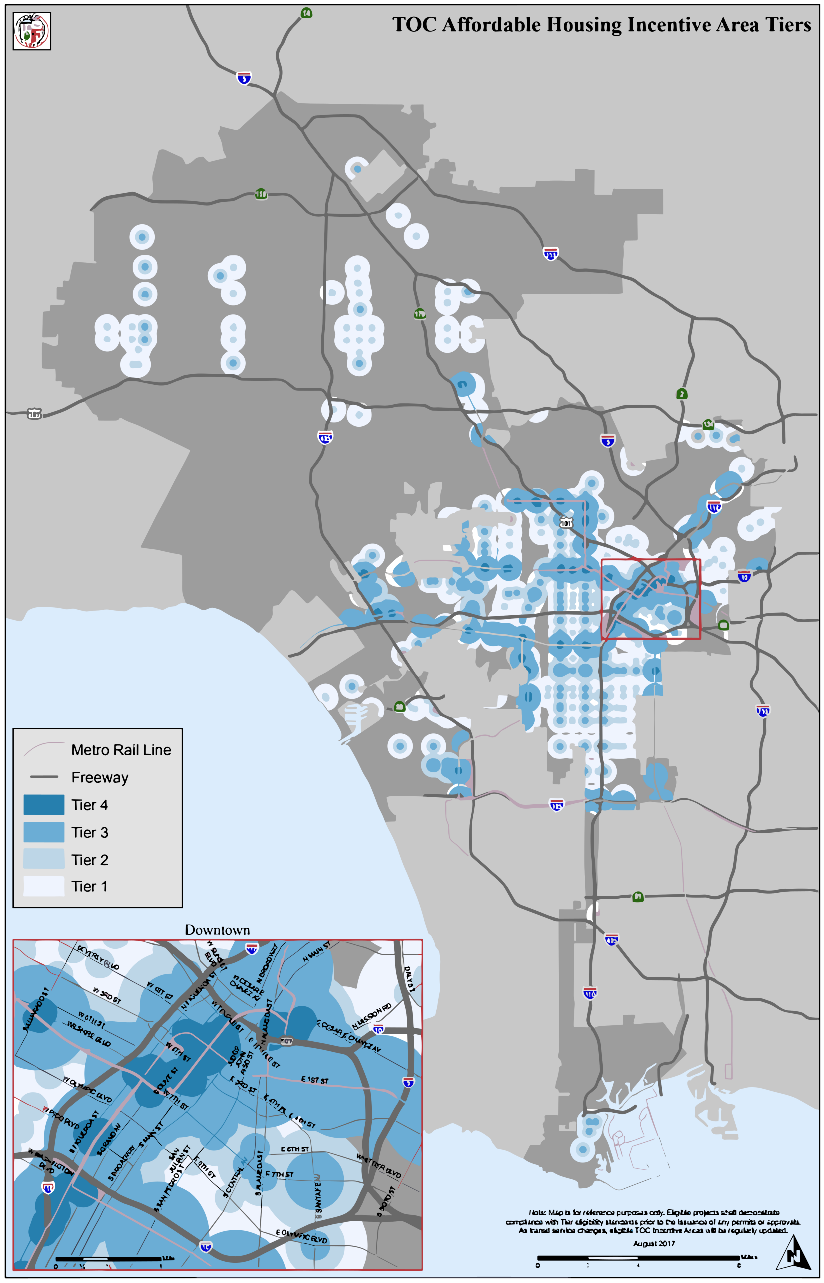


Figure 2.1: TOC Incentive Areas. Source: LA Planning

affordable units is required when the target is less poor. Lastly, as shown in the Table, the baseline market-rate units are always outweighed when taking the policy.

Table 2.1: Transit Oriented Communities (TOC) Requirements and Affordability Tiers

	Income groups			Base Incentive		Pctg. Market Rate			Pctg. Affordable		
	(ELI)	(VLI)	(LI)	Density	FAR	ELI	VLI	LI	ELI	VLI	LI
Tier 1	8%	11%	20%	50%	40%	129%	125%	112%	11%	15%	28%
Tier 2	9%	12%	21%	60%	45%	132%	128%	115%	13%	17%	30%
Tier 3	10%	14%	23%	70%	50%	135%	129%	116%	15%	21%	35%
Tier 4	11%	15%	25%	80%	55%	138%	132%	116%	17%	23%	39%

Note: This table shows the benefits of TOC for different distance tiers and housing targets. ELI refers to extremely low-income families, VLI refers to very low income, and LI refers to low income. HUD defines all these taxonomies

Along with the tiered structure and the inclusion of VLI groups, the TOC rules try to incentivize the production of affordable units by adding extra benefits, simplifying the building permit process, and being applicable to different types of housing. The principal characteristics are:

- The eligibility criteria define on-site restricted affordable housing, through new developments or rehabilitations.
- Developments must have more than five units and comply with at least the minimum percentages described in Table 2.1.
- Rents for each socioeconomic group are calculated city-wide based on Area Median Income (AMI) tabulations[10].
- Developers can't seek or receive any other state or local development bonus.
- Developers don't participate in the allocation process. Families participate in a city lottery to obtain a voucher valid across Los Angeles[11].
- There is a covenant recorded before issuing the Building Permit. This document guarantees the affordability of the units for 55 years.
- TOC Building Permits are less lengthy than the regular streamline. On average, a by-right TOC development takes 6 months instead of a year (Zhu et al., 2021). The same applies to extra entitlements (seatbacks and lot width reductions, among others), which process is about half of the time too.

[10]The Area Median Income is defined by the US Housing and Urban Development Department (US), which estimates fair market rates for section 8 based on deviations from the median income. To illustrate, a very low-income (VLI) family pays $1,340 per month for 2-bedroom units, while a low-income (LI) household pays $2,144 for the same

[11]The HUD website listed that nearly 25,000 units are leased in Los Angeles through public subsidies, while the waitlist exceeds 200,000 families, with an average wait time of approximately two years

According to the Los Angeles City Planning dashboard[12], there are 28,954 approved units since its launch, of which 22% are affordable dwellings. Moreover, the subsidized share is steadily composed of 40-45% extremely low-income and low-income apartments. Finally, the rate of new dwellings converges to 6,000 to 7,000 per year until 2022, with the exemption of 2018 that added a half.

2.2.2 Theoretical predictions

In this section, I develop a simple framework based on the assumption that developers choose based on the marginal benefit between the TOC bonus and the baseline development. Since neighborhoods are heterogeneous in rents, cost, and land use intensity, developers should not be indifferent to using the policy, which I show through a financial framework that I simulate to compare different scenarios and their implications.

The framework illustrates how a density bonus implies different trade-offs to developers. On the one hand, TOC boosts the number of units, hence increasing profits. On the other hand, adding affordable housing might impose (1) potential losses in property values and rents, and (2) affordable units can yield lower profits in wealthy areas if they are more expensive to develop due to higher amenities and fixed city-wide subsidies. Along with these trade-offs, density can also leverage the probabilities of developing affordable housing when upzoning plots with large density (Dong, 2021) and development potential (Greenaway-McGrevy & Phillips, 2023). Hence, zoning incentives should lead to an increase in the affordable housing stock in areas where (1) there is a small price gap between market-rate and affordable units, and (2) there are higher densities for multifamily developments.

Following Grimes and Aitken (2010), I consider housing developers as price-takers and profit-seekers agents within regional markets. They develop in a given neighborhood i when the expected sale price, determined by the present value of future rents, exceeds or equals the endogenous development cost $\pi_0 = Q_i \times (P_i - C_i)$. Furthermore, developers choose constrained by zoning, building between zero (no development) and the maximum number of units permitted in the plot $\underline{Q_i}$. As shown by Gabbe (2018), developers tend to maximize zoning parameters in Los Angeles, especially near transit areas and when building affordable housing.

Upon introducing TOC, a developer can opt to develop $\underline{Q_i} \times (1 + \sigma)$ market-rate units, where $\sigma \geq 0$, in exchange for $Q_S \geq 0$. Along with the quantity effect, affordable housing can impose positive or negative premiums λ_i depending if it's perceived as an amenity

[12] More information on the Los Angeles City Planning Progress Report.

or disamenity in a given neighborhood (Diamond & Mcquade, 2019). Therefore, the new profit function π_1 is defined by:

$$\pi_1 = \underline{Q_i} \times (1 + \sigma) \times [P_i(1 - \lambda_i) - C_i] + Q_S \times (P_{AH} - C_i) \tag{2.1}$$

It's important to highlight that C_i is common to both options, since developers cannot differentiate between market-rate and subsidized units. Then, the marginal profit between options is:

$$\Delta\pi_{1-0} = \underbrace{\sigma \times \underline{Q_i} \times (P_i - C_i)}_{\text{Supply effect}} - \underbrace{\underline{Q_i} \times (1 + \sigma) \times P_i \times \lambda_i}_{\text{Spillover effect}} + \underbrace{Q_{AH} \times (P_S - C_i)}_{\text{Affordable Housing Effect}} \tag{2.2}$$

The difference between profits highlights different counteracting forces when taking the policy benefits, from which some might create disincentives to take TOC:

- Firstly, the Supply effect follows the same direction as π_0, meaning that if it is convenient to develop on a plot of land, then the supply effect will always be positive too. Moreover, if the initial density is high, it can be expected that the same bonus will lead to more units than in low-density areas[13].
- The second term derives from the potential Spillover effect λ_i of adding affordable housing to a development. This term varies according to the socioeconomic characteristics of each i neighborhood, as affluent areas can associate these developments with a disamenity. Conversely, low-income districts can be indifferent or show an appreciation if new amenities are added (Diamond & Mcquade, 2019). If λ_i is large enough, the spillover effect on P_i can outweigh the direct supply effects, as it impacts both the marginal and baseline units.
- Thirdly, the profits derived from the Affordable Housing Effect can differ between neighborhoods since the quality of each development is not directly correlated with the affordable rents, which price ceiling is set city-wide while they must comply with the same quality between market and affordable units. Hence, in high-end neighborhoods, where P_i are higher than the rest of the city, endogenous development costs C_i are decoupled with the affordable rents. It can be expected that different i neighborhoods vary in their costs[14] meaning that developers can either choose between maintaining the same quality as other developments to ensure $P_i$or decreasing it to

[13]To illustrate, if a plot allows 10 or 100 units, then a 20% benefit translates into 2 or 20 extra units, showing how initial density can amplify the effects of TOC on profits.

[14]This has been studied in Los Angeles since construction costs are lower in neighborhoods with lower rents due to using cheaper construction materials such as wood instead of concrete (Zhu et al., 2021)

match it with affordable housing rents P_s. Nonetheless, the latter wouldn't be rational as the proportion of affordable housing tends to be around 20% of the total development in (Zhu et al., 2021)

- Lastly, since subsidized rents are fixed and limited on yearly growth, the opportunity cost increases as housing prices P_i are a function of future rent expectations (Clapp & Salavei, 2010). Hence, the 55-year covenant might be a disincentive for developers as they have to maintain affordability for large periods, whose property appreciation can be lower than market-rate units.

To summarize, the effects on P_i of TOC impose empirical questions based on neighborhood responses to the supply effect and its baseline density, property depreciation, development heterogeneity and rent thresholds[15]. This is captured in the scheme shown in Figure 2.2. Overall, when considering low- versus high-end neighborhoods, it can be expected that P_i, C_i, and λ_i behave in similar directions. This taxonomy also helps to isolate factors by housing prices, which can have counteracting forces in affluent areas, impacting both the direct supply effect (positive impact) and the spillover effects (which can be negative).

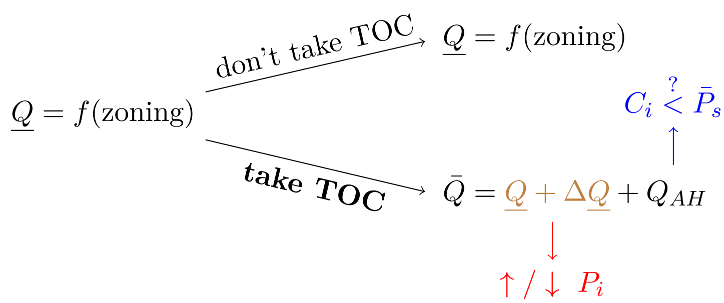


Figure 2.2: Decision frames for a profit-maximizing developer with zoning incentives.

To illustrate, I simulated a proforma valuation model, which is detailed in Appendix 1 and based on Zhu et al. (2021) and Phillips (2024). As shown in Figure 2.4, the difference in IRR (ΔIRR) between developments with and without TOC is positive below \$2,000 under the absence of any depreciation. At the same time, it decays to \$1,500 when there is a 5% depreciation on market-rate rents. This pattern resembles Figure A2.1 shown in the Appendix, which plots the average share of affordable developments built since 2010.

Similarly, there is an intensive margin factor, which shows that a larger number of units amplify the results on ΔIRR, if this interacts with the assumption of positive and negative

[15] Which change yearly for baseline calculations from HUD, as well as it has a growth cap, based on Los Angeles regulation.

appreciation, it also derives that smaller developments should be placed in more expensive neighborhoods, while the opposite in low-income.

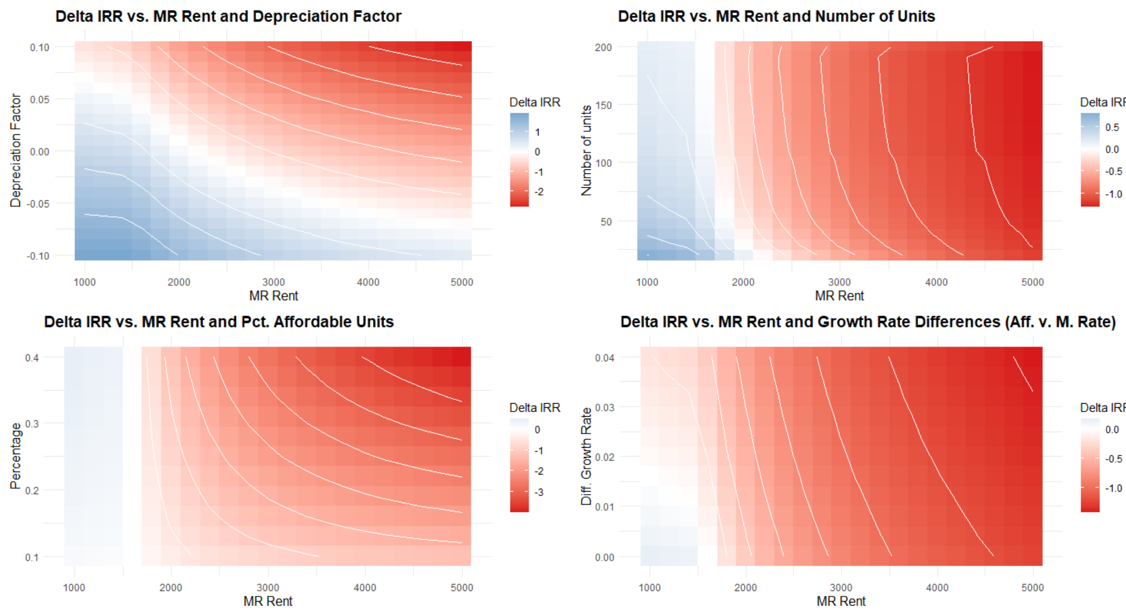


Figure 2.3: ΔIRR sensitivity

Note: The figure shows IRR Montecarlo simulations based on proforma developments and information gathered from (Zhu et al., 2021). The results are a sensitive analysis comparing the variation between development with and without TOC. More sensitivity tables in the Appendix 2.9.2

Finally, similar results are observed when adding more affordable units per development as well as when the growth rate between market-rate and affordable units increases. Again, this resembles the pattern observed in FigureA2.1 of the Appendix, where after the range of $1,500 to $2,000, developments tend to include a lower share of subsidized units per development. Lastly, when running Montecarlo simulations based on development information from Zhu et al. (2021), the observed probability of developing affordable housing resembles the data studied, where there is a clear threshold in rents below and above $1,500.

As a difference to Mandatory Inclusionary Zoning[16], voluntary zoning can lead to positive impacts or no changes as the development decisions don't enforce choosing the extra benefit. Therefore, it can be expected that the incentives will be higher to develop in low- and middle-income areas where subsidized market rents are similar to market rents. Furthermore, since the opposition to these developments has been associated with single-family areas reluctant to change[17], it should also be likelier that the positive impacts concentrate in central or denser areas. On the contrary, there should not be an effect on affluent or

[16] Mandatory inclusionary housing has been associated with a negative production of housing as it can be seen as a tax on developments(Krimmel & Wang, 2023)
[17] Add demandas

single-family zoned areas. Finally, if the zoning incentive implies a significant production of Q_{AH}, the overall stock should also increase in the areas where there are positive effects.

2.3 Data

2.3.1 Data Sources

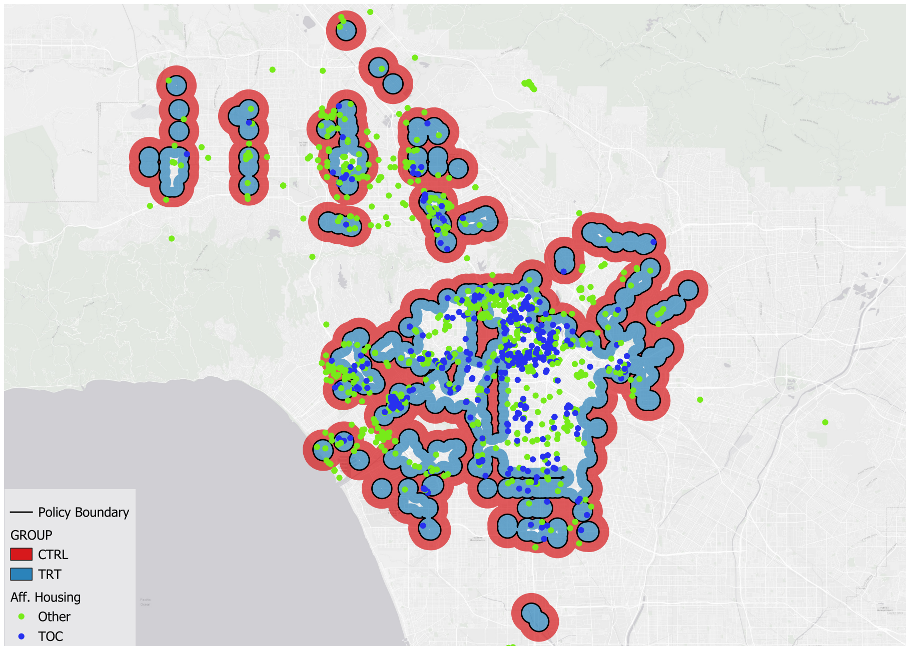
I assemble a panel dataset by joining different geocoded sources for my empirical analysis. I use the affordable housing covenants from the LA Comptroller, including all the developments between 2010 and 2021 that have a certificate of occupancy. The dataset includes 1,298 projects that individualize addresses, zip codes, council districts, year of the covenant, affordable and total units, the certificate of occupancy date, the program (TOC, DB, others), and whether they are market-rate developments or publicly funded by a housing trust fund. 78% are done by private developers, from which 42% were benefited by the previous DB program and 28% by TOC. Since the policy applies to mixed developments, I only work with market-rate projects as the others might be subject to public funds and agencies, which are unrelated to TOC and can be developed through other mechanisms such as land trust or by a local non-profit.

I intersect the geolocated projects with the census tracts' socioeconomic characteristics and the policy buffers. As shown in Figure 4.4, the developments are heterogeneously scattered across the city and the policy boundaries. If the policy bisects a tract, I create two new geographies to obey the maximum distance that defines treatment[18]. I use the new geographies in the fixed effects of the main specification.

I intersect the Building Permits (BP) from 2014 to 2021 with the census tracts to account for new multi-family developments (1,586) and the units they add. I filtered all the permits revoked or expired. Then, I matched the multi-family BP with the affordable projects based on the covenant year, block, and number of units to distinguish between new developments and rehabs. Nearly 30% of them are new affordable housing project[19], where about 22% of the units are subsidized[20].

After filtering and cleaning the data, I assembled tract-by-year panel data, obtaining 14,392 observations over eight years in 1,799 tracts. I calculated the distance from each tract centroid to the policy boundary, categorizing the treated areas by positive values and the controls by negative values. I set a base scenario of 500 meters on each side of the bound-

[18] I calculate the main specification with and without these tracts in my robustness checks.
[19] I matched them with the covenant data and through spatial intersections at the block level
[20] The range varies between 8 to 100% affordable



Note: The figure shows the boundary of the policy buffers overlapped. The 500-meter bandwidth is shown as blue for treated areas and red for controlled.

Figure 2.4: TOC developments

ary[21], implying a panel of 5,232 observations, equivalent to 654 neighborhoods observed across one kilometer. Over the 8-year window, about 10% of the tracts received at least one new building and 4.5% some type of affordable housing.

Finally, the main data sources are complemented with the Secured Basic File (SBF), the LA County Parcel Boundary Map bought from the Office of the Assessor of Los Angeles County, and CoStar data on build-to-rent developments. The first dataset contains information at the parcel level about the construction class and quality, its unit construction cost, the number of bedrooms, bathrooms, units, and size, and the date and amount of the last sale. The second source contains the geocode of each parcel, which I can merge with the policy boundary to georeference each lot from the SBF. Lastly, the build-to-rent data includes a cross-section of developments, which indicates the number of units and floors, the average rent and size, address, submarket, and information about whether they are market-rate, completely affordable, or mixed-developments, and the type of subsidy used. I use these sources to study prices, rents, and costs in the mechanisms section.

[21] I run sensitivity analyses from 300 to 1,000 meters from the boundary to test results consistency.

2.3.2 Summary Statistics

According to the Los Angeles City Planning Progress Report, there has been an evolving landscape in allocating proposed housing units. From 2015 to 2022, 211,475 units had been proposed, with TOC accounting for 43,580 units since 2017, constituting more than 30% of the affordable units since its enaction. Approximately 19% of the proposed units are designated as affordable. Lastly, there is a pronounced emphasis of TOC developers on low-income housing, with its share rising from 21% in 2017 to nearly 50% in 2020 and 2021. TOC added 74 developments within the study area, equivalent to 532 units, between 2018 and 2021.

To define the variables of comparison between treated and controlled groups, I first test for the determinants of affordable housing at the census tract level. I use demographic, socioeconomic, and geographic features that may influence the probability of affordable housing. Table 2.2 shows that a higher proportion of Black and Hispanic residents, increased household heads with low educational attainment, higher poverty rates, and a greater proportion of renters are positively associated with this probability. Likewise, the dummy variable for tracts below the median rent (nearly $1,280, as shown in Table 2.3) is also positively associated with the dependent variable, suggesting that these developments are not indifferent to the market they locate in.

As shown in panel A of Table 2.3, the main socioeconomic characteristics in 2014 show non-significant mean differences in the first 500 meters around the boundary, as opposed to city-wide statistics where there are systematic differences for all the variables displayed. Panel B shows that before the policy, both areas had analogous tendencies in the number of new buildings and affordable units per tract. Lastly, panel C shows similar trends for new affordable projects as they tend to be similar in the total and affordable units as well as in their proportion; furthermore, they tend to be located in areas with similar median rent profiles.

Table 2.2: Determinants of the Probability of Affordable Housing in a Census Tract

	Prob. Affordable Housing
Log(Pop)	0.150
	(0.104)
Log(CBD)	−0.021
	(0.024)
Pct. Black	0.006^{**}
	(0.003)
Pct. Hispanic	0.006^{**}
	(0.003)
Pct. Female_head	−0.006
	(0.007)
Low Ed_Att	0.042^{***}
	(0.007)
Pct. Poverty	0.013^{***}
	(0.005)
Pct. Renters	0.016^{***}
	(0.002)
Below Median rent	0.273^{**}
	(0.108)

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Table 2.3: Summary Statistics Pre Treatment

	0-500 mts			**All city**		
Variable	**CTRL**	**TRT**	**p-value**	**CTRL**	**TRT**	**p-value**
Panel A: Neighborhood characteristics						
log_pop	8.3 (0.3)	8.3 (0.3)	0.48	8.3 (0.4)	8.2 (0.3)	<0.001
Black	13.6 (20.4)	11.6 (17.8)	0.20	9.2 (15.8)	11.7 (17.0)	<0.001
Hispanic	46.3 (29.2)	47.9 (28.6)	0.48	47.0 (30.9)	50.0 (29.5)	<0.001
Female_head	17.4 (10.0)	17.6 (9.5)	0.89	16.7 (8.8)	17.8 (9.7)	<0.001
Ed_Att	20.6 (13.1)	19.8 (12.8)	0.43	19.9 (12.3)	19.2 (13.2)	0.039
Poverty	16.7 (12.0)	17.2 (12.5)	0.59	14.6 (10.7)	20.9 (14.4)	<0.001
Panel B: Affordable housing and Developments per tract						
New_Buildings	0.07 (0.3)	0.08 (0.4)	0.63	0.08 (0.6)	0.14 (0.5)	<0.001
Demolitions	0.65 (1.6)	1.00 (2.3)	<0.001	0.96 (3.9)	1.39 (2.8)	<0.001
Additions	1.93 (3.5)	2.27 (4.5)	0.031	3.74 (7.6)	2.26 (4.1)	<0.001
Alterations	10.24 (13.8)	12.94 (18.8)	<0.001	16.99 (29.2)	18.69 (28.7)	0.013
MR_Units	1.46 (10.2)	3.23 (26.0)	0.016	1.68 (19.0)	6.75 (69.2)	<0.001
Tot_units	1.57 (10.7)	3.40 (26.4)	0.015	1.80 (19.3)	7.32 (69.7)	<0.001
Aff_Projects	0.02 (0.2)	0.03 (0.2)	0.049	0.01 (0.1)	0.04 (0.2)	<0.001
Aff_Units	0.11 (2.3)	0.17 (1.9)	0.45	0.12 (2.8)	0.57 (6.7)	<0.001
Panel C: Affordable Housing Covenants						
Total_Units	41.6 (57.6)	52.1 (99.4)	0.53	35.0 (42.1)	50.2 (81.3)	0.031
Median_Ren	1,354.6 (463.2)	1,281 (257.0)	0.37	1,295.1 (363.2)	1,221.2 (313.8)	0.090
Aff_Units	3.4 (4.4)	4.1 (5.2)	0.54	3.3 (3.7)	5.9 (11.2)	0.002
Pct_aff	0.10 (0.07)	0.09 (0.03)	0.44	0.11 (0.11)	0.13 (0.16)	0.32

2.4 Empirical Strategy

This section evaluates the local impacts of TOC on affordable housing by exploiting the spatial discontinuity across the policy boundary. The treatment is binary since the zoning bonus only activates inside the defined areas while it is zero outside.

Since the policy rationale is based on distances to transit stations, the development decision can be endogenous. To overcome this specification challenge, I exploit the boundary discontinuity of the policy and compare the non-treated areas adjacent in a Difference-in-Difference approach in the first 500 meters of the boundary. My main identification strategy relies on the assumption pre-treatment similarities between groups around the boundary.

2.4.1 The impact of TOC on affordable housing

As mentioned before, the panel is balanced in the first 500 meters prior TOC enactment. As shown in Figure 2.5, there is a significant visual impact after 2018 in the 500-meter buffer; nevertheless, I include this year the first covenants took place during 2017[22]. Furthermore, it also suggests the chance of an increase in the intensity of application over time. Along with this trend, figures A2.4 and A2.5 from the Appendix also show similar density and spatial trends across the boundary before the intervention. It's worth highlighting that in both figures, a mass section moved from the control to the treated area after the intervention, suggesting a positive effect that is mostly located in central areas of Los Angeles.

By exploiting proximity to the boundary, I test for the impacts of TOC by using a canonical DiD [23] specification on the probability of affordable housing, followed by the next equation:

$$Y_{it} = \ \beta * TOC_i * Post_{t \geq 2017} + \mu_i + \gamma_t + \varepsilon_{it} \tag{2.3}$$

Where i index Census Tracts and t years. β corresponds to the coefficient of interest. Y_{it} represents either the linear probability of a census tract to develop affordable housing, the number of these developments, and the number of affordable units added post-treatment. The variable TOC_i is a dummy, taking the value of 1 when the region falls within the treated area. The variable $Post_{t \geq 2017}$ takes a value of 1 since the immediate year after

[22] I test the effects by lagging the variable one year as a robustness check.

[23] As shown in A2.6, the density of affordable developments tends to be similar across the 500-meter buffer, which can be explained by the small number of projects. This is of importance since although there is a baseline setup for a Boundary Discontinuity Design, the low density of points do not provide the ideal scenario for using this methodology

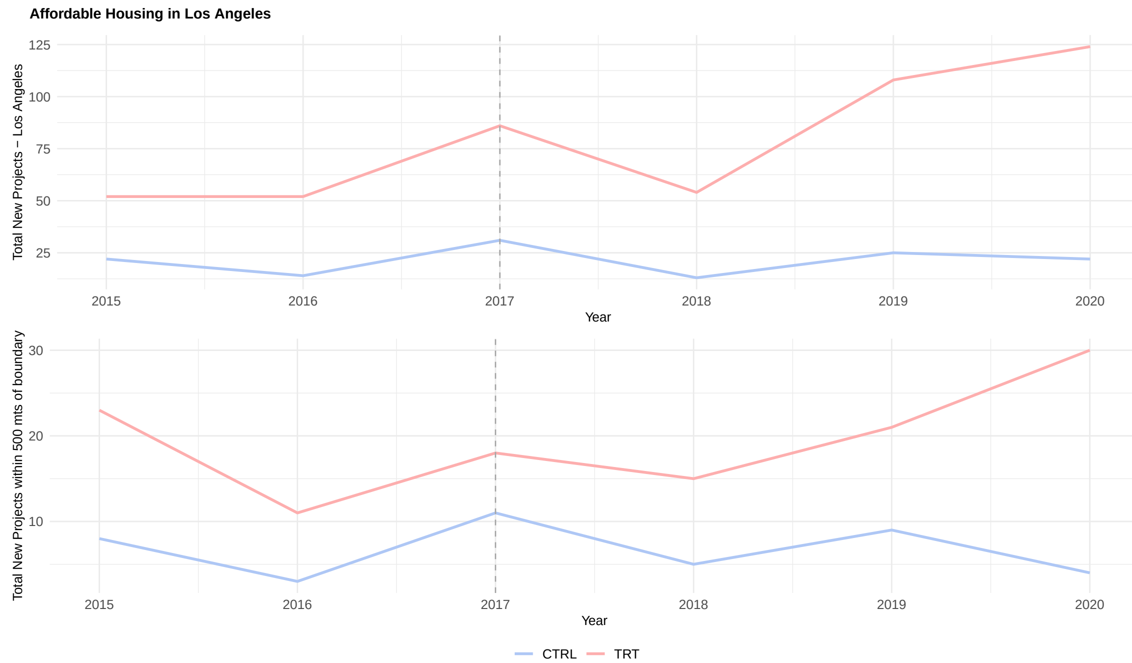


Figure 2.5: Evolution of affordable housing

TOC implementation since obtaining a building permit takes approximately six months when done by right (Zhu et al., 2021). I also include a vector of Census Tracts Fixed Effects μ_i to account for heterogeneity in fixed amenities as well as I add time fixed-effects γ_t to account for different time-varying shocks. Finally, the regression clusters standard errors by Census Tracts to account for potential spatial correlation in the location of affordable housing.

Table 2.4 presents the results from the baseline equation. The estimates show a significant increase in the probability of adding new affordable housing after the implementation of TOC. Since the number of projects usually tends to be one per tract, the effects converge to similar values. Lastly, there is evidence of new units being added in the policy area.

Table 2.4: Impact of TOC on Affordable Housing

	Prob (Aff. Project)	Aff. Projects	Aff. Units
TOC*Post	0.028***	0.035***	0.233***
	(0.010)	(0.013)	(0.090)
Observations	5,232	5,232	5,232
R^2	0.275	0.260	0.196
Note:			*p<0.1; **p<0.05; ***p<0.01

Note: Standard errors clustered at the Census Tract level. Fixed effects per Census Tract and Year

To test the bandwidth sensitivity, I regress the baseline estimation for different distances to the policy boundary. In all cases, results are persistent from 300 to 1,000 meters, as shown in Figure 2.6. Similarly, I also run an event study but interacting TOC_j by each year rather than $Post_{y>2017}$ to test for parallel trends. As shown in Figure 2.7, I don't find significant changes in the probability of developing affordable housing and the number of affordable units before the introduction of TOC, indicating that affordable housing production changed substantially only after introducing the new policy. Furthermore, the average treatment effect for each year shows consistently increasing coefficients.

Although the results can be seen as mechanical (increasing zoning can lead to more affordable housing), these results provide evidence that the policy is meeting the overarching goals of adding more developments and units in the planned areas. Hence, developers respond positively to the zoning incentive.

Notwithstanding the positive effects, due to the empirical setup, the results might raise concerns about displacement effects between and within the boundary. If that happens, the overall impacts would be spurious as they only change locally the location patterns instead of increasing the housing supply in the area. I formally test this in Section 7, where I run different robustness checks on my main specification that shows how TOC is driving positive impacts and not just changes from one group to the other.

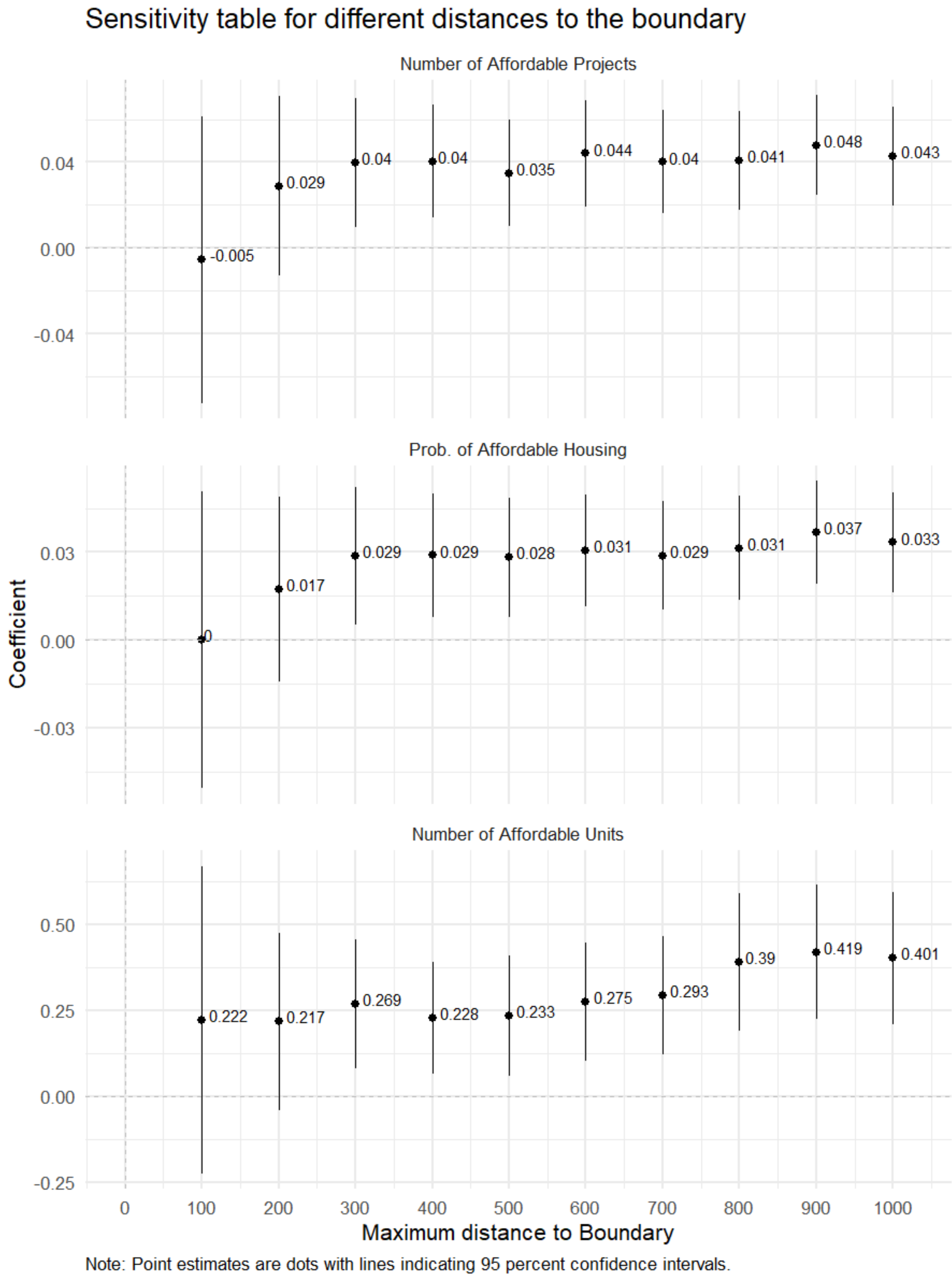
Since the policy leads to positive effects, the following question concerns the location of TOC. If they concentrate on low-income areas, the policy impacts wouldn't change the current segregation pattern of Los Angeles. More importantly, the stimulus would be used in areas less needed as subsidized and market rents should tend to be similar.

2.4.2 Heterogeneity analysis: The location of affordable housing

According to the theoretical framework, profit-maximizing developers should be more likely to develop affordable housing in areas where market and subsidized rents are similar at most; furthermore, they should also try to maximize zoning and build in denser or taller areas. To test these hypotheses, I subsample the census tracts by median rents and functional areas through machine learning algorithms that cluster tracts by land use intensity and socioeconomic characteristics.

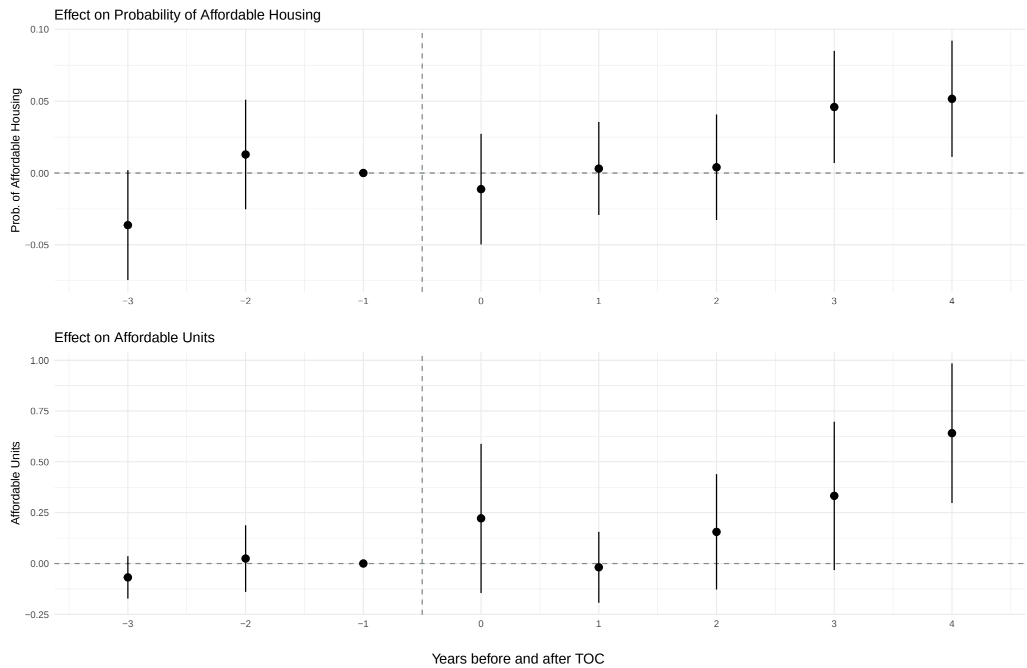
Median rents

Firstly, I divide the sample of median rents per tract by the percentile 50th. By running Model (2.3), I found that the chances of developing affordable housing in the first group



Note: The figure shows the sensitivity analysis of Equation 2.3 for the three variables measured in Table 2.4 for a bandwidth between 100 to 1,000 meters.

Figure 2.6: Sensitivity graph of Equation 2.3



Note: The figure shows the event study of Equation 2.3, interacting TRT x Year for the three variables measured in Table 2.4.

Figure 2.7: Event studies and parallel trends

significantly increased from 2.8% to 4%. On the contrary, the second group diminishes to a non-significant 1.9% likelihood (Table 2.5). The median is approximately $1,100, which is similar to subsidized rents that rank between $1,154 to $1,490 for a 1- and 2-bedroom apartment in the fiscal year 2016, respectively.

Table 2.5: Heterogeneity by Rent Group

	Prob (Aff. Project)		
	Sample	Below Med. Rent	Above Med. Rent
Panel A: Prob. Affordable Housing			
TOC*Post	0.028***	0.040***	0.019
	(0.010)	(0.015)	(0.014)
R^2	0.275	0.224	0.308
Panel B: Affordable Units			
TOC*Post	0.233***	0.392**	0.106
	(0.090)	(0.161)	(0.095)
R^2	0.196	0.165	0.236
Note:			*p<0.1; **p<0.05; ***p<0.01

Note: Standard errors clustered at the Census Tract level. Fixed effects per Census Tract and Year

To test the robustness of my results, I use two extra sub-sample taxonomies. On the one hand, I divide by deciles, where the results follow a similar pattern, as shown in panel A of Table A2.1 in the Appendix. The significant effects are in Q2 and Q4, where the likelihood increases to 7.2% and 6.5%, respectively. It's worth highlighting that the tendency is non-monotonic as the likelihood increases from Q8 to Q10; nevertheless, these are non-significant. On the other hand, I use a K-means clustering algorithm based on rents[24] to derive non-arbitrary rent bins. The results in panel B of the same table show that developers choose areas where median rents are lower than $1,200, which is consistent with Table 2.5.

Functional Areas

Secondly, I develop functional areas based on a spatially constrained clustering algorithm (SKATER) that proxies large-scale neighborhoods with similar characteristics such as residential zoning density, the share of single-family units, and different socioeconomic characteristics as covariates[25]. As highlighted in Section 2.2, denser areas can lead to more units when benefiting from TOC, which increases profits in areas where market rents are similar to affordable housing, which is not captured in the previous section.

As shown in Figure A2.16 of Appendix 3, Los Angeles can be summarized into three functional areas. The first refers to the north of the city, where affluent and educated, mostly white, single-families cluster; furthermore, median rents are higher than the other groups. The second is the CBD and its surrounding tracts, which show a larger share of multifamily units, renters, and families living below poverty levels as well as higher residential densities; as opposed to the first group, median rents are the lowest here. The third cluster is like the first regarding the proportion of single-family units, but rents are lower and more racially diverse. When applying Model 2.3 applied to these groups resemble to the previous findings. As shown in Table 2.6, only the second cluster exhibits significant impacts of 5.0% higher chances of developing affordable housing.

In summary, both results suggest that developers consider tracts below median rent zoned for dense multifamily developments when building mixed-income housing. This suggests that the policy only increases the affordable housing stock without changing the overall location patterns of them.

After detecting the heterogeneous effects on the affordable housing supply, the question of why results concentrate on these neighborhoods is still mildly answered. As hypothesized,

[24]Details on Section 2.9.3 in the Appendix
[25]Details on Section 2.9.4 in the Appendix

Table 2.6: Heterogeneity by Spatial Clusters

	Cluster 1	Cluster 2	Cluster 3
TOC*Post	0.021	0.050***	0.018
	(0.014)	(0.015)	(0.028)
R^2	0.304	0.178	0.207
Observations	3,376	1,408	448
Note:	*p<0.1; **p<0.05; ***p<0.01		

Note: Standard errors clustered at the Census Tract level. Fixed effects per Census Tract and Year

these results can be due to house price/rents appreciation or depreciation, heterogeneous construction costs against affordable rent ceilings or density gains, but the latest seems to be in proxies to low-income areas only. In the next section, I explore the relationship between affordable housing, sales, rents and development costs to identify potential links between them and the impacts of TOC.

2.5 Mechanism: Housing prices and Construction costs

To answer why developers are prone to develop in the previously mentioned tracts, I turn my analysis to understand how sales, rents, and development costs correlate with developing affordable housing. For this purpose, I first study the relationship between these projects and neighborhood responses proxied by single-family sales based on data at the parcel level from the Secured Basic File (SBF) and the LA County Parcel Boundary Map. Then, I focus on a potential second mechanism to correlate affordable housing with rents as well as to study how development costs vary across rent-bins, as both channels can negatively impact on ΔIRR.

2.5.1 Not in my backyard: the effects of TOC and Affordable Housing on Sales

Based on the theoretical predictions, housing prices might not behave similarly after placing affordable units. There have been controversies around TOC as some neighbors have argued about its negative effects on the places they live in. Predominantly single-family neighborhoods have organized against "tall and dense" TOC developments[26] as they can

[26] One example is the lawsuit against the Santa Monica project, which, according to local inhabitants, is expected to reach 79 feet instead of the 57 that would be allowed under the existing zoning ordinance. More details here

change the neighborhood characteristics. These perceptions should negatively impact housing sales near NIMBY neighbors.

To test these perceptions, I regress an event study on housing prices while controlling for several property and parcel characteristics. I rely on the assumption that supply and amenities should be similar in the boundary vicinity before TOC. I only study properties built before 2017, as new developments might have different amenity values when compared to older buildings[27]. Lastly, since only a small portion of blocks receive an affordable project, I test my specification on the TOC impacts as well as how newly built affordable units influence property prices in the adjacent blocks to test for spillover effects. The baseline model is defined as follows:

$$Y_{it} = \alpha + \sum_{t=-q}^{-1} \beta_j (TRT_i \times Year_t) + \sum_{t=0}^{m} \rho_j (TRT_i \times Year_t) + \gamma X_i + \delta_i + \theta_t + \epsilon_{it} \tag{2.4}$$

Where i index Census Blocks and t years. Y_{it} represents the logarithm of the sale, while TRT_i is defined as 1 if the sales occur within the 500-meter buffer of TOC, while is 0 between 1,000 and 1,500 meters away from the building. The 500-meter buffer between the treated and control groups is to avoid any contamination effects between groups. $Year_t$ are dummy variables, where $t < 0$ refers to leads and $t \geq 0$ to lags. X_i relates to a vector of housing-specific controls, while δ_i and θ_t are block and year fixed effects variables. Finally, the regression clusters standard errors by blocks.

TOC and Sales

The TOC impacts are shown in Table 2.7, which suggests no significant effects of the policy on overall housing prices in the first 500-meter bandwidth. This can be because less than 1% of the blocks received one affordable development or because of potential spillovers from the treated area to the immediately adjacent properties. To rule out this hypothesis, I ran event studies with properties from 1,000 to 1,500 meters away from the boundary as a control group. Then, I also consider the treatment of the first 500 meters and the next ring to be between 500 and 1,000 meters. As can be seen in Figure A2.7 of the Appendix, there are no significant changes in any of the rings studied.

Affordable housing and Sales

I now switch to new affordable housing developments as the unit of analysis since they only represent a small fraction of the sample. If the theoretical predictions are in line with

[27]Notwithstanding this concern, I control for the construction year of each unit.

Table 2.7: Impact of TOC on Housing Prices

	Log(Price)		
	Sample	Below Med. Rent	Above Med. Rent
TOC*Post	0.004	0.018	−0.012
	(0.018)	(0.017)	(0.025)
Observations	73,145	26,227	46,530
R^2	0.803	0.769	0.795
Note:			*p<0.1; **p<0.05; ***p<0.01

Note: Standard errors clustered at the Census Tract level. Fixed effects per Census Tract and Year

Diamond and Mcquade (2019), results should differ between properties in tracts below and above median rents.

To evaluate the aggregate effects of new affordable housing, I compare the first 500-meter ring with the following two groups of the same distance (500 to 1,000 and 1,000 to 1,500). As shown in Figure A2.9, there are no severe differences in the first group, while the farther ring does exhibit a change in trend. Here, the overall effects on surrounding sales diminish by −3.6% at the 10% significance level. Nonetheless, when subsampling by below and above median rents, the impacts concentrate in the second group, showing a depreciation of −7.7%. Furthermore, as shown in Figure 2.8, these effects tend to occur after three years of the covenant date. Panel D of Table 2.8 also suggests that the impacts concentrate in the first functional area, which is primarily single-family and affluent.

I run event studies based on Equation 2.4 by 200-meter rings from each property. If there are spillover effects, the intensity of the effects should be present only in the first rings. As shown in Figure A2.8, the impacts occur only in the first 200 meters in tracts above median rents, which range between 5%[28] in the third year to 10% in the fifth year. Consequently, the local spillovers vanish approximately after two blocks of developing a new project.

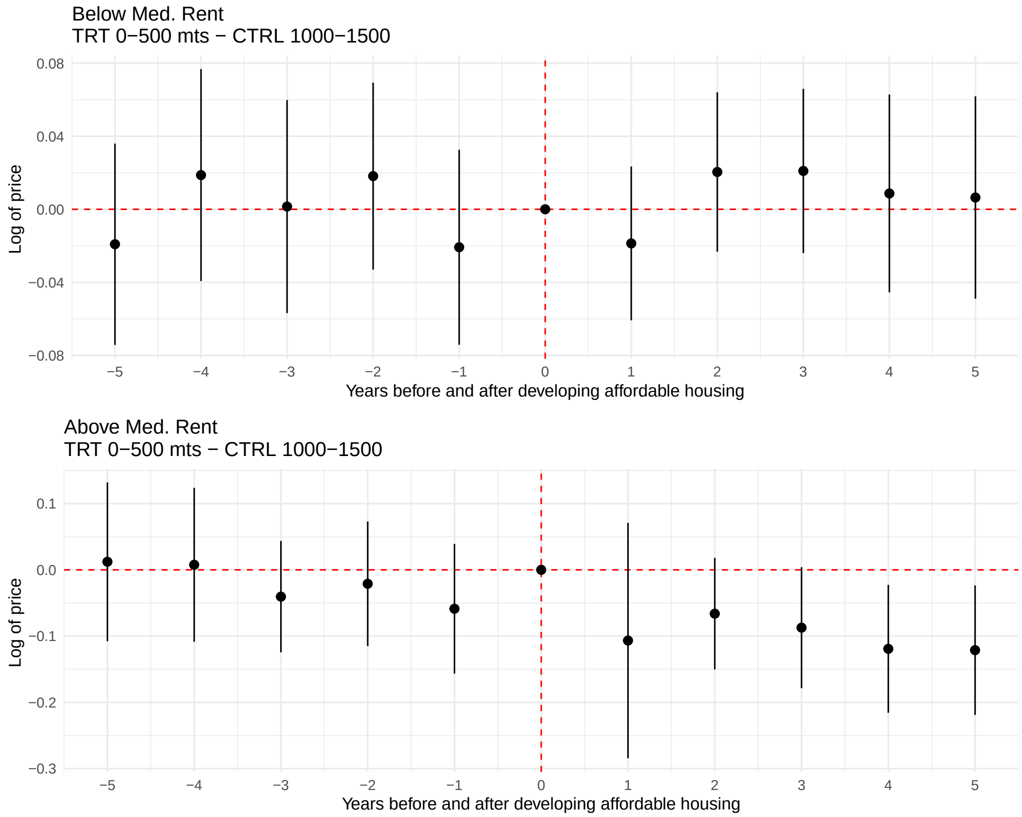
Due to data limitations, I don't estimate the effects on rents across time. Although this might correlate with the effects on housing prices, the latest capture expectations of future rents discounted at a risk factor, meaning it doesn't capture short-run impacts on the market.

[28]Significant at the 10% level

Table 2.8: Affordable housing price spillovers

	Log(Price)		
	Sample	Below Med. Rent	Above Med. Rent
Panel A: Overall properties			
Near*Post	−0.036*	0.006	−0.077***
	(0.019)	(0.013)	(0.027)
Observations	92,564	32,843	57,805
R^2	0.809	0.809	0.797
Panel B: Single-Family sales			
Near*Post	−0.037**	0.008	−0.071***
	(0.015)	(0.012)	(0.020)
Observations	81,327	26,288	53,188
R^2	0.849	0.832	0.839
Panel C: Multi-Family sales			
Near*Post	0.071	−0.050	0.106
	(0.067)	(0.105)	(0.082)
Observations	11,237	6,555	4,617
R^2	0.869	0.858	0.870
Panel D: Spatially Constrained Clusters			
	(1)	(2)	(3)
Near*Post	−0.056**	−0.012	0.062
	(0.026)	(0.014)	(0.041)
Observations	62,913	23,766	4,958
R^2	0.804	0.817	0.809

Note: Standard errors clustered at the Block level. All regressions include block and year fixed-effects and housing controls such as the square footage, number of bedrooms, bathrooms, construction quality, and superstructure category.



Note: The figure shows the event study of Equation 2.4, interacting TRT x Year for the three samples shown in 2.7. All regressions include block and year fixed-effects and housing controls such as the square footage, number of bedrooms, bathrooms, construction quality, and superstructure category.

Figure 2.8: Event study on housing prices before and after developing affordable housing.

2.5.2 Not in my development: Rents and Construction costs

Some developers have expressed their dissatisfaction with the policy due to the 55-year covenant and the difficulties that rent-stabilized units might impose in the long run due to lower profits. For this section, I use a cross-section of rents obtained from CoStar to test if there are any correlations between affordable housing and market rents. Then, I study how development costs behave across different rent tiers.

Affordable housing and rents

In this subsection, I study the correlation between affordable housing and market rents based on cross-sectional data from CoStar, which includes 18,113 developments that are categorized between market-rate, affordable, and mixed-income buildings. The sample also includes the type of subsidy they use, the construction date, class and quality, the vacancy rate, address, and the percentage of each number of bedrooms within the development.

Lastly, it also states the average square footage of the units and mean development rent. After geocoding each observation, I also add the block and census tract.

Table 2.9 shows the results of regressing the logarithm of the mean rent against the different covariates mentioned before. As can be seen, there is a negative appreciation in tracts above median rents of -13.2%. At the same time, there are no negative impacts in the other group, suggesting that affordable housing and market rents equalize. As expected, the negative results also concentrate on the first cluster, where single-family affluent neighbors are predominant.

Table 2.9: Average rent by project

	Log(average rent)		
	Sample	Below Median	Above Median
Affordable	-0.058***	-0.027	-0.132***
	(0.022)	(0.025)	(0.033)
Observations	18,113	9,359	8,606
R^2	0.941	0.949	0.935
Panel D: Spatially Constrained Clusters			
	(1)	(2)	(3)
Affordable	-0.097***	-0.002	0.181
	((0.024)	(0.043)	(0.226)
Observations	11,224	5,475	1,266
R^2	0.939	0.952	0.937
Note:		*p<0.1; **p<0.05; ***p<0.01	

Note: Standard errors clustered at the Block level. All regressions include block and year fixed-effects and housing controls such as the square footage, number of bedrooms, bathrooms, construction quality, and superstructure category.

These results must be taken with caution not only because of the cross-sectional nature of the data but also because they don't represent the direct relationship of affordable housing since the observations are average rents per development. Hence, there is a mechanical component driving changes when market rents differ significantly from subsidies. To illustrate, if in 2023 the mean rent is \$3,000[29] and the average affordable rent is roughly \$1,900[30], then the average rent decreases approximately 7.0% when adding 20.0% of affordable units. Notwithstanding these mechanical changes, the average rent decrease is higher than the estimated coefficient when comparing it with different rent bins and affordability shares shown in Table A2.2 of the Appendix.

[29] Which represents an average development

[30] Which is obtained by calculating the weighted average of the HUD rents for Los Angeles and the share studied in the CoStar developments for each type of bedrooms

Development Cost and Quality

For this subsection, I use the information from the Secured Basic File (SBF) to understand the distribution of housing quality and single costs. Quality is defined in the appraisal's manual as a range between 1 and 12.5. This standardized measure is used to compare different buildings of the same class during the assessment process. The ratings are strictly correlated with construction costs, as the SBF manual defines. Additionally, the dataset also includes construction costs, which are proxied through quality too.

As shown in Table 2.10, both variables show a monotonic increase across rent quartiles. Since quality and costs are not constant, it can be expected that there will be lower incentives to develop in affluent areas when subsidies are indifferent to the tract's rent. These results complement the previous subsection as developing in low-income areas is cheaper while there is no property depreciation. Hence, marginal profits should be higher here[31].

Table 2.10: Cost per rent quartile

	Quality (normalized)	Unit Cost
Quartile 2	0.225***	185.119***
	(0.051)	(71.302)
Quartile 3	0.518***	420.549***
	(0.047)	(98.422)
Quartile 4	0.732***	945.279***
	(0.055)	(116.497)
Observations	301,442	301,442
R^2	0.106	0.038
Note:	*p<0.1; **p<0.05; ***p<0.01	

Overall, both results are in line with the theoretical predictions, showing that financial mechanisms can also explain areas without significant changes. Either higher development costs or rent depreciations can lead to negative marginal returns when taking the bonus generosity, even if this allows for building more market-rate units, which can also be negatively affected by mixed-income developments.

2.6 Overall impacts of TOC in the housing market

Finally, I study the impacts of TOC on market-rate developments, units, and overall tract affordability. As hypothesized in the theoretical section, since the benefits of TOC are

[31] To rule out the hypothesis that developers decrease building quality, I regress a hedonic model on the unit cost pre and post-TOC, as shown in the Appendix, there are no significant changes

always higher than the baseline scenario, there should be a significant impact in tracts below median rents – where there are positive TOC effects. Lastly, I also study the overall patterns of the policy at the city level, for which I use synthetic measures to overcome the unbalanced nature of tracts across Los Angeles.

2.6.1 TOC and Building Permits

Studying Building Permits (BP) imposes an empirical challenge, as building affordable housing is likely to impact this decision, especially if they are correlated with rents. Furthermore, since only about 1% and 5% of the sample get affordable housing and new developments, it is relevant to distinguish between the intention to treat (ITT) and the local average treatment effects (LATE). For this purpose, I estimate the overall impacts of TOC on BP and pair the sample based on propensity score matching to derive a suitable control group. Hence, along with Equation (2.3), I calculate the treatment probability based on the determinants of affordable housing described in the summary statistics section.

I use Equation (2.3), where Y_{it} represents (1) the probability of new market-rate developments, (2) the total number of market units[32], and the (3) the percentage of affordable units. I also control for location and time-fixed effects, as well as cluster standard error at the tract level. As shown in Table 2.11, the panel is appropriately balanced[33].

Table 2.11: Balancing measures PSM

Variable	TRT	CTRL	t-test	Diff.Adj
log_pop	8.30	8.30	0.98	-0.0027
Black	11.8	11.2	0.75	0.0374
Hispanic	42.7	42.4	0.94	0.0094
Female_head	15.4	15.3	0.94	0.0089
Ed_Att	24.2	24.3	0.97	-0.0038
Poverty	17.8	17.7	0.98	0.0033
quartile	2.70	2.68	0.81	0.0273

Note: The algorithm matched all the 139 treated areas to a control, leaving 2,029 unmatched potentials.

After regressing the ITT and the LATE effects on building permits, some interesting results arise. Panel A on Table 2.12 shows an effect of about 1.17 extra units instead of 0.3 as well as a probability of 12% instead of 3%. As expected, the effect intensifies in tracts below median rents. Panel B in the same table shows that there is no overall effect on the ITT or the LATE on Building Permits. Still, this relationship becomes positive and significative

[32] Since the TOC developments also include market-rate units, this indicator equals the total sum of units minus the affordable units allocated in each affordable housing development.

[33] As can be seen in Figure A2.11 and Figure A2.12 the adjusted sample shows similar density distributions and non-significant differences in the variables used for PSM.

in tracts below median rents, where the first indicator approximates to 2 and the second to 5.6. When comparing both, there is a relation of 2 to 5 between affordable and market-rate units, which is similar to the average relationship in mixed-income developments. Lastly, there are no effects on affordability as the new developments tend to be located in already affordable districts.

Table 2.12: PSM Results in the 500-meter bandwidth

	Sample	Below Med. Rent	Above Med. Rent
Panel A: Affordable housing			
Prob (Aff. Project)	0.122***	0.184***	0.068
	(0.039)	(0.057)	(0.054)
Aff. Projects	0.145***	0.193**	0.103
	(0.048)	(0.073)	(0.064)
Aff. Units	1.167***	1.870***	0.540
	(0.375)	(0.642)	(0.402)
Panel B: Market Rate (MR) Building Permits			
Prob (MR Bldg)	0.016	0.015	0.017
	(0.030)	(0.051)	(0.035)
MR Units	1.128	5.659**	−2.869
	(2.551)	(2.700)	(4.195)
Pctg. Affordable	0.042	0.048	0.022
	(0.029)	(0.059)	(0.030)
Observations	1,248	584	664
Note:			*p<0.1; **p<0.05; ***p<0.01

Note: Standard errors clustered at the Block level. All regressions include block and year fixed-effects and housing controls such as the square footage, number of bedrooms, bathrooms, construction quality, and superstructure category.

2.6.2 TOC in Los Angeles

To finalize, I study the relationship between the policy implementation and the overall affordable housing trends across the city. Since there is an inherently unbalanced sample between central areas that are mostly treated and not captured in the first set of estimators in Section 4, I also use PSM to compare between the ITT and the LATE.

As shown in Table 2.13, the results tend to indicate a similar trend to the results in Section 4, including the different heterogeneous effects detected when subsampling by median rents and by the different spatial clusters (shown in 2.14). Although the results tend to increase their significance, these results must be taken with caution as there are inherent differences across the city that might not be fully captured in synthetic measures.

Table 2.13: PSM Results at the city level

	Sample		Below Med. Rent		Above Med. Rent	
	(OLS)	(PSM)	(OLS)	(PSM)	(OLS)	(PSM)
Panel A: Affordable housing						
Prob (Aff. Project)	0.051***	0.141***	0.069***	0.181***	0.027***	0.075**
	(0.007)	(0.019)	(0.010)	(0.024)	(0.010)	(0.032)
Aff. Projects	0.071***	0.192***	0.100***	0.260***	0.031*	0.083*
	(0.010)	(0.028)	(0.015)	(0.036)	(0.014)	(0.043)
Aff. Units	0.723***	2.024***	1.023***	2.766***	0.304**	0.833**
	(0.132)	(0.355)	(0.210)	(0.509)	(0.130)	(0.404)
Panel B: Market Rate (MR) Building Permits						
Prob (MR Bldg)	−0.004	−0.008	0.007	0.005	−0.017*	−0.026
	(0.007)	(0.017)	(0.009)	(0.022)	(0.010)	(0.027)
MR Units	−1.840	2.228	−2.573**	5.626**	−7.268***	−2.859
	(1.615)	(1.799)	(1.068)	(2.504)	(3.456)	(2.476)
Pctg. Affordable	0.027	0.045*	0.027	0.060	0.019	0.028
	(0.033)	(0.025)	(0.071)	(0.025)	(0.015)	(0.025)
Observations	14,392	3,992	7,064	2,336	7,328	1,656
Note:				*p<0.1; **p<0.05; ***p<0.01		

Note: Standard errors clustered at the Block level. All regressions include block and year fixed-effects and housing controls such as the square footage, number of bedrooms, bathrooms, construction quality, and superstructure category.

Table 2.14: PSM Results at the city level per Spatial Cluster

	Cluster 1		Cluster 2		Cluster 3	
	(OLS)	(PSM)	(OLS)	(PSM)	(OLS)	(PSM)
Panel A: Affordable housing						
Prob (Aff. Project)	0.018*	0.051	0.084***	0.200***	0.044**	0.183***
	(0.010)	(0.034)	(0.011)	(0.021)	(0.021)	(0.066)
Aff. Projects	0.024*	0.063	0.117***	0.276***	0.053**	0.219**
	(0.014)	(0.048)	(0.015)	(0.031)	(0.025)	(0.080)
Aff. Units	0.238**	0.692*	1.205***	2.855***	0.763**	3.184**
	(0.116)	(0.379)	(0.254)	(0.556)	(0.380)	(1.253)
Observations	8040	1944	5344	1808	1008	264
Note:				*p<0.1; **p<0.05; ***p<0.01		

Note: Standard errors clustered at the Block level. All regressions include block and year fixed-effects and housing controls such as the square footage, number of bedrooms, bathrooms, construction quality, and superstructure category.

2.7 Robustness Checks

I run a series of robustness checks to support the main findings and validate the research strategy. Firstly, I look over the impacts of the density bonus (DB) across time as, in some cases, lower affordability requirements than TOC can be more attractive to developers. Secondly, I re-estimate Table 2.4 to check for potential spillovers and displacement effects. Thirdly, I use alternative specifications such as lagging 12-month TOC, excluding the tracts cut by the policy definition, and estimating the main specification at the block level. Lastly, I use synthetic measures like SDID and Matrix Correction to avoid any discrepancies in pre-treatment trends.

2.7.1 The impact of DB on affordable housing

After the implementation of TOC, some developers still used the DB due to lower affordable housing requirements. I test whether this was also a driver in producing affordable housing after 2017. For this purpose, I subtracted all the developments and units related to TOC from the sample to re-run equation (2.3).

As seen in Panel A of Table A2.3 and as suggested in Figure A2.10, there are no significant results derived from the DB. In fact, the panel indicates a slight decline in these projects, which is supported by the trends exhibited in Figure A2.10. These results are non-significant, meaning that the trend has been stable over time without impacting the provision of affordable housing developed through market-rate developments. Yet, the decline in the overall trend also supports the idea that TOC has become more desirable for developers.

The conclusions of these results allow to associate any potential increase in affordable housing to TOC, as both are the only mechanisms available to develop subsidized projects through mixed-income buildings.

2.7.2 Displacement of supply across boundaries

To validate the main results, there can't be spillovers between both areas. Displacement could occur if the policy induces the migration of developers from one side of the boundary to the other over short distances. If these results prevail, TOC would only induce mechanical changes at the local level across boundaries.

I test two sets of regressions based on this model. Firstly, I reproduce Table 4 but dropping all the observations in the first 250 meters (equivalent to 1-2 blocks) and regressing results on a bandwidth between 250-750 meters. As can be seen in Panels B and C of Table A2.3, when dropping the adjacent observations, the results hold. Secondly, if I move further away from both boundaries, the probability is 4.3%, and units increase significantly when compared to the control group.

Then, I follow Carozzi et al. (2020) and Turner et al. (2014) intuition of migration close and far away within each boundary. If there were displacement, the effects should be statistically significant near the boundary relative to farther away developments in TOC areas while showcasing opposite results in the control areas. Both predictions can be tested by changing the parameter $TOC_j * Post_{y>2017}$ in equation (1) for $\text{Near}_j * Post_{y>2017}$, where Near_j is a dummy taking the value of 1 for properties near the boundary and 0 when away from the boundary.

I estimate the probability of new developments considering $\text{Near}_j = 1$ when the distance is below 250 meters to the boundary, and $\text{Near}_j = 0$ between 250 and 500 meters. As can be seen, Panels D and E of Table A2.3 show no significant effects.

As a result, I conclude there are no displacement effects. Hence, changes are produced by TOC that add more developments and units to the treated areas.

2.7.3 Alternative specifications

Firstly, I test for the impacts after the first year of implementation. Suppose the predictions are correct and the policy changed the affordable housing trend. In that case, results should tend to increase as more developers would have had more time to fill in building permits and produce affordable housing. When lagging the variable to $Post_{y>2018}$, I found that the probability slightly increased by about half a percentage point; i.e., as shown in Panel F of Table A2.3, the probability increases from 2.8% to 3.3%.

Then, I drop all the Census Tracts cut by the policy. By doing this, the results hold similarly to Table 2.4, as the probability of affordable housing is 3.2% and the number of extra units tends to be similar, as shown in Panel G of Table A2.3.

Finally, although census blocks can provide more heterogeneity than census tracts, rents and balancing covariates are at the later level. Nonetheless, I estimate the baseline equations from Table 4 to validate the results at this geographic level, which tend to follow similar trends as shown in Table A2.4.

2.8 Conclusion and Policy Implications

The estimated effects indicate that the Transit Oriented Communities (TOC) policy is effectively promoting affordable housing and increasing the overall housing supply across Los Angeles. The results show positive impacts on the number of developments and units in the targeted areas, which are transit hubs that can help low-income families reduce transportation costs.

Despite these overall results, the location pattern of new developments remains relatively the same, as the incentives are more attractive in tracts below median rents where the zoning boost translates into developing more units of the current development trends, i.e., there are no opportunity costs. These findings align with the theoretical predictions, as developers are more inclined to build in denser areas where market rents are close to subsidized rents. Consequently, these dwellings will remain concentrated in the same districts rather than being distributed across the city. However, it's worth noting that zoning incentives may be less necessary in these areas. If this pattern persists, TOC could not circumvent the ethos of inclusionary zoning.

This raises important questions about how to enhance and target developments in affluent areas. Although the treatment effects indicate that the city is providing more units near transit areas, the clustering of affordable housing in low-income neighborhoods—coupled with resistance from affluent single-family homeowners—are concerns that might diminish the potential benefits of the TOC policy or, at least, to question its outcomes.

Consequently, it might be necessary to reconsider the real potential of inclusionary zoning policies. The overall evidence indicates that mandatory inclusionary zoning doesn't work effectively, as it is perceived as a tax on developers. At the same time, voluntary policies like TOC might not significantly alter the segregation patterns of American cities, but at least they can help boost the affordable housing supply. This discussion mirrors the debate between the quantity and quality of housing outcomes, something that needs to be clearly defined when designing housing policies.

The estimates also indicate that the policy leads to more market-rate units in the targeted areas. This suggests a transition towards mixed-income developments in Los Angeles, as TOC doesn't trade off affordable units with market-rate units due to generous benefits that significantly exceed the affordability requirements.

However, a remaining question concerns how developers will behave in the future as TOC continues to be enacted, especially since the remaining lots may be less attractive for development under this policy. In some cases, the previous density bonus might be more appealing due to lower affordability requirements. Policymakers should monitor these trends and consider adjustments to the policy to maintain its effectiveness over time.

Furthermore, to address the issue of the uneven distribution of affordable housing, policymakers could consider enhancing incentives for developments in higher-income areas or implementing complementary policies that mitigate resistance from affluent communities. This might involve community engagement initiatives and adjusting zoning regulations to make development in these areas more feasible.

As stated in the introduction, this paper represents the local equilibrium effects of upzoning in different places within the city of Los Angeles. The analysis focuses on the immediate impacts within the treated areas and their adjacent neighborhoods, capturing how TOC influences affordable housing development at a micro-level. However, it does not capture the general equilibrium conditions of the city as a whole. Factors such as migration patterns, changes in overall housing supply and demand, and changes in amenities still need to be fully captured in this chapter.

Future research can be conducted to understand the political economy of affordable housing and land use. TOC showed how land use changes trigger responses from different stakeholders, such as local communities and developers. Community resistance can create barriers to the development of affordable housing through lobbying, lawsuits, and massive opposition, which are factors yet to be fully understood. These forces might be necessary for understanding how they shape the urban landscape in modern times, as the opposition can disincentivize developers looking to avoid this confrontation. On a similar note, how to design incentives that equalize the opportunity cost of building in more expensive areas, where subsidies diverge from market rents, is also a remaining subject of study, especially if these policies are becoming more popular.

2.9 Appendix: Additional Tables and Figures for Chapter 2

2.9.1 Tables

Table A2.1: Heterogeneity 2

	Prob (Aff. Project)				
	Q1	Q2	Q3	Q4	Q5
Panel A: Deciles					
TOC*Post	0.009	0.072**	0.037	0.065***	0.002
	(0.030)	(0.033)	(0.039)	(0.021)	(0.028)
R^2	0.197	0.320	0.223	0.213	0.213
Observations	400	472	584	576	688
	Q6	Q7	Q8	Q9	Q10
TOC*Post	0.023	−0.026	0.051	0.042	0.034
	(0.024)	(0.029)	(0.040)	(0.030)	(0.031)
R^2	0.406	0.350	0.195	0.296	0.279
Observations	712	744	568	488	440
Panel B: Rent Groups (K-means)					
	≤ 1200	1200-1600	1600-2200	≥ 2200	
TOC*Post	0.041***	0.0001	0.041	0.075	
	(0.015)	(0.017)	(0.030)	(0.052)	
R^2	0.222	0.346	0.239	0.272	
Observations	2,448	1,832	752	200	
R^2		0.304	0.178	0.207	
Observations		3,376	1,408	448	
Note:	*p<0.1; **p<0.05; ***p<0.01				

Note: The regressions shown are the results of Equation 2.3 for different rent bins. Standard errors clustered at the Census Tract level. Fixed effects per Census Tract and Year

Table A2.2: Rent decay for different affordability percentages and rent bins

Average Rent	**Pct. Affordable**			
	20%	**15%**	**10%**	**5%**
2,000	1.6%	1.2%	0.8%	0.4%
2,500	5.3%	4.0%	2.6%	1.3%
3,000	7.7%	5.8%	3.9%	1.9%
3,500	9.5%	7.1%	4.7%	2.4%
4,000	10.8%	8.1%	5.4%	2.7%
4,500	11.8%	8.9%	5.9%	3.0%
5,000	12.6%	9.5%	6.3%	3.2%
Average	**8.5%**	**6.4%**	**4.2%**	**2.1%**

Note: As shown in Figure A2.1, the share of affordable units vary between 20% to 10% when rents are above $2,000

Table A2.3: Robustness Checks

	Prob (Aff. Project)		Aff. Projects		Aff. Units	
Panel A: Impacts of Density Bonus (N=5,232)						
TOC*Post	−0.007	−0.007	−0.007	−0.007	−0.086	−0.086
	(0.009)	(0.009)	(0.011)	(0.011)	(0.057)	(0.057)
Panel B: 250 to 750 meters bandwidth (N=4,472)						
TOC*Post	0.031**	0.031**	0.039**	0.039**	0.407***	0.407***
	(0.012)	(0.012)	(0.016)	(0.016)	(0.149)	(0.149)
Panel C: 500 to 1000 meters bandwidth (N=2,992)						
TOC*Post	0.043***	0.043***	0.058**	0.058**	0.705***	0.705***
	(0.016)	(0.016)	(0.024)	(0.024)	(0.222)	(0.221)
Panel D: Within Treated variation (N=3,064)						
TOC*Post	−0.001	−0.001	0.003	0.003	−0.110	−0.110
	(0.016)	(0.016)	(0.020)	(0.020)	(0.148)	(0.148)
Panel E: Within Controlled variation (N=2,168)						
TOC*Post	−0.003	−0.003	0.002	0.002	−0.065	−0.065
	(0.014)	(0.014)	(0.017)	(0.017)	(0.082)	(0.081)
R^2	0.019	0.244	0.016	0.231	0.013	0.197
Panel F: Treatment Lagged by 1 year (N=5,232)						
TOC*Post	0.033***	0.033***	0.040***	0.040***	0.345***	0.345***
	(0.011)	(0.011)	(0.013)	(0.013)	(0.107)	(0.107)
Panel G: Without splitted tracts (N=3,672)						
TOC*Post	0.032**	0.032**	0.041***	0.041***	0.347**	0.347**
	(0.013)	(0.013)	(0.015)	(0.015)	(0.139)	(0.139)
Note:						*p<0.1; **p<0.05; ***p<0.01

Note: The regressions shown are the results of Equation 2.3 for different robustness checks. Standard errors clustered at the Census Tract level. Fixed effects per Census Tract and Year

Table A2.4: Blocks

	Prob (Aff. Project)	Aff. Projects	Aff. Units
TOC*Post	0.0012**	0.0014***	0.0188***
	(0.0005)	(0.0005)	(0.0051)
Observations	138,576	138,576	138,576
R^2	0.1621	0.1657	0.1355

Note:
*p<0.1; **p<0.05; ***p<0.01

Note: The regressions shown are the results of Equation 2.3 at the block level. Standard errors clustered at the block level level. Fixed effects per block and Year

2.9.2 Figures

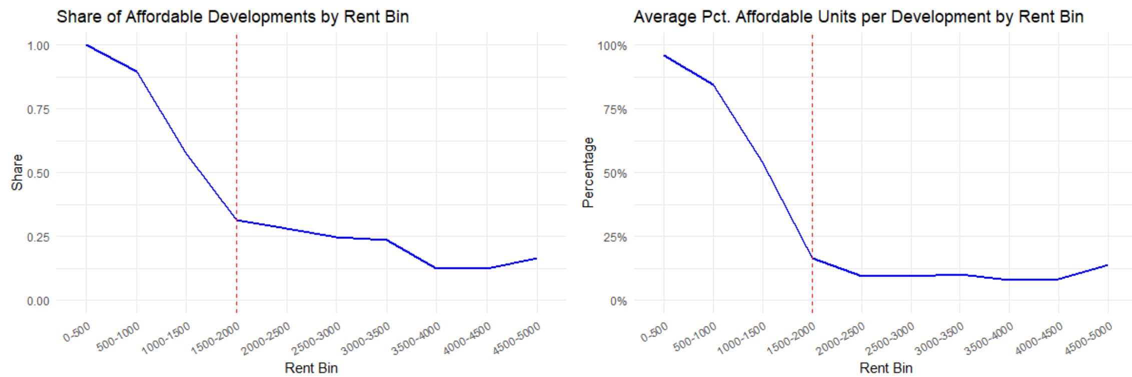


Figure A2.1: Share of developments and units in new affordable housing developments since 2010.

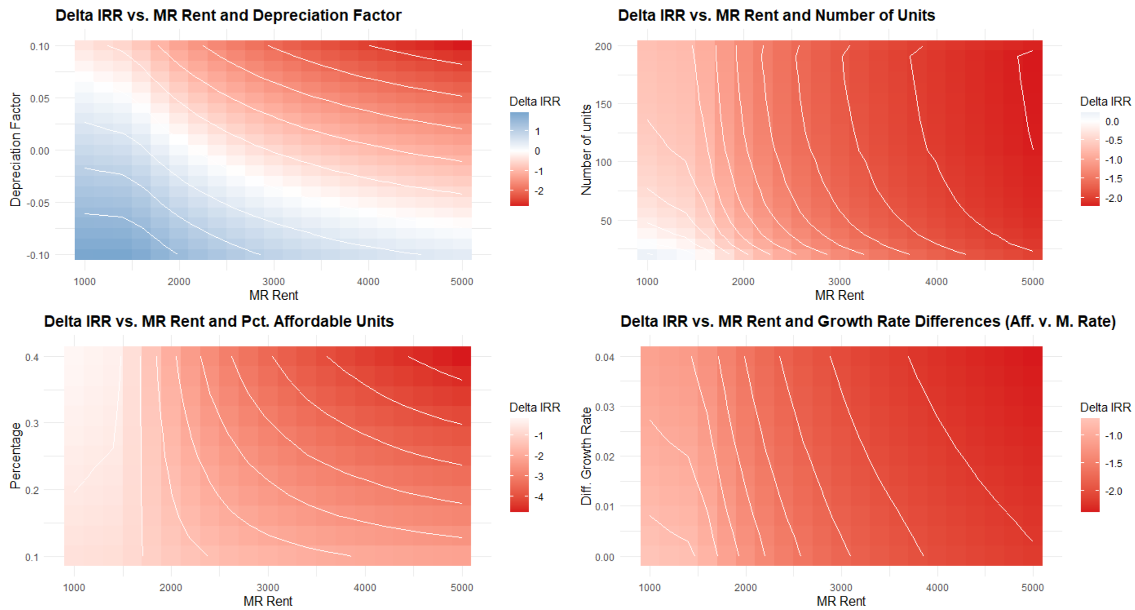


Figure A2.2: Sensitivity of ΔIRR for different variables - 5% depreciation

Note: The figure shows IRR Montecarlo simulations based on proforma developments and information gathered from (Zhu et al., 2021). The results are a sensitive analysis comparing the variation between development with and without TOC. The figure shows the analysis for figures 2, 3, and 4 when including a 5% depreciation factor.

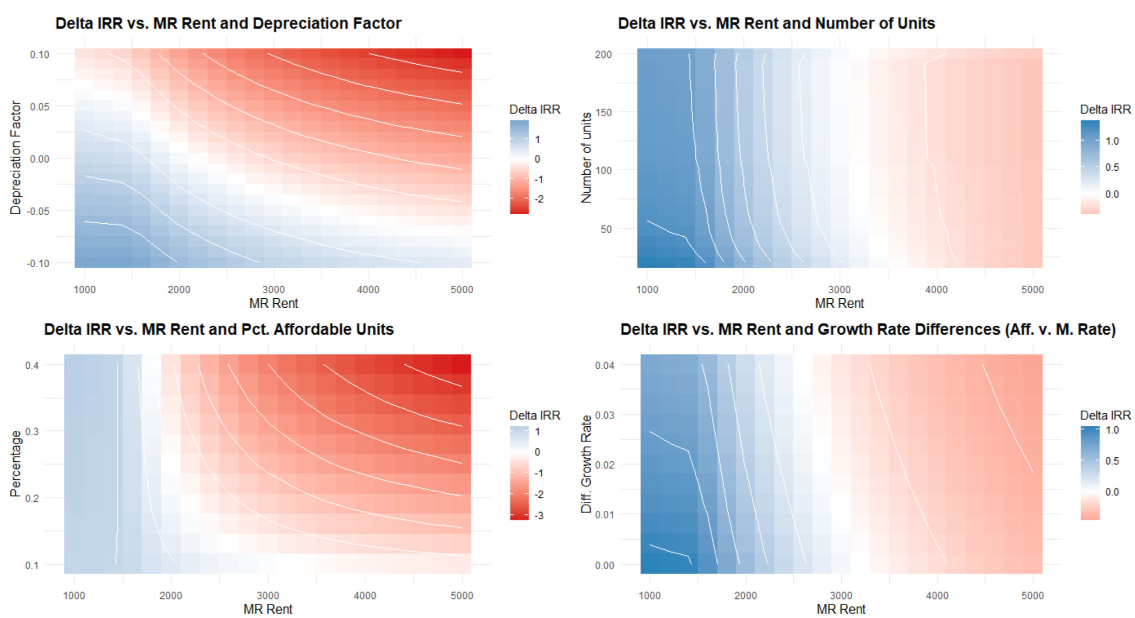


Figure A2.3: Sensitivity of ΔIRR for different variables - 5% appreciation

Note: The figure shows IRR Montecarlo simulations based on proforma developments and information gathered from (Zhu et al., 2021). The results are a sensitive analysis comparing the variation between development with and without TOC. The figure shows the analysis for figures 2, 3, and 4 when including a 5% appreciation factor.

Figure A2.4: Affordable housing and new buildings density in Los Angeles

Note: The figure shows the density of new market rates and affordable housing developments around the policy boundary. Positive distances correspond to the treated group and negative to the control. **Red indicates post-treatment, and blue pre-intervention**.

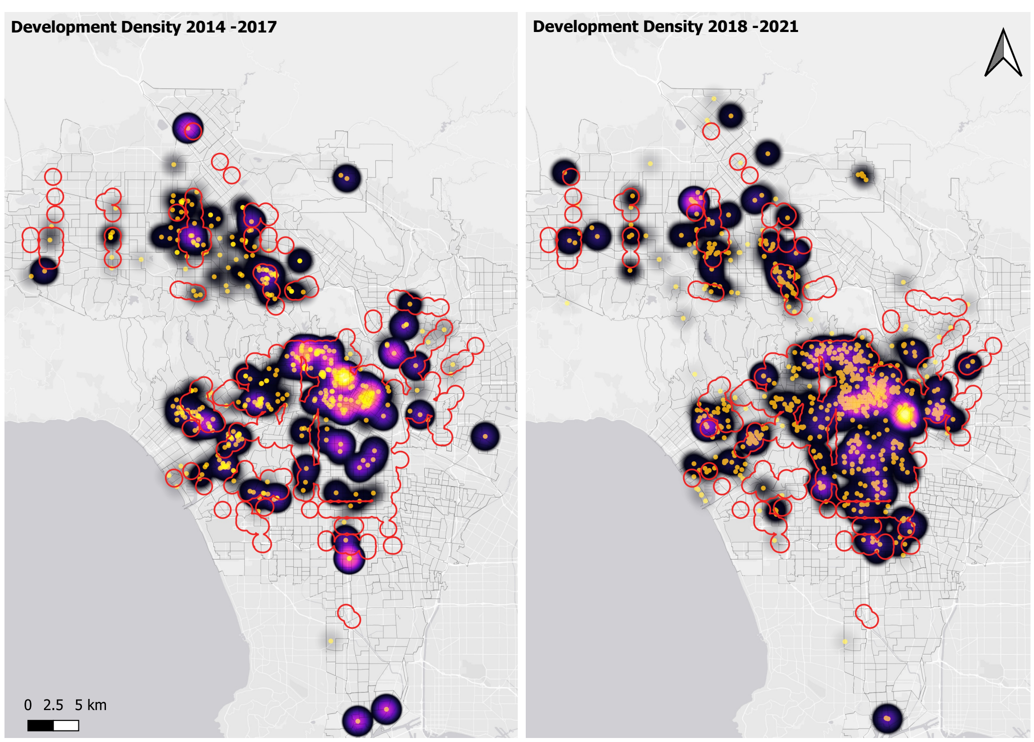


Figure A2.5: Spatial density of affordable housing pre and post TOC

Note: The figure shows the density of affordable housing developments across Los Angeles. The left figure indicates pre-treatment developments, and the right post.

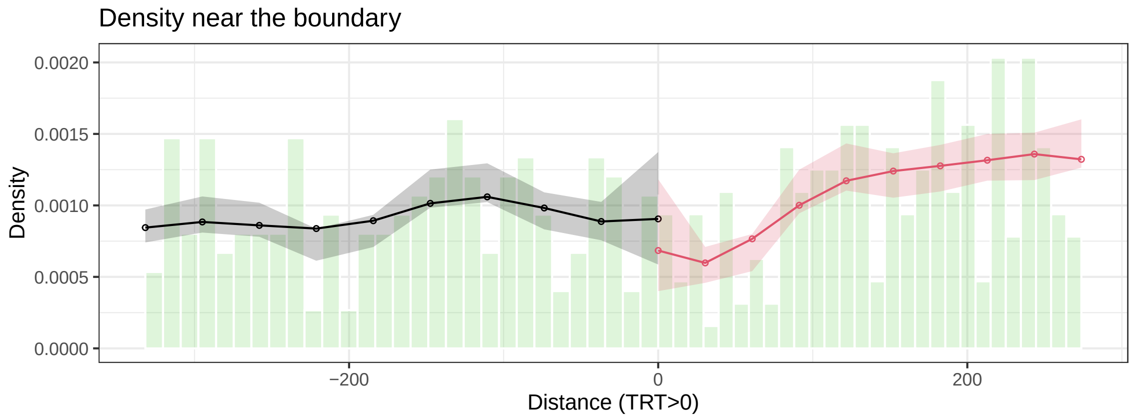


Figure A2.6: Density of affordable housing around the 500 mts bandwidth

Note: The figure shows the density of affordable housing developments around the policy boundary. This shows low-density values and no-significant differences between groups, which indicates that the data is not suitable for an RDD design.

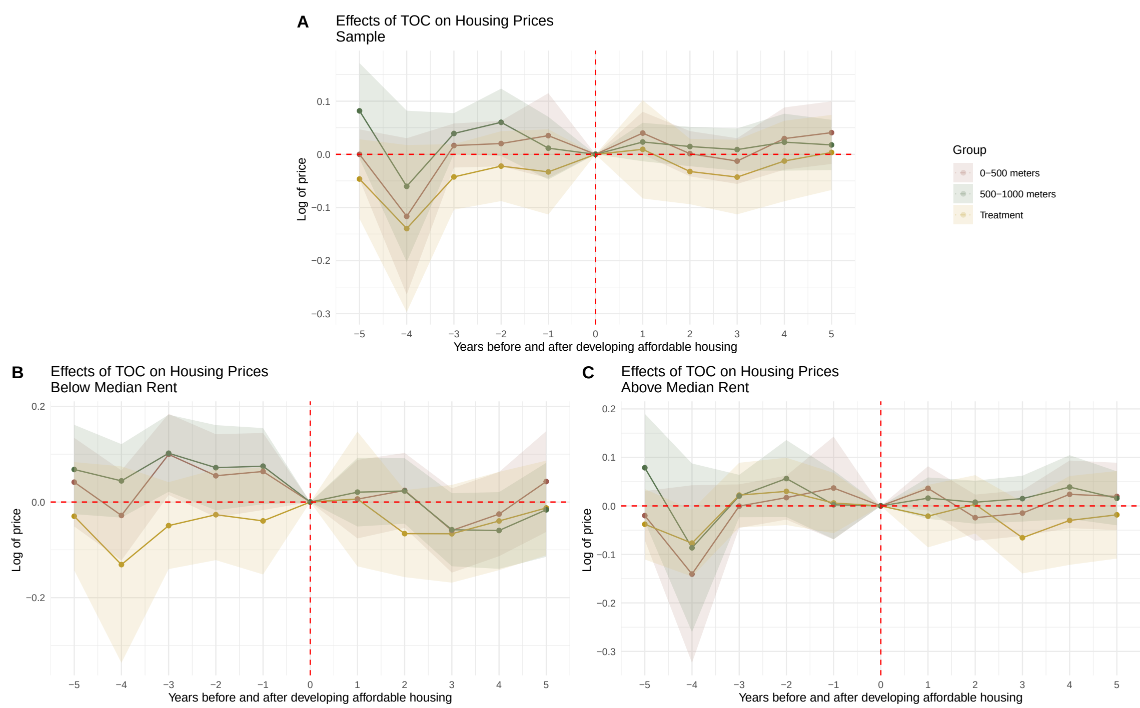


Figure A2.7: Spillover effects of TOC housing on Sale prices

Note: The figure shows the spillover effects for the three bandwidths defined in Section 2.5.1 and Equation 2.3. All regressions include block and year fixed-effects and housing controls such as the square footage, number of bedrooms, bathrooms, construction quality, and superstructure category. Standard errors clustered at the Block level.

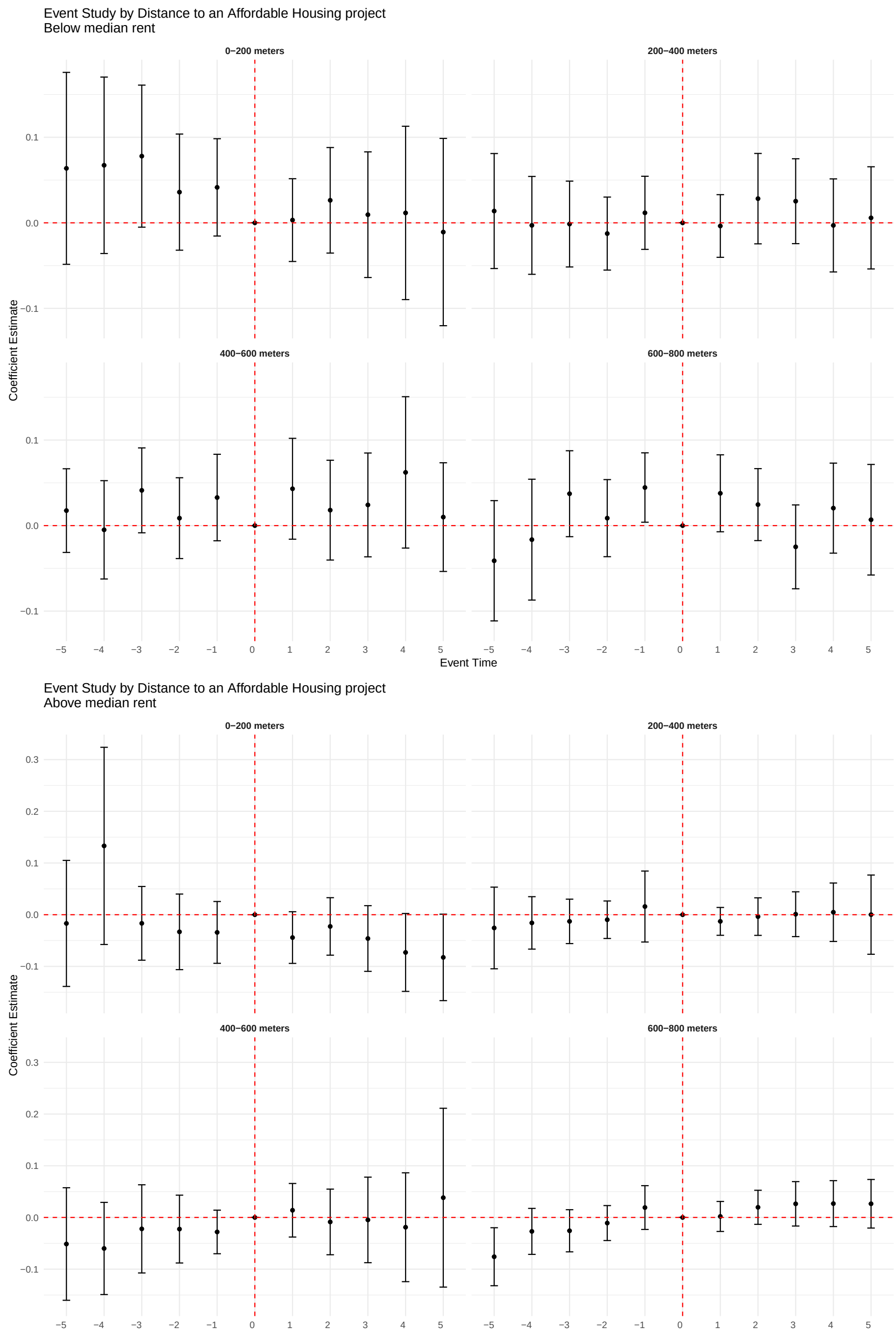


Figure A2.8: Spillover effects of new affordable housing on Sale prices

Note: The figure shows the spillover effects of affordable housing for different bandwidths around new affordable housing in an event study based on Equation 2.3 but interacting TRT x each lead and lag. All regressions include block and year fixed-effects and housing controls such as the square footage, number of bedrooms, bathrooms, construction quality, and superstructure category. Standard errors clustered at the Block level.

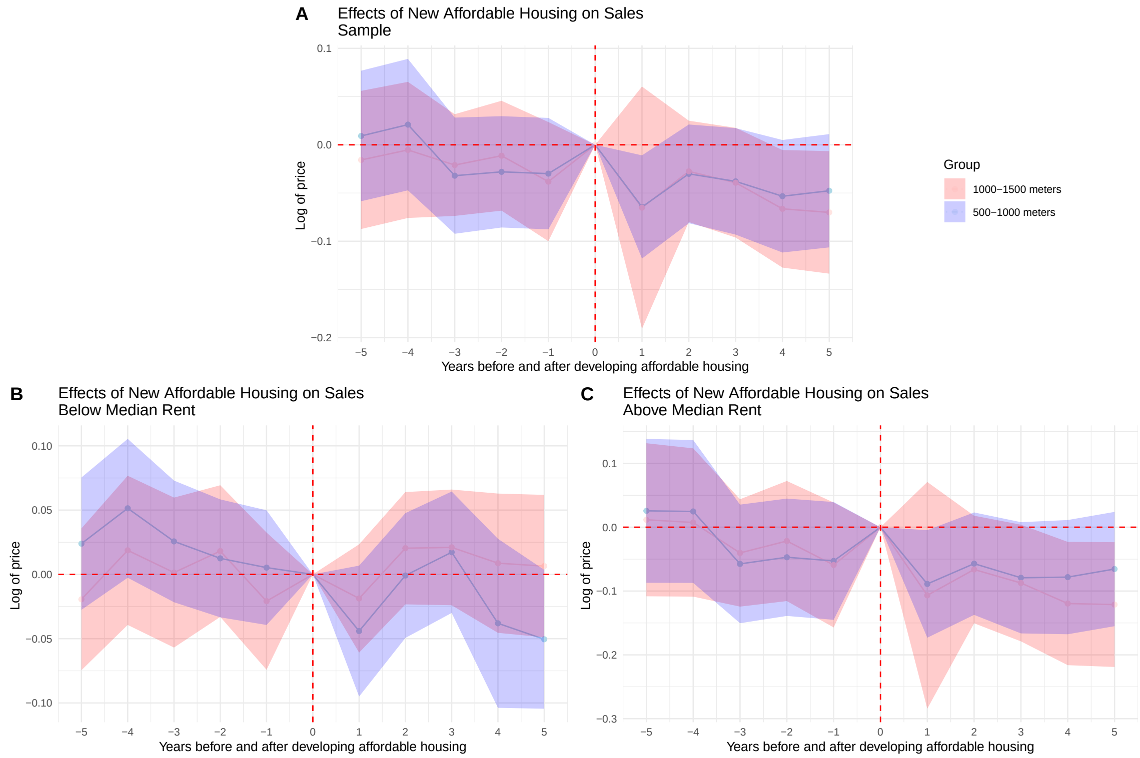


Figure A2.9: Spillover effects of new affordable housing on Sale prices

Note: The figure shows the spillover effects for the three bandwidths defined in Section 2.5.1 and Equation 2.3. All regressions include block and year fixed-effects and housing controls such as the square footage, number of bedrooms, bathrooms, construction quality, and superstructure category. Standard errors clustered at the Block level.

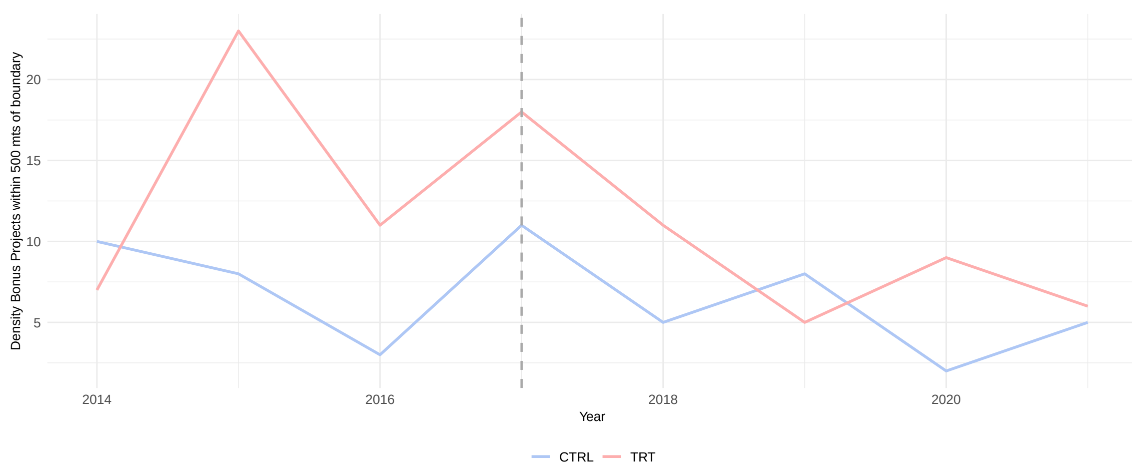


Figure A2.10: Evolution of Density Bonus across the 500 mts bandwidth

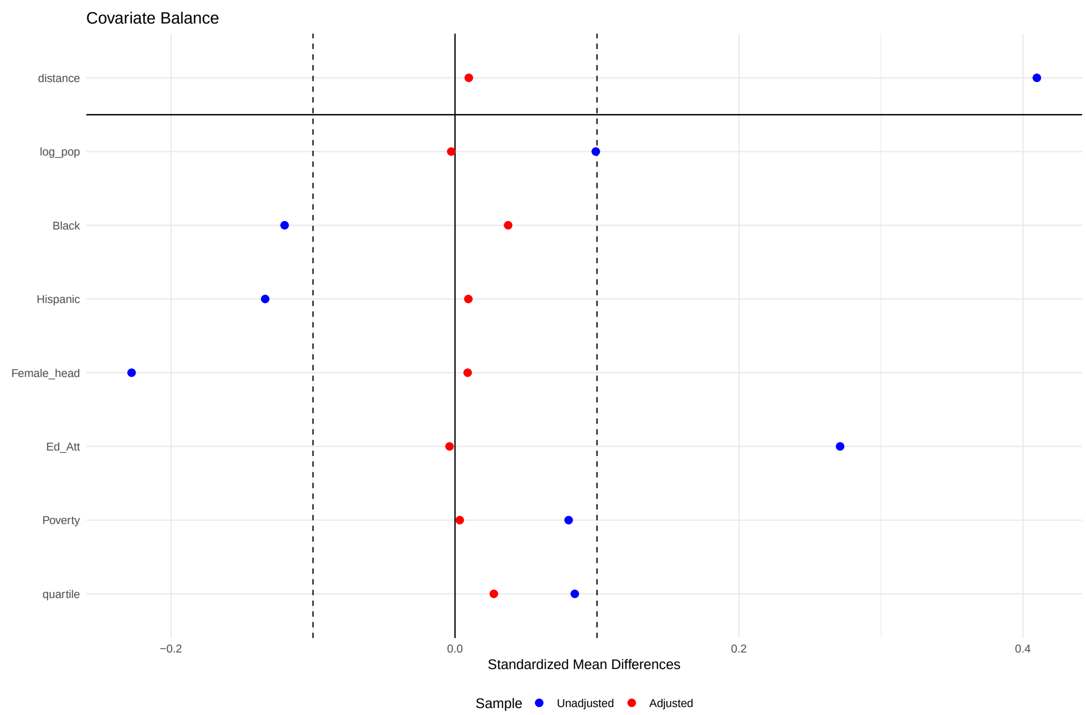


Figure A2.11: PSM Covariate balance

Note: The figure shows the adjusted difference of means for the adjusted and unadjusted sample in the PSM algorithm defined in Section 2.6.2.

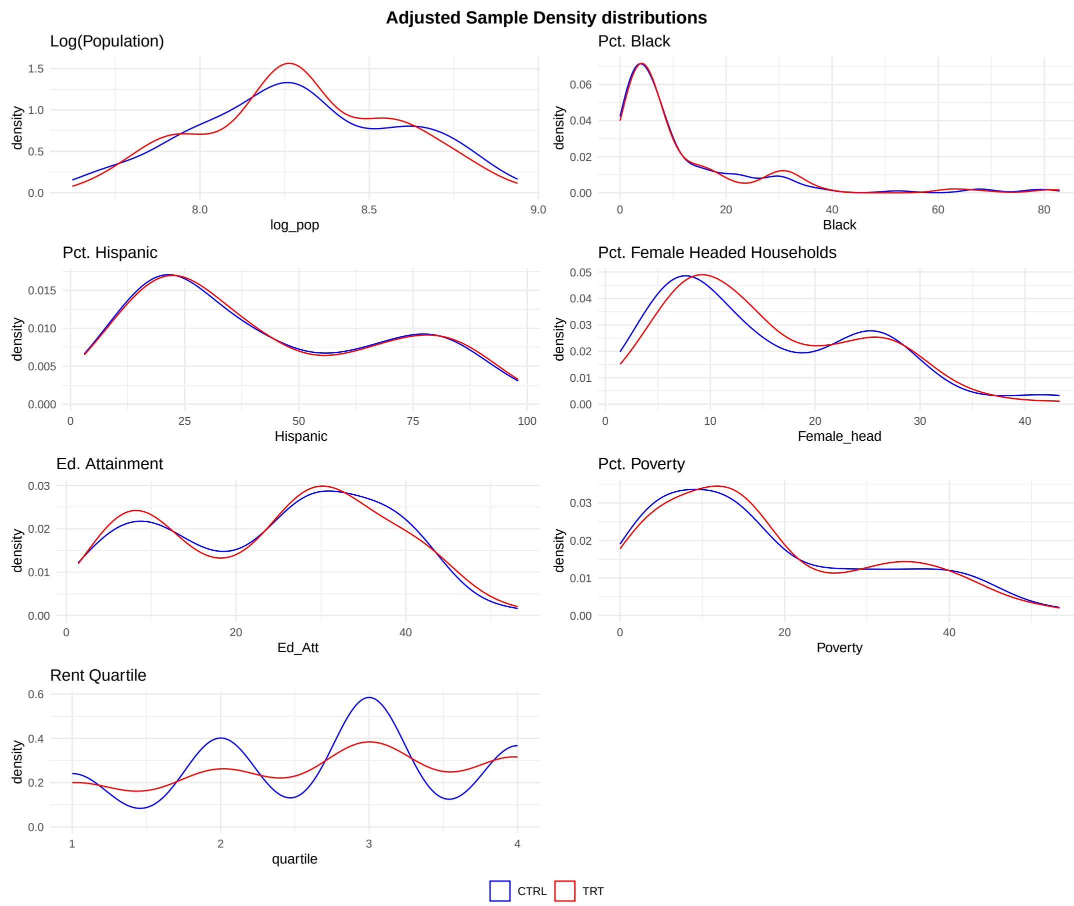


Figure A2.12: PSM Density of each covariate.

Note: The figure shows the density for each variable and group used in the PSM algorithm defined in Section 2.6.2.

2.9.3 K-means algorithm

I use a K-means clustering algorithm to define clusters for the heterogeneity analysis using the demographic and socioeconomic variables displayed in the determinants of affordable housing described in the data Section. I select the number of clusters, k, based on minimizing the total within-cluster variance. Each observation is assigned to the cluster whose centroid (mean) is closest to it, as measured by the Euclidean distance.

To determine the optimal number of clusters, k, I employed several standard cluster validation techniques:

1. **Elbow Method**: Evaluates the total within-cluster sum of squares (WSS) for different values of k and identifies the point at which the marginal gain from adding more clusters decreases.
2. **Silhouette Analysis**: Measures the average silhouette width, which reflects how similar each point is to its assigned cluster compared to other clusters.
3. **Calinski-Harabasz Index**: Quantifies the ratio of between-cluster dispersion to within-cluster dispersion.
4. **Gap Statistic**: Compares the WSS against that expected under a null reference distribution and identifies the optimal number of clusters based on the largest gap.

Each of these techniques was applied to the dataset with values of k ranging from 2 to 10 to find the most suitable number of clusters. Figure A2.13 displays the results from each clustering validation method:

The elbow plot shows a tipping point at $k = 4$, where the total WSS starts to plateau, suggesting diminishing returns for more clusters. The Calinski-Harabasz Index increases steadily as k grows, with a more gradual increase beyond $k = 4$, suggesting that adding more clusters does not significantly improve the separation of clusters. The Gap Statistic peaks at $k = 4$, making this the strongest indication that $k = 4$ is the optimal number of clusters. Lastly, while the highest silhouette width occurs at $k = 2$, the drop from $k = 3$ to $k = 4$ is minimal, indicating that the clustering remains reasonably well-defined at $k = 4$.

To cross-validate these results, I also use a Principal Component Analysis (PCA). The results in Figure A2.14 show a clear distinction between the four groups. Clusters 1 (red) and 2 (blue) the largest. However, Clusters 3 (green) and 4 (purple) exhibit distinguishable differences, too; although they might be more similar between them due to a smaller subsample.

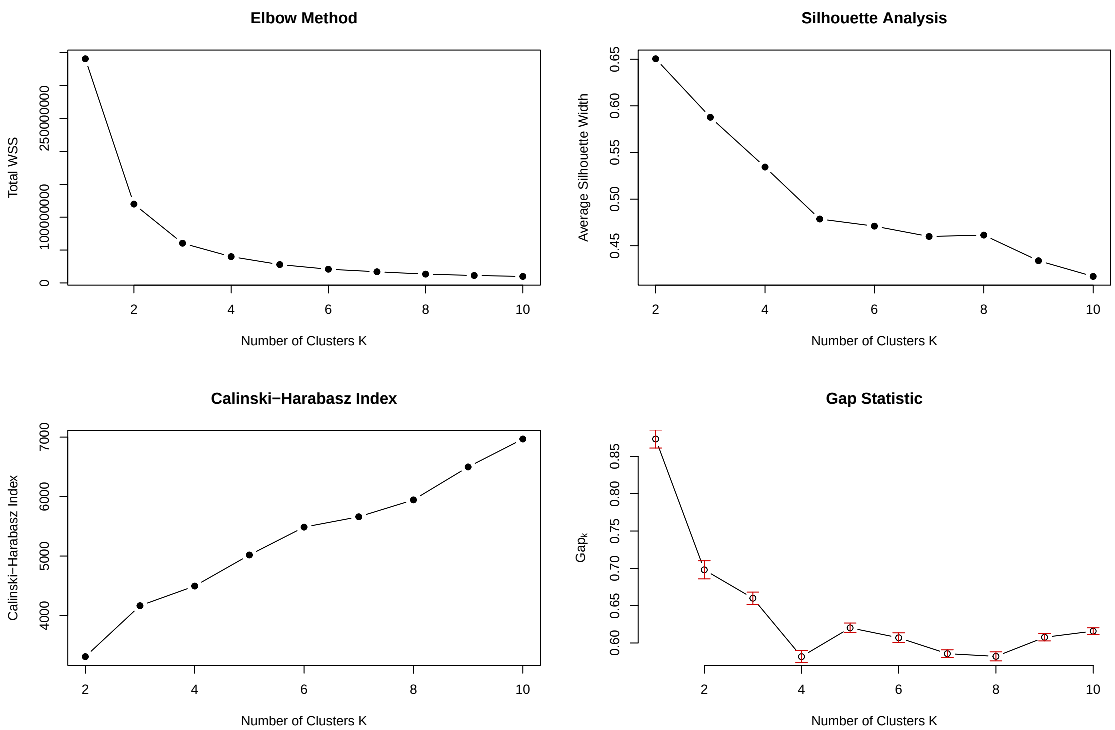


Figure A2.13: Clustering validation methods

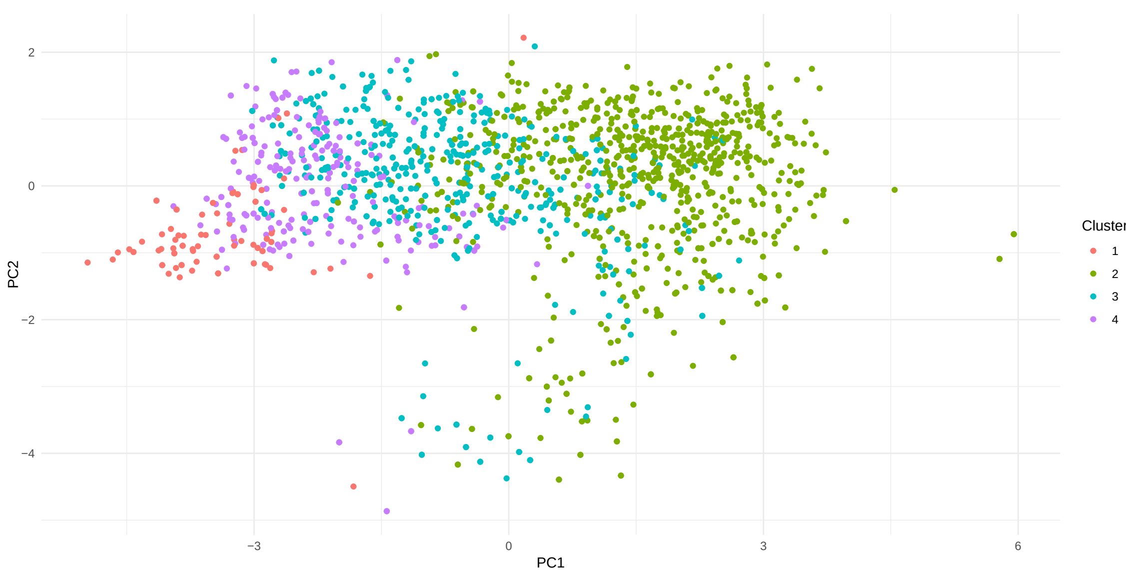


Figure A2.14: Principal Component Analysis.

Based on the validation techniques, I choose four clusters ($k = 4$). A map illustrating the spatial distribution of the four identified clusters is provided below :

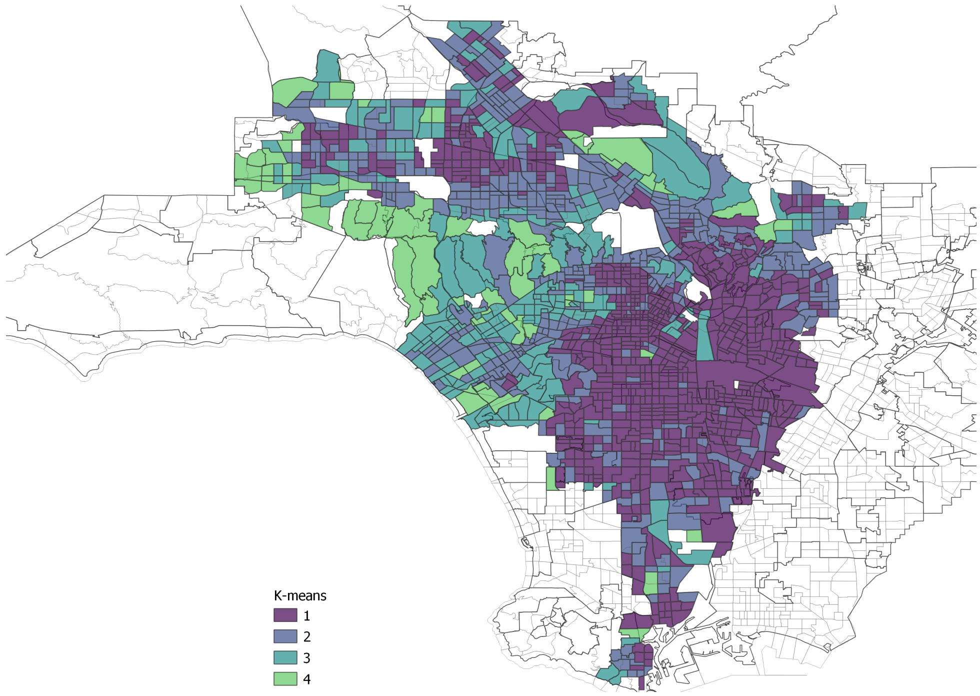


Figure A2.15: K-means clustering by median rents

2.9.4 Spatially constrained clustering algorithm

To complement the heterogeneity analysis, I added a second restriction to clustering: spatial contiguity, which accounts for autocorrelation and the influence on proximate observation blocks in this case. For this purpose, I developed a SKATER algorithm that creates clusters by building a minimum spanning tree (MST) that connects geographic areas with the least total dissimilarity. It progressively removes edges from the tree to form clusters while maintaining geographic contiguity. This is particularly advantageous over traditional k-means, which do not account for spatial variables.

For this analysis, geographic areas were clustered based on land use characteristics, density measures, and socio-demographic factors. These included percentages of single-family (SF) and multi-family (MF) housing, commercial and industrial land uses, as well as the socioeconomic variables used across the chapter.

The clustering analysis initially considered 4 clusters to match with the K-means algorithm. However, with more than three clusters, the number of observations in the third and fourth became too small to offer meaningful insights. For instance, introducing a fourth or fifth cluster led to groups with fewer than 50 units, reducing the reliability of the findings. Therefore, I opted for a three-cluster solution, balancing interpretability and statistical robustness.

I used Moran's I statistics to evaluate the clustering solution's performance. Moran's I statistic results indicate that the clusters are geographically consistent, with significant spatial autocorrelation. Hence, the SKATER algorithm successfully captures spatial patterns.

Metric	**Value**
Moran's I Statistic	0.8715
Expectation	-0.00057
Variance	0.00028
Z-Score	51.91
P-Value	< 0.0001

Table A2.5: Moran's I Test Results

Table A2.6 presents the characteristics of each cluster. Cluster 1 is dominated by single-family housing and low-density areas, with a predominantly White population and higher median rents, suggesting an affluent suburban profile. Cluster 2 shows higher multi-family housing shares and a higher proportion of Hispanic residents, indicating more urban, affordable areas. Cluster 3 stands out with a predominantly Black population and mixed density, reflecting minority neighborhoods with moderate affordability.

Table A2.6: Mean values per clusters.

Cluster	1	2	3
Pct. SF	0.63	0.44	0.60
Pct. MF	0.17	0.31	0.28
Pct. Comm	0.06	0.09	0.06
Pct. Ind	0.03	0.05	0.02
Low Density	0.60	0.25	0.53
Mid Density	0.20	0.44	0.29
High Density	0.03	0.07	0.01
Black	4.35	16.80	59.30
Hispanic	41.50	66.50	29.90
White	63.20	43.30	26.10
Poverty	12.90	27.50	14.60
Female_head	13.60	25.30	22.40
Renters	58.60	68.70	55.50
Ed_Att	24.80	10.70	15.30
Median_Ren	1,314	958	1,160

As shown in the following map, the spatial clusters match with density and land uses, capturing Los Angeles's spatial configuration.

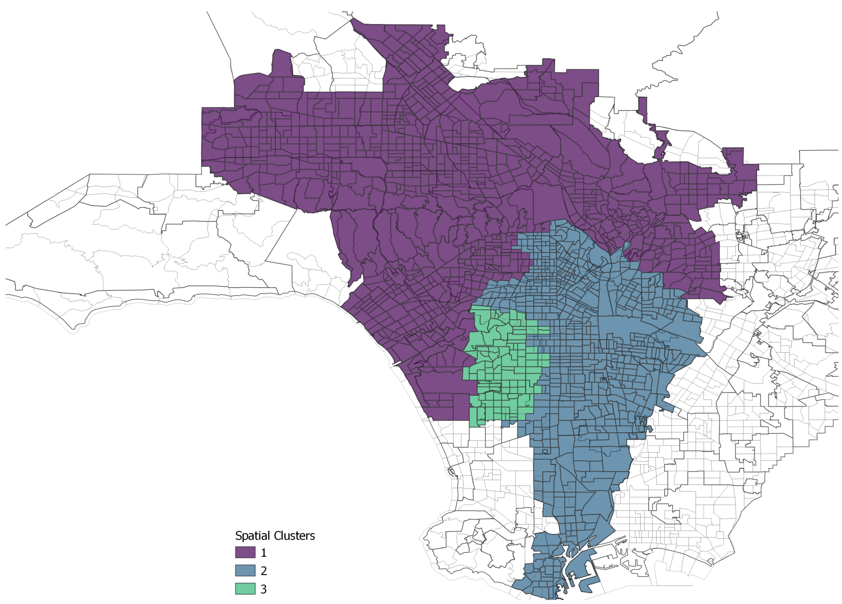


Figure A2.16: Spatially constrained clustering

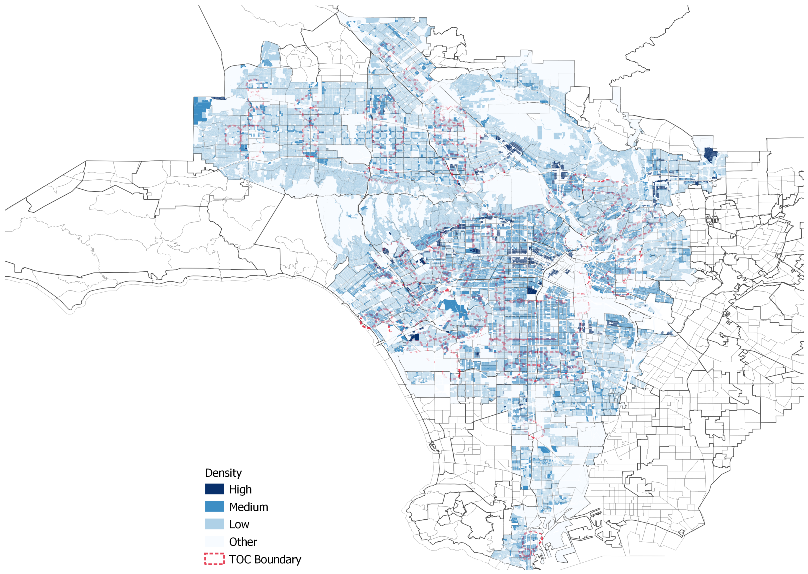


Figure A2.17: Residential density per lot

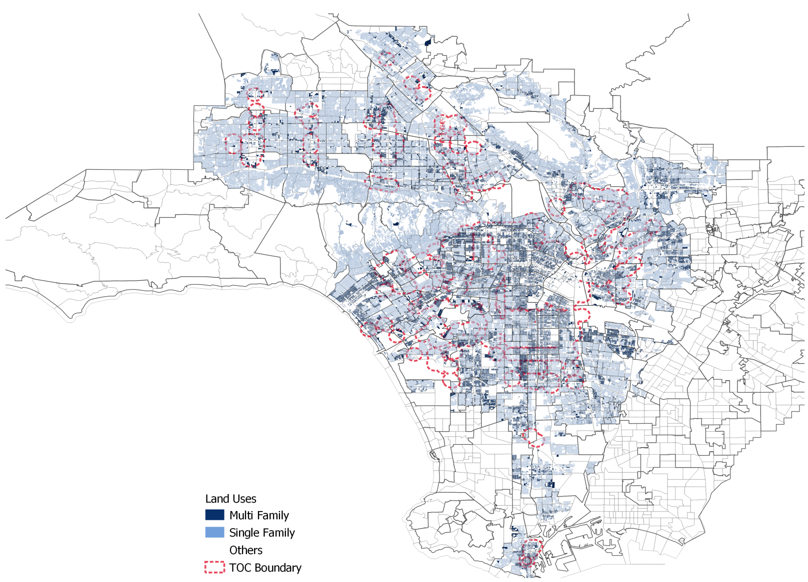


Figure A2.18: Residential zoning per lot

Chapter 3

Upzoning New York. The economic impact of public rezoning

3.1 Introduction

Over the last few years, affordability issues have increased as housing prices have risen substantially (Albouy et al., 2016). This problem is exacerbated in metropolitan areas, which usually face tighter land use regulations and greater scarcity (Hilber & Schöni, 2022). Consequently, supply-side solutions, such as relaxing building parameters, have become more popular. Despite the popularity of these policies, some academics argue that they could intensify affordability challenges due to the amenity value of new properties and the endogenous influx of residents after rezoning, causing housing prices to rise (Guerrieri et al., 2013; Rodriguez-Pose & Storper, 2020).

During the late 20th century and the first decade of the 2000s, property prices and land values soared in the U.S., especially in cities like New York, where a booming population and low responsive new housing supply exacerbated this problem (Glaeser & Gyourko, 2005). In response, Mayor Bloomberg's administration implemented several rezoning schemes across the city, modifying the zoning of several neighborhoods (Furman Center, 2010; Podemski, 2013). Zoning parameters such as Floor Area Ratio (FAR) and land uses were relaxed in different neighborhoods between 2002 and 2014 to bolster economic and housing development (Goldberg, 2015). After a decade of implementation, the results and their mechanisms remain unclear, triggering a vivid debate about the impacts of local supply-led policies on housing affordability[1].

[1] In recent years, there has been a candid debate between influential researchers about the role of supply-led solutions in tackling affordability issues. On the one hand, Rodriguez-Pose and Storper (2020) criticized them by arguing that increasing market-rate housing supply could lead to gentrification. On the other hand, Manville et al. (2022) responded, arguing that we need to build taller and denser buildings to alleviate the current U.S. housing crisis, and zoning is an important tool to accomplish this.

To inform this discussion, I conduct hedonic event studies of housing prices and the housing stocks to study the local impacts of large publicly initiated rezonings across New York City (NYC) between 2007 and 2013[2]. By conducting an intra-city analysis, I test for location heterogeneities and provide disaggregated results for different neighborhoods while using adjacent areas as a suitable control to evaluate the aggregate shock over the timeframe of these local changes.

While there is a large body of literature exploring citywide land-use effects on housing supply (Glaeser & Gyourko, 2005; Glaeser & Gyourko, 2002; Hilber & Vermeulen, 2016), few papers comprehensively explore the local effects on neighborhood changes after enacting these policies. This question is of particular importance for underserved communities living for decades in these places, who might face potential displacement risk if their neighborhoods change drastically. To explore this framework, I hypothesize that central areas should behave differently than peripheral upzoning, where the potential for change is higher due to an older stock. By exploiting the heterogeneous locations, this paper aims to reconcile findings from other studies based in different cities that differ in results and are less comparable.

One example that clearly illustrates these tensions and how local effects matter is the well-documented case study of Williamsburg, New York. Before its upzoning in 2003[3], the area was primarily zoned for manufacturing, housing low-income families in a neighborhood with amenities such as its views to the Manhattan's skyline and its rapid connection to Central Manhattan by subway. After the land-use change that allowed for high-density residential constructions, the area became the target of commercial and residential developments (Zukin et al., 2009). Consequently, low-income families and migrants were displaced as lofts replaced the old stock while manufacturing properties were transformed into luxury developments in the shoreline (Curran, 2007).

The underlying rationale behind the policy was that housing prices should decrease as a consequence of relaxing zoning constraints and, consequently, building more units if developers were allowed to do it (Gabbe, 2018; Newman & Wyly, 2006). From a theoretical perspective at the city level, this premise is widely supported by empirical research, which indicates that supply constraints such as regulation and geography positively correlate with housing prices and land costs (Hilber & Vermeulen, 2016; Kok et al., 2014; Saiz,

[2]According to (Furman Center, 2010; Goldberg, 2015), Bloomberg's changed nearly 40% of the total land uses in the city

[3]This rezoning is not part of the study due to data limitations. Nonetheless, there is sufficient academic evidence about the neighborhood change following the land use change (Curran, 2007; Stabrowski, 2014; Zukin et al., 2009).

2010). Under this rationale, new units tend to moderate price increases by helping to make housing more affordable to low- and middle-income households (Been et al., 2019; Glaeser & Gyourko, 2018; Manville et al., 2022), which is known as the *Supply Effect*. However, there is skepticism about the potential effects at the local level, as new developments can also lead to neighborhood revival (González-Pampillón, 2022), which is defined as the *Amenity Effect*. Furthermore, if supply elasticity varies across locations (Baum-Snow & Han, 2019) and there are imperfect substitutes (Hilber, 2017), the capitalization of a supply shock should also vary across locations. All in all, these different forces impose empirical questions that cases like New York can help to solve thanks to the spatial heterogeneity of the upzoning process.

As discussed in my theoretical framework, the location and development potential of the upzoned area matter, as the marginal value of new construction is not the same in centrally dense areas as in peripheral undeveloped areas. Hence, my research aims to test the following questions:

- How does upzoning impact housing prices and development patterns in New York?
- What are the local supply and amenity effects of upzoning in central and peripheral neighborhoods?
- Does upzoning meet affordable housing goals?

To test these empirical questions, I exploit the granular data of housing sales and the existing stock per year across time and location to recover the quasi-experimental impacts of upzoning in New York. For this purpose, my strategy relies on event studies of housing prices, dwelling and commercial units, and affordable housing developments between the treated areas and their adjacent blocks.

Estimating the impacts of rezoning imposes two endogeneity challenges. First, this process usually responds to endogenous community problems before rezoning, such as rising rents in specific areas. However, this doesn't seem to be the case regarding housing prices. The median rent for upzoned neighborhoods did not significantly vary compared to other districts across the city before the policy implementation (Furman Center, 2010). Second, as X. Li (2019) highlighted, developers are more likely to follow fast-appreciating areas, challenging the identification of causal relationships for a specific policy.

To overcome these challenges, I exploit the exogenous timing of the different rezoning implementations and the clear boundary discontinuities to control for the local policy impacts. The primary assumption is that properties are similar around the policy boundary; hence, I can derive a proper control group if they show similar pre-rezoning development and socio-demographic trends. Nonetheless, this also imposes the empirical challenge of accounting for housing spillovers, as changes in the housing stock within the treated area can partially impact variables such as housing prices. Consequently, it is worth highlighting that this paper estimates local effects and does not calculate the overall equilibrium changes of upzoning New York[4].

Regarding my findings, I conclude that the overall results align with previous studies showing that prices decrease of about 12% in the intervened areas (Asquith et al., 2019; X. Li, 2019; Pennington, 2021). Furthermore, there is a pattern of spatial heterogeneity in the interventions, as when I separate between peripheral and central upzoning, the results vary significantly.

On the one hand, the peripheral group exhibits an increase in housing prices of about 16% to 19% after four years of implementation. This increase can be associated with changing areas that were facing a steady increase in the built environment, but when upzoned the treated blocks do increase the commercial space and units. After upzoning, the number of commercial units, renovations and floors increase, while both the treated and control areas show an upward trend in units and developments. These results relate to Zahirovich-Herbert and Gibler (2014) and Ooi and Le (2013), who claim that the concentration of new projects creates an amenity effect in similar areas.

On the other hand, the central upzoning shows opposite results concerning prices; in this case, they correlate with a decay of about 23% to 28% in housing prices. These results are positively correlated with an increase in the number of units and buildings per block, as well as with renovations. Here, there are no increases in commercial units, suggesting higher supply than amenity effects.

Consequently, disaggregating interventions across space demonstrates that location and the built environment matter, as the magnitude of amenity and supply effects varies within a large city.

As an additional result, I find cyclical responses regarding the provision of affordable housing developments. The results exhibit a short-run positive response after the policy implementation; however, they vanish over time, becoming negatively significant in both areas after five to six years of changing land use. These findings could suggest that market-rate developments primarily drive urban renewal processes and reinforce the hypothesis

[4]This question imposes more empirical questions since other districts were downzoned or, at least, updated their zoning code to resemble current local trends.

about high Amenity Effects and the role of development potential when increasing zoning parameters.

These conclusions directly affect policy decisions, as they show that the same policy can produce different results within the same city. As expected, since density, heights, and Floor Area Ratios (FAR) differ across locations, the expected effects of upzoning should differ between different city areas; I formalize this intuition in Section 2.2.

This paper relates to the literature examining the role of supply-led policies at the local level on property prices and affordable housing (Asquith et al., 2019; Diamond & Mcquade, 2019; Freemark, 2020; González-Pampillón, 2022; X. Li, 2019; Pennington, 2021) by adding a new component to the analysis: the role of geography on the effects of public interventions. Usually, monocentric models associate peripheral areas with less attractiveness than central neighborhoods due to higher opportunity costs of transportation; however, these models don't account for neighborhood changes over time, meaning that dynamic Amenity Effects are implicitly absent. While central areas are more attractive than the periphery, the marginal value of new construction should differ since the former is usually more developed than the latter. Hence, policies leveraged by authorities could have unintended consequences if they trigger large-scale changes in areas with development potential.

In light of these countervailing effects, some researchers have tried to measure the impacts of new construction at the local level, finding contrasting results. On one hand, there is evidence aligning with city-wide results where new buildings lead to reduced housing prices and rents in New York City (X. Li, 2019), San Francisco (Pennington, 2021), and in low-income central areas of different MSAs (Asquith et al., 2019). Even though they all conclude that there are minor amenity effects, the supply effects outweigh them. On the other hand, Freemark (2020) studied the impact of a major upzoning plan across Chicago, finding increased property prices and no evidence of new construction filling through building permits after the policy implementation. It is worth mentioning that the policy was based on Transit-Oriented Development (TOD) lots (Metropolitan Planning Council, 2015), which are known to impact property prices (Ahlfeldt & Wendland, 2011; Bartholomew & Ewing, 2011).

When evaluating more aggregated policies at larger scales, results can contrast with the previous studies. For instance, González-Pampillón (2022) found that a large subsidy targeting middle-income neighborhoods in Uruguay induces amenity effects that increase housing prices by 12%. Similarly, Schwartz et al. (2006) studied lots mainly located in distressed areas of NYC, finding that property prices increased near subsidized housing that replaced city-owned available land and that the effect increased with project size while decaying when moving away from them. Finally, Zahirovich-Herbert and Gibler (2014) found that the concentration of projects larger than the average size leads to minor positive effects on housing prices. Hence, when projects act on aggregate in specific areas, the amenity effects increase as they drive neighborhood change.

Finally, location also seems to be an important driver in the role of net effects. Diamond and Mcquade (2019) show that the Low-Income Housing Tax Credit (LIHTC) presents variable results conditional on neighborhoods since the spillover effects of new projects are positive in low-income areas but negative in affluent districts. Moreover, Baum-Snow and Han (2019) also showed that supply responses in a city are not constant, as the outskirts tend to be more elastic than central areas.

This paper also builds upon how spillovers interact in housing markets (Asquith et al., 2019; Fischer et al., 2018; González-Pampillón, 2022) and the expected effects of urban policy on affordable housing provision (Diamond & Mcquade, 2019). Unlike previous studies, the results are compared intra-city rather than across metropolitan areas. This approach helps circumvent unobserved systemic differences between cities and makes counterfactuals more suitable for comparing the policy's heterogeneous effects.

The structure of the paper is as follows. Section 2 describes the institutional settings of the policy and presents a theoretical framework to explain how local supply, demand, and location interact in the presence of a supply shock, such as upzoning a neighborhood. Section 3 describes the data and the empirical approach. Section 4 presents the main results and derived analysis. Section 5 discusses potential mechanisms. Finally, Section 6 provides conclusions and policy implications.

3.2 Policy Background and Theoretical Predictions

3.2.1 Policy Background: Rezoning in New York.

The current Zoning Resolution was enacted in 1961, representing the city's second comprehensive plan after the first document was released in 1916 (CPC, 2022). Instead of constantly changing land uses[5], the 1975 revision of the New York City Charter stated that if a project does not comply with the regulation, any stakeholder, including public agencies, can start a Uniform Land Use Review Procedure (ULURP) to change its zoning

[5]As the CPC document states, this is a slow effort that can take years and might not address the problems it aims to solve due to the lags in the process

parameters and use. This process has triggered developers to ask for land use changes to build larger projects; moreover, public agencies have also used this tool to enhance their lots and try to make it feasible or build more units.

Before the formal start, the Department of City Planning (DCP) performs a land-use revision and an environmental review to disclose any potential impact the proposal might have.[6] Once both are completed, the application starts a public review process through community boards and public hearings for 60 days. Then, the borough president and the borough board review it for 30 days and submit recommendations to the City Planning Commission (CPC), where a public hearing is held to modify, approve, or disapprove the proposal within a deadline of 60 days. If the CPC approves the application, the City Council has 50 days to make any observations, and the mayor, who can veto council actions, has five days to do it, too. [7] Finally, the entire process cannot exceed one year.

Under this process, the Bloomberg administration implemented massive changes in land uses in different neighborhoods to encompass several goals, such as catalyzing economic development, accommodating the expected population growth, and preventing out-of-scale developments in specific areas (Furman Center, 2010; Goldberg, 2015). Approximately one-fifth of the city underwent a land-use change[8] during his administration, of which most of them were to preserve neighborhood characteristics and preventing new developments from changing the local landscape (Podemski, 2013).

Although each intervention had different rationales, rezoning can be summarized into three groups. The first relates *upzonings* to relax zoning conditions through two main mechanisms: (1) renewing manufacturing areas to allow residential uses and (2) addressing city-wide housing needs in areas by increasing the development potential. The second is the opposite, *downzoning*, which aims to restrict land uses to preserve neighborhood characteristics and prevent out-of-scale developments. Finally, a large set of *contextual rezonings* includes different purposes, such as reorienting large developments to the main corridors and restricting uses and heights in interior blocks.

Figure 4.1a shows all the rezonings held during the administration. As can be seen, some applied to specific blocks while others applied to a few blocks or entire neighborhoods. Also, some of these projects only changed a small portion of lots' regulations, as shown in Figure 3.1b, which means that their potential is limited with respect to increasing the local housing supply. Hence, this paper focuses on large publicly initiated upzoning, which

[6]For more information about the steps and requirements, please visit: here.
[7]For more information about the steps and requirements, please visit: (ULURP Process).
[8]Including green areas (Furman Center, 2010).

is derived from a data-driven algorithm to avoid discretionary upzoning selection, which is explained in Section 3.

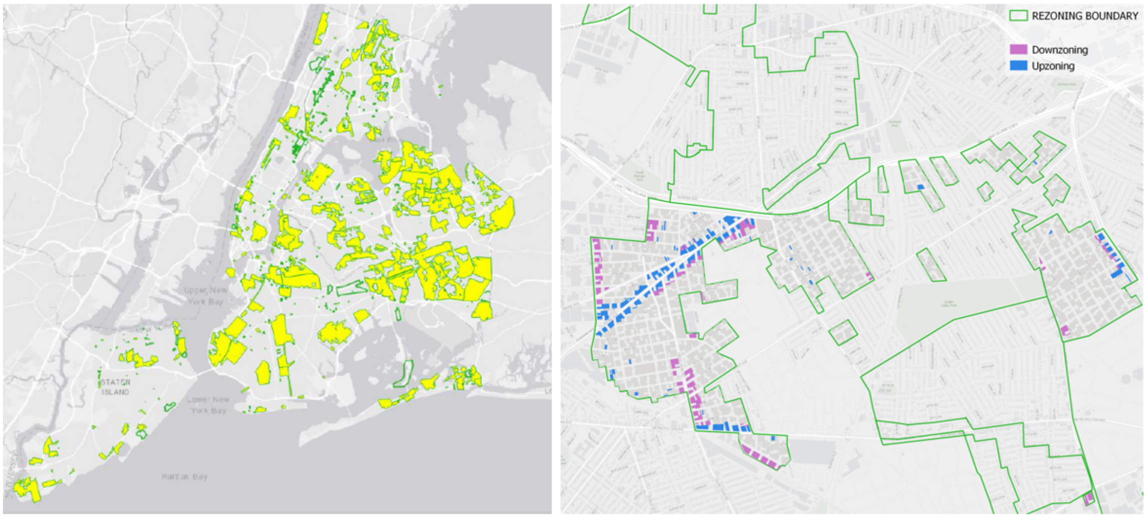


Figure 3.1: Rezonings during Bloomberg's administration

Note: The figure shows all the densities held during Mayor Bloomberg's administration on the right; this includes upzoning, downzoning, and contextual held by private and public organizations. On the right, there is an example of contextual upzoning that updates the land use code but doesn't significantly change its regulation.

3.2.2 Theoretical predictions

In the following section, I develop a theoretical framework to analyze how relaxing land-use regulations through upzoning affects housing prices and supply in different urban contexts. Building upon Hilber (2017) and Baum-Snow and Han (2019) models of housing markets with imperfect substitutes and supply, I incorporate the roles of heterogenous amenities and geography between neighborhoods.

This framework explores how variations in demand elasticity, supply responsiveness, and amenity effects can lead to differing outcomes in central versus peripheral areas when zoning changes occur. By considering the countervailing forces of supply increases and amenity-induced demand shifts resulting from new developments, I derive predictions about the potential impacts on housing prices and neighborhood dynamics, where it can be expected that prices increase in peripheral areas when upzoning is under the context of urban renewals. In contrast, the opposite can happen in central districts where the marginal impact of one extra building is lower than the previous context.

Regarding the identification of the local effects of relaxing land-use regulations on property prices, as Hilber (2017) states, local demand is usually assumed to be perfectly elastic when comparing neighboring areas, and supply is considered invariable across a city. In that scenario, any price variation in housing would be driven automatically by changes in demand only. However, this assumption is difficult to meet in metropolitan areas since neighborhoods inherently differ in the provision of public goods and amenities. Due to household sorting and heterogeneous preferences, the willingness to pay for these services is not constant across space; thus, neighborhoods can be modeled as imperfect substitutes.

As shown by González-Pampillón (2022), Diamond and Mcquade (2019), and Asquith et al. (2019), local programs targeting supply can create amenity effects that outweigh the addition of new units to these areas; moreover, neighborhood revival can also attract affluent families with a higher willingness to pay Guerrieri et al. (2013). Some mechanisms that explain these processes include the beautification of places and the provision of new amenities, such as new constructions, structural renovations, sidewalks, the reduction of abandoned structures, and the concentration of new units that differ from current neighborhood trends (Ooi & Le, 2013; Zahirovich-Herbert & Gibler, 2014). These changes can be perceived as amenities due to improvements in neighborhood quality (Campbell et al., 2011; Rossi-Hansberg et al., 2010).

Hence, if a rezoning is assumed to trigger changes with respect to neighboring areas, the new amenities create differences between the treated and their adjacent areas, making them imperfect substitutes.[9] However, new developments usually add sidewalks, green areas, or local services at the ground level.[10] As expected, the addition of communal and commercial areas, as well as the beautification of a neighborhood, can spillover to the most adjacent blocks. González-Pampillón (2022) and Asquith et al. (2019) have shown that changes in local supply create differences due to the replacement of old or abandoned units that positively impact housing price appreciation. Usually, this spillover tends to vanish after 150-200 meters from the treated boundary. One example is the case of González-Pampillón (2022), who finds an appreciation of over 12% in areas outside the city center where manufacturing and warehousing stocks were replaced by new housing.

So far, which force is stronger is an empirical question studied in different latitudes like Chicago (Freeman & Schuetz, 2017), Seattle (Krimmel & Wang, 2023), New Zealand (Greenaway-McGrevy et al., 2021), and Sao Paulo (Anagol et al., 2021), to name a few. Nevertheless, along with the opposing results, it is challenging to derive proper conclu-

[9]Some examples could be indoor gyms or training facilities, meeting rooms, and private green areas in gatted communities.

[10]Usually, the Department of Housing and Preservation (HPD) and the Economic Development Corporation (EDC) tend to incentivize adding communal areas that benefit the entire communities when financing this projects.

sions when there is a lack of external validity between cases due to the intrinsic differences between cities and zoning codes.

Geography and the built environment can help separate these effects. On the one hand, Baum-Snow and Han (2019) provides evidence that housing supply tends to be more elastic in peripheral areas compared to urban centers, which is partly explained by land availability and differences in zoning regimes. Furthermore, they add that neighborhoods with higher FAR are less supply-responsive to changes over time, meaning that tracts with a higher initial housing supply are associated with lower stock variations. On the other hand, there are differences between the building size and the number of residential units per development between groups. To illustrate, one development in the Central Business District (CBD) can encompass more than 100 residential units; conversely, the same number of dwellings could imply multiple constructions and lots in peripheral areas. These differences can be explained by land scarcity and the substitution effect between space consumption and distance to the CBD, which also helps to understand the higher baseline of buildings in central areas.

In summary, after inducing a supply shock, new construction could induce variations in housing prices P_{it}, which might be heterogeneous based on the location L_i of each upzoning. If the supply effects Q_{it} outweigh the amenity effects A_{it} created by new developments –and potentially neighborhood change– then prices should decrease. This is more likely to happen in central areas, as the opposite effect should tend to happen in peripheral areas.

In my empirical analysis, I use the location heterogeneity in New York upzoning to test the overall effects on prices across treated areas in the city. Then, I subsample by central and peripheral upzoning to test for possible heterogeneity in the results observed. I use different variables such as the number of buildings, commercial and residential units, and changes in density to test for both effects across time.

3.3 Data

I use different public datasets available in NYC Open Data, such as rolling sales from the Department of Finance (DOF) and the historical repository of land-use changes from the NYC Zoning Application Portal (NYC-ZAP). I complement this data with the historic Primary Land Use Tax Lot Output (PLUTO) datasets from the NYC Department of City Planning (DCP), containing lot-by-lot information for each year between 2004 to 2019, as limited by the availability of sales that are public in the DOF website. Lastly, I add information about affordable housing from the Furman Center's Core Data, which indicates whether a project benefits from public subsidies. After describing the primary data sources, I present how I use them to classify rezoning in a data-driven process.[11]

3.3.1 Data Sources

Upzoning

To categorize upzoning, I combined three datasets. First, I downloaded all the completed publicly initiated rezonings between 2005 and 2015 that went through the ULURP process from the NYC-ZAP website. I selected only those initiated by public agencies such as the DCP, the Economic Development Corporation (EDC), and the Department of Housing Preservation and Development (HPD) between 2007 and 2013[12]. Then, I matched them by their City Environmental Quality Review (CEQR) numbers from the ZAP Portal Search with the Zoning Map Amendment shapefile available on the DCP website, obtaining 233 publicly initiated rezonings.

I intersect the filtered shapefile with the 2003 and 2014 PLUTO versions. Then, I determine, lot by lot, if they are upzoned when (1) there is an increase in FAR or (2) the zoning changes from any use to residential (Figure 3.2a). Then, I calculate the remaining potential developments per rezoning, which I define as the summation between the maximum FAR and the build FAR multiplied by each lot size to compute the overall change after enacting each land use change.

After detecting all the potential upzonings, I perform a second cleaning process that encompasses: (1) eliminating all the small upzonings that involve one or only a few blocks for a specific development—usually supported by HPD or EDC aiming for affordable housing deals; (2) deleting the mixed and contextual rezonings, e.g., those that upzone the main corridor but decrease FAR in the rest of the treated area[13]; and (3) removing from the sample upzoned areas destined for commercial development without changes in residential parameters.

This process resulted in 13 large upzonings across the four main boroughs of NYC. Furthermore, I also detected downzonings near the upzoned areas (Figure 3.2b). I consider these as controls in the econometric model based on a 200-meter buffer for any possible

[11] Other studies classify rezoning based on NYC DCP categories. However, I found this approach limiting, as they categorize upzoning and downzoning beforehand based on policy rationale rather than studying changes in building parameters across the intervened areas.

[12] This selection is driven by DOF Sales, that start in 2004, allowing for at least three years of pre-treatment for the first upzonings.

[13] In many cases this derives into an overall downzoning as the total available FAR decreases

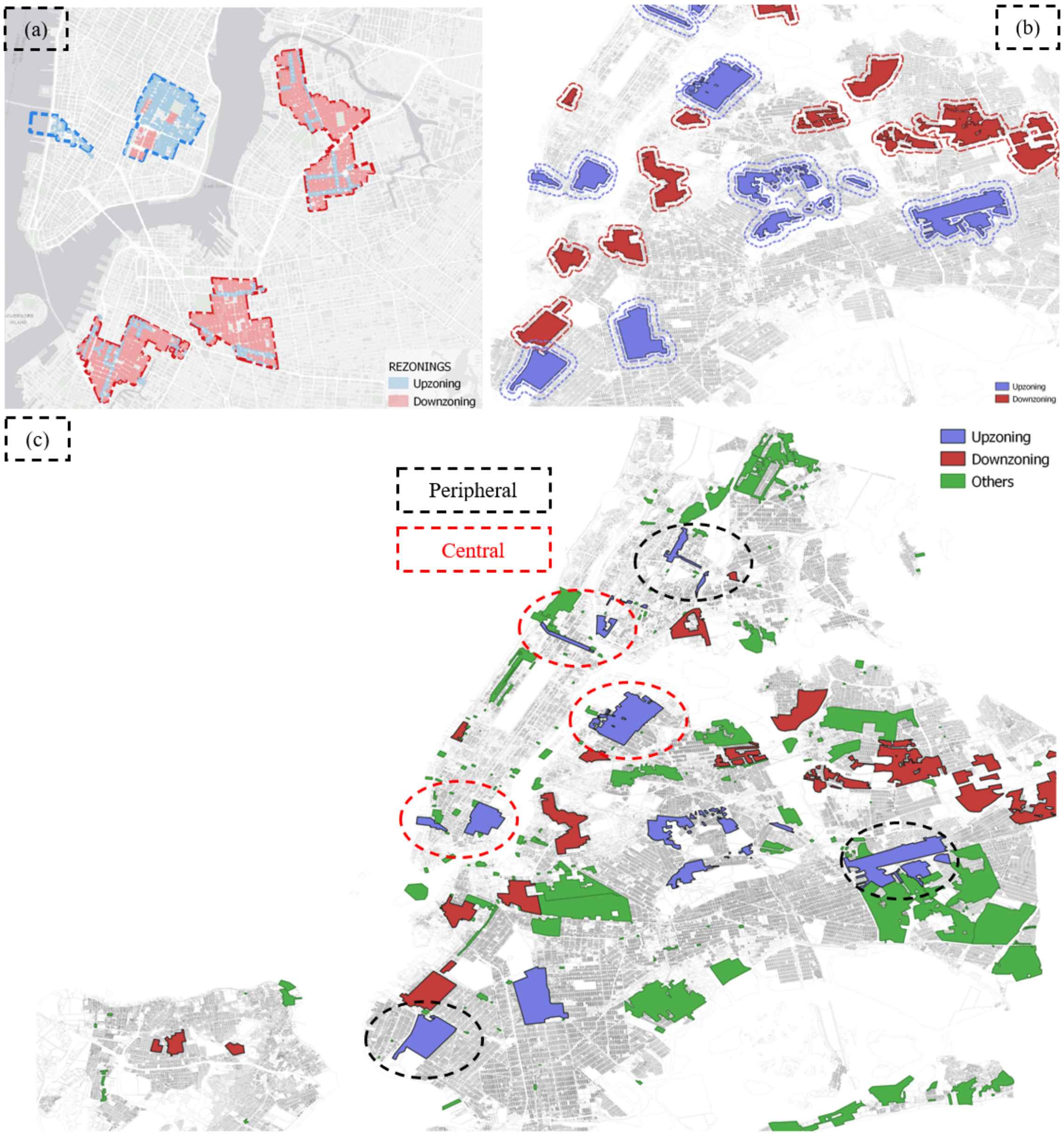


Figure 3.2: (a) Upzoning classification process, (b) buffers, and (c) final results.

Note: The figure shows examples of upzoning (light blue) and downzoning (light red) and their spatial distribution. Furthermore, it shows the classification of central and peripheral upzoning.

spillover from one changed neighborhood to the other[14]. Finally, I distinguish between central and peripheral upzonings. For the first group, I selected those in Manhattan or facing its skyline and near transportation hubs that connect them directly to the CBD.[15] In contrast, the second group encompasses peripheral areas far from the CBD with lower densities and development potential.

After this classification, I obtained five central areas and five treated peripheral areas. The other three upzonings are excluded of this category because they are near important amenities such as green areas or transportation hubs in pericentral areas, which might confound effects. This distinction also indirectly separates high- and low-income areas, as the most expensive properties in NYC are located in the first group, which I show in the next subsection. The final result is shown in Figure 3.2c and the summary of the total zoning increase is shown in Table 3.1.

Table 3.1: Upzoning Areas and Percentage Change

Name	Category	Change
Boricua village/melrose commons ura	Non	145%
North tribeca rezoning	Central	64%
Lower concourse	Central	63%
Crotona park e/w farm	Peripheral	57%
Special forest hills dist	Non	47%
125th st corridor	Central	42%
The jamaica plan	Peripheral	30%
Third ave-tremont ave corriodors	Peripheral	25%
Astoria rezoning	Central	18%
161st street rezoning	Non	16%
East village/lower east side	Central	11%
Dyker heights/ft hamilton rezoning	Peripheral	10%
Flatbush rezoning	Peripheral	9%

Housing Sales

To determine housing sales, I use the NYC DOF Rolling Sales between 2004 and 2019. This dataset contains the date of sale, the price paid, the borough, block, and lot identification (BBL), and other variables of interest, such as the square footage (sqft) and property type. Prices are adjusted by the Consumer Price Index (CPI) and cleaned based on Fischer et al. (2018), Ellen et al. (2021), X. Li (2019), and Cohen et al. (2020), which includes

[14] I base this on González-Pampillón (2022) and Asquith et al. (2019).

[15] The intuition behind including areas outside Manhattan is based on their development potential and connectivity. A clear example is the changes experienced by Williamsburg after its rezoning.

omitting co-ops,[16] eliminating non-arm's-length sales, and those that are below $50,000. Furthermore, I calculate the per-unit sale price since some multifamily include more than one unit per sale.

I use the BBL to match the data with NYC PLUTO and add covariates to control for the number of floors, type of building, and whether they have elevators, garages, etc. This process allows me to identify if a property is a single-family, multifamily, mixed-use, or condo. It's worth mentioning that condos have a different BBL in the DOF dataset—associated with each unit—and in the PLUTO data—associated with the lot. To match properties, I use a three-step process. First, I search by borough and block, as there is only one condo per unit in many cases. Then, if there is more than one condo per block, I use the Property Address Directory (PAD) of the NYC DCP to match addresses. Finally, the remaining condos are identified individually by comparing addresses between Google Maps and the PLUTO shapefile.

Some condos don't have information about the sqft per unit, as they are aggregated by building in NYC PLUTO. I correct this by calculating the first sale of each unit during the first year of sales to determine the average $ per sqft sale. Then, I use the sale price to calculate the sqft. At the end of the paper, I add an appendix with a robustness check of the regressions without using sqft, showing that the estimations remain similar.

Finally, to avoid systematic differences in prices of the new units after the rezoning, I dropped all the observations built after the change in land use. By doing this, I focus on the impact of existing properties without considering the new supply that can encompass new amenities or quality, as highlighted in the previous chapter.

Primary Land Use Tax Lot Output (PLUTO) Data

The Primary Land Use Tax Lot Output (PLUTO) dataset is a comprehensive compilation of tax lot–level data provided by the New York City Department of City Planning (DCP). It includes detailed information on land use, zoning, and property characteristics. Relevant variables are the maximum and build Floor Area Ratio (FAR), zoning district, land use designation, lot area, building area, number of residential units, year built, building class, and geographic identifiers such as borough, block, and lot (BBL).

For this study, I use the versions between 2003 and 2019 versions of the PLUTO dataset to analyze changes in zoning and property characteristics over time. By intersecting the

[16] Co-ops are multifamily buildings owned by a corporation where each unit owner holds shares of it. A new co-op buyer must go through board interviews and approval processes to purchase a property.

upzoned areas from the shapefile with the PLUTO data, I can determine, on a lot-by-lot basis, whether a property has been upzoned. Specifically, I identify upzoning when there is (1) an increase in FAR or (2) a change in zoning from any use to residential. This granular level of detail allows for precise identification of zoning changes and their impact on development potential. I also use this dataset to study the relationship of upzoning with the housing stock and the addition of extra commercial area, to name a few.

Affordable Housing

I use the NYU Furman Center Core Data website to select all the projects built after 2000 because older properties can also apply to obtain tax reductions by renting affordable units. However, since the tax reduction usually lasts 25 years, I avoid their effect by filtering out projects built before that year. I matched this dataset with the NB data to obtain the new projects categorized as affordable in the application process.

A limitation of this dataset is that it does not indicate the number of affordable units per project. However, since I compare boundaries, there is no reason to think that the new projects will have a different share of affordable units. In most cases, projects implement the minimum requirement (20%) if they are located in attractive areas, rather than 100% of the units as in areas where the Area Median Income (AMI) and median rents are near HUD's threshold—as is the case in peripheral areas. Hence, I assume that the number of projects added per rezoning might serve as a proxy for the provision of affordable housing in an area.

3.3.2 Summary Statistics

From 2003 to 2020, the total number of transactions in the treated and control areas was 84,508. The average sale price in the sample is $820,664, with mean values ranging from $479,540 to $1,621,313 among the groups presented in Table 3.2. From the sample, 39,507 units are categorized as single-family units, 20,792 as multifamily, and 24,209 as part of mixed-use developments. As shown in the Appendix, Figure A3.1 indicates that the logarithm of prices and size tend to behave like a normal distribution centered around 12.5 and 7.5, respectively.

As shown in Table 3.2, there are systematic differences between the average property in central and peripheral areas. As expected, a property in Manhattan or facing its skyline is worth three times as much as a house on the outskirts. Notwithstanding this fact, it's interesting to see that, on average, the central group tends to decrease in value after

Table 3.2: Summary statistics

	Upzoning		Peripheral Areas		Central Areas	
	TRT	CTRL	TRT	CTRL	TRT	CTRL
Sales - Pre-treatment						
N	14,492	20,628	5,646	5,496	4,346	10,466
Av. Sale per unit	628,300	727,607	479,540	521,294	1,621,313	1,482,175
Sales - Post-treatment						
N	20,654	28,734	8,296	8,227	5,334	13,014
Av. Sale per unit	714,039	811,008	482,939	513,742	1,134,778	1,166,730
Pre-treatment regulation						
Av. FAR	1.3	1.4	1.0	1.0	1.9	3.0
Av. Units per building	5	6	3.01	4	7.17	16
Av. Floors per building	2.5	2.6	2.2	2.3	3.1	4.2
Pre-treatment Units distribution						
One & Two Family	22%	18%	38%	30%	9%	3%
Multifamily	57%	60%	48%	56%	58%	61%
Mixed residential	19%	20%	11%	13%	32%	34%
Condominiums	211	1,295	37	233	155	838

the rezoning. At the same time, peripheral dwellings have a steadier value over time. Of course, this can be driven by the rezoning year or even the heterogeneity of units in the sample; nevertheless, this justifies separating the sample and testing whether location triggers different results in a rezoning.

Regarding regulation, there are also relevant differences between both groups. On the one hand, the average built FAR in the center doubles the peripheral group. Furthermore, these areas tend to have taller buildings with more units per building. Finally, as shown in Table 3.2, the type of residential unit differs between areas since the periphery has a higher presence of single-family units. In contrast, central areas encompass more mixed-use buildings and have a larger share of condominiums, which reflects the mixed uses and, probably, the higher availability of amenities.

About the built environment, there are also relevant differences as shown in Table 3.2, especially about the presence of mixed-use developments. Furthermore, Figure 3.3 shows a clear increase in lots with a building potential[17]. This suggests the upzoning increase as well as the subsequent decay that suggests how developers start utilizing the additional zoning increase. Despite the increase in FAR, the number of buildings remains relatively constant, implying that developers may prioritize increasing density within existing structures over new developments. This is supported by the observed rise in the number of units, total

[17] Measured as the difference between the maximum FAR allowed and the build FAR

building area, and average number of floors, indicating that vertical expansion or renovation is the preferred development strategy.

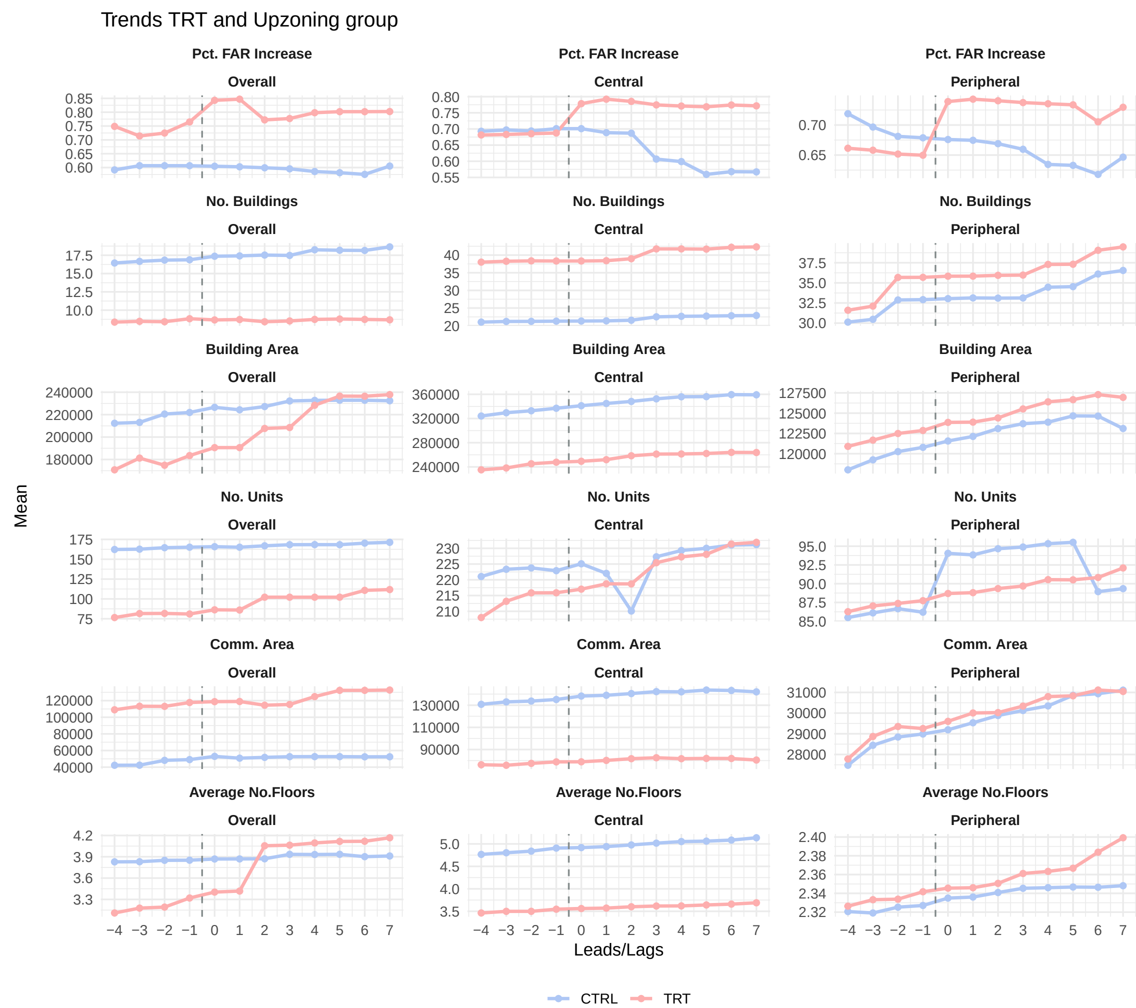


Figure 3.3: Housing and commercial stock trends before and after upzoning.

As shown in Figure 3.3, the response in central areas to upzoning is more subtle; FAR increases remain stable, and the number of new buildings shows little change. However, there is some expansion in units and floors, indicating that development focuses on enhancing the capacity of existing buildings. In contrast, peripheral areas show a more dynamic response in the treated and controlled blocks, with noticeable increases in the number of buildings, units, commercial space, and building area, all suggesting heightened development activity. These positive trends in peripheral areas suggest an overall revitalization.

3.4 Main Results

Before studying the impacts on housing prices and the built stock, I first focus on whether upzoned lots indeed became more developable- For this purpose, I conduct an event study focusing on changes in building potential following the upzoning. I regress the Building Potential (BPot), defined as the difference between the maximum allowable and the build FAR multiplied by the lot area as a measure of the undeveloped potential. The model is as follows:

$$\ln(BPot_{it}) = \alpha + \sum_{k=-q}^{-1} \beta_k \times \text{TRT}_i + \sum_{k=0}^{m} \delta_k \times \text{TRT}_{it} + X_i + \gamma_t + \text{BB}_i \tag{3.1}$$

Where $BPot_{it}$ is the building potential. TRT_i defines the treated blocks within the building perimeter, and k ranges between -4 to 7[18] to account for each lead and lag. I control for Boro-Block BB_i fixed and γ_t as yearly fixed effects. I cluster standard errors per block.

The results shown in Figure 3.4 indicate that the development potential increases significantly after upzoning, particularly in peripheral areas. The overall sample shows a steady increase in development potential immediately after the upzoning. As shown in the Appendix, Figure A3.2 also shows heterogeneous effects between central and peripheral upzoning, being the first those with more additional capacity to absorb new developments. Since the variable measures building potential, the spike in central areas can be due to different reasons beyond new upzoning in these areas[19] such as that smaller plots were enlarged or developed in the treatment group, or that the controlled areas faced downzoning or new developments that use large available lots.

Quantitatively, the overall development potential notable increases between 1,000 sqft and 2,500 sqft. This change differs by zone as central upzoning reaches up to 5,000 extra sqft while peripheral districts nearly 1,500 sqft. Since an average apartment ranges between 800 to 1,200 sqft in New York, this increase is equivalent between 2 to 6 extra units in the outskirts and the CBD, respectively.

Since the policy effectively creates differences in the building capacity, I now move to studying the impacts of these changes in housing prices.

[18] Since most of the datasets range from 2003 and 2020 while the rezonings vary from 2007-2013, the range of [-4,7] allows to include all the areas in the leads and lag

[19] I double-checked that each upzoning changed their building capacity only once during the period of observation

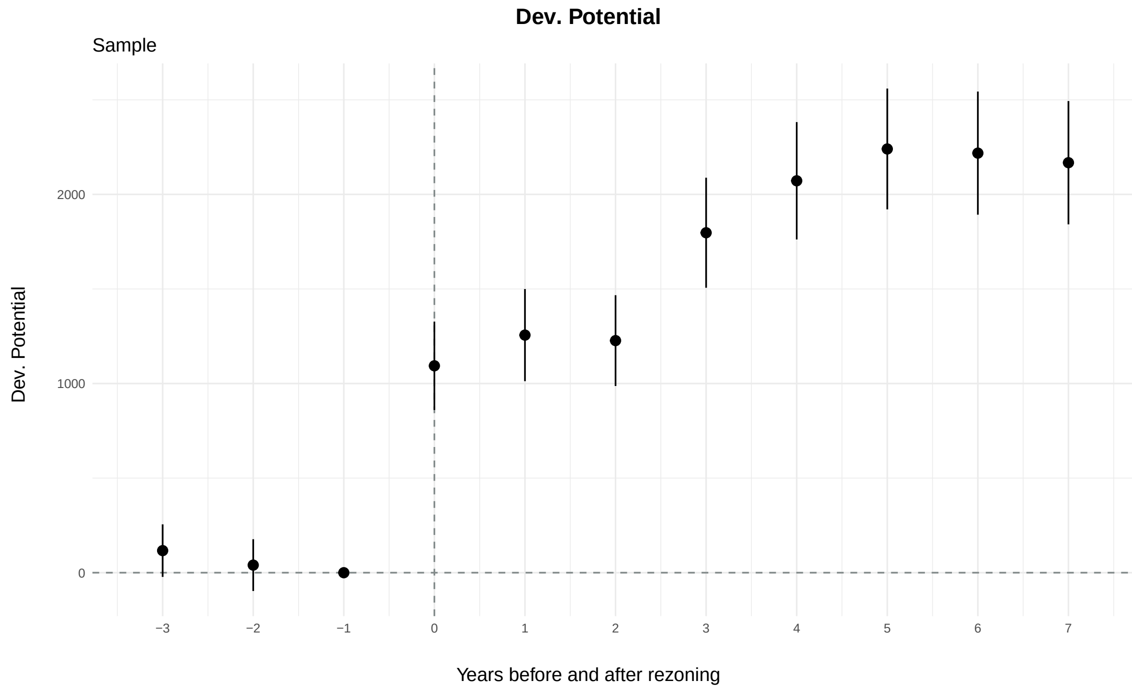


Figure 3.4: Changes in Development Potential per lot

Note: The figure shows the coefficients of the event study regression based on Equation 3.1. This uses year and block fixed effects. Clustered standard errors at the block level.

3.4.1 Housing Prices

To assess the impact of upzoning on housing prices, I use a hedonic event study between the treated upzoning and adjacent areas. As discussed before, it's expected that the first blocks might also be treated by spillovers as well as by the fact that people can move locally, meaning that if there is an increase in demand within the treated areas, the first adjacent blocks might suffer a negative shock (Rosenthal & Ross, 2015). To test for the potential spillovers, I create two buffers. The first is between the boundary and 150 meters away from it, based on the empirical effects of housing spillovers (Asquith et al., 2019; González-Pampillón, 2022). Then, I create a second ring between 150 and 500 meters to compare the first groups and their possible indirect treatment. To avoid any confounding effect, I eliminate any interception from the rings they can have with any other rezoning. Furthermore, I control the proximity to other rezonings by a dichotomic variable. Finally, the model is as follows:

$$\ln(P_{it}) = \alpha + \sum_{k=-q}^{-1} \beta_k \times \mathrm{TRT}_i + \sum_{k=0}^{m} \delta_k \times \mathrm{TRT}_{it} + X_i + \alpha \times \mathrm{Prox}_i + \rho \times \mathrm{Borough}_i \times \gamma_t + \mathrm{CT}_i \quad (3.2)$$

Where TRT_i defines each upzoning, and k ranges between -4 to 7[20] to account for each lead and lag. Then, I control for a vector of housing characteristics X_i, such as sqft, type of property, and the number of floors. Furthermore, I include $Prox_i$, which indicates if the rezoning is proximate to any other rezoning to account for any potential spillover from these interventions. Based on Li (2019), I control for independent local housing market trends by interacting with the year of sale in each borough. This is important since the study window includes different cycles, such as the subprime crisis. I control for census tract CT_{it} fixed effects to account for unobserved and idiosyncratic characteristics at the local level. Finally, I cluster standard errors per census tract.

Figure 3.5 shows the overall impacts of upzoning on housing prices. As can be seen, there is an overall decrease in housing prices, but they are not significant in most cases in the first bandwidth of 0 to 150 meters. In this group, the results are fuzzier, probably because the properties next to the border are indirectly affected by different mechanisms, as mentioned in previous sections. When observing the second group, the results become more evident, exhibiting an overall decrease after four years of implementation. To estimate the impacts I pool the dataset into two post-policy groups: 1 to 4 years, and 5 to 7 years. As shown in Table 3.3, the overall impact in the second group after four years of upzoned is a 12% decrease in housing prices. The lag between rezoning and the increase can intuitively be explained because an average mid-rise and high-rise construction takes three to four years to complete after its building permit is approved (X. Li, 2019).

Table 3.3: Pooled regression of housing prices after upzoning.

	0-150 mts	150-500 mts
Post(1-4 years)	-0.06^{***}	-0.03
	(0.02)	(0.02)
Post(5-7 years)	-0.07^{**}	-0.12^{***}
	(0.03)	(0.03)
Num. obs.	27735	56773
R^2	0.68	0.79

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Note: The table shows the coefficients of Equation 3.2 pooled for 1 to 4 years after upzoning and 5 to 7 as a second group. All regressions include census tract and year fixed-effects and housing controls such as the square footage, construction quality, type of housing, construction year, the land use category, and a dummy variable to account for proximity to other rezoning. Standard errors clustered at the Census Tract level.

[20] Since most of the datasets range from 2003 and 2020 while the rezonings vary from 2007-2013, the range of [-4,7] allows to include all the areas in the leads and lag

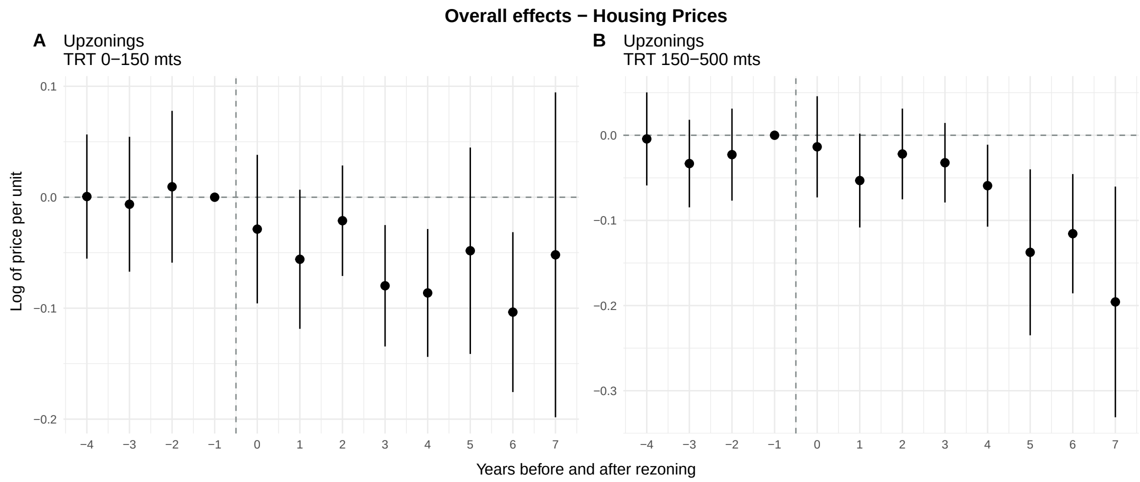


Figure 3.5: Overall Impact of Upzoning on Housing Prices

Note: The figure shows the coefficients of the event study regression based on Equation 3.2. All regressions include census tract and year fixed-effects and housing controls such as the square footage, construction quality, type of housing, construction year, the land use category, and a dummy variable to account for proximity to other rezoning. Standard errors clustered at the Census Tract level.

3.4.2 Heterogeneity by location

Notwithstanding the negative impacts of upzoning on housing prices, a remaining question is about their potential heterogeneity. As derived from Section 2.2, it can be expected that an upzoning process can trigger housing prices to go up if they replace the old stock or add new amenities to a neighborhood. As seen in Figure 3.3, the peripheral areas exhibit positive trends in new developments, units and commercial areas, which can be signs of a neighborhood renewal process.

To test this hypothesis, I regress Equation 3.2 for each group and distance bandwidth. When decomposing the sample between peripheral and central upzoning, the results diverge, as seen on Table 3.4; the overall impacts are decomposed by a positive effect in peripheral areas and a negative in central districts (the event study plots can be seen in the Figure A3.3 of the Appendix. Like in the overall group, the results tend to be more pronounced in the second ring, where spillover effects tend to vanish after four years of implementing the upzoning. Interestingly, in the central upzoning, the effects appear after implementing the land-use change, which suggests adverse anticipation effects. This might be explained by the fact that even though construction activity is highly constrained in NYC, scaffolding, street blockages, and noise can negatively affect demand and act as a disamenity in the short run, which can spread rapidly.

Both results suggest that amenity and supply effects act differently within the city. Fur-

Table 3.4: Pooled regression of housing prices after upzoning by location.

	0-150 mts		150-500 mts	
	Peripheral	Central	Peripheral	Central
Post(1-4 years)	-0.01	-0.13^{**}	0.04^{**}	-0.10^{**}
	(0.02)	(0.06)	(0.02)	(0.05)
Post(5-7 years)	0.16^{**}	-0.23^{***}	0.18^{***}	-0.28^{***}
	(0.06)	(0.08)	(0.05)	(0.10)
Num. obs.	10732	7482	16933	25585
R^2	0.57	0.73	0.64	0.82

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Note: The table shows the coefficients of Equation 3.2 pooled for 1 to 4 years after upzoning and 5 to 7 as a second group for Central and Peripheral areas. All regressions include census tract and year fixed-effects and housing controls such as the square footage, construction quality, type of housing, construction year, the land use category, and a dummy variable to account for proximity to other rezoning. Standard errors clustered at the Census Tract level.

thermore, the amenity effect might take longer to manifest than the supply effect, which intuitively aligns with the fact that a neighborhood takes more time to change. Firstly, single projects do not transform an entire area; thus, more developments are needed. As Baum-Snow and Han (2019) discuss, the supply is less responsive in peripheral areas as they are intrinsically less attractive, meaning that changes in these neighborhoods take more time than in central areas. It is intuitive to think that these areas might not be the first development option, as rents and prices are lower (Table 3.1). Secondly, after a project is completed, it takes time for people to move in, as neighborhood change is also driven by new residents (Guerrieri et al., 2013).

3.4.3 Heterogeneity by treatment intensity

Lastly, since not all parcels are treated with the same intensity, I also test for the effects of upzoning by subsampling between the largest projects and those that show a more modest change in land use parameters. As shown in Table 3.5, the results are similar to the overall results from Table 3.3 as the 7 largest are a mix between central, peripheral and non-categorized districts. In this group, the effects are around -13% after 4 years of implementation. These results show that the location of these changes reflects better the impacts than the treatment intensity.

3.5 Mechanism

The variations in housing prices after upzoning can be due to different mechanisms. On the one hand, the new stock, through an increase in units and density, can help to explaining

Table 3.5: Pooled regression of housing prices after upzoning by treatment intensity.

	0-150 nts	150-500 mts
Post(1-4 years)	-0.04	0.02
	(0.02)	(0.03)
Post(5-7 years)	-0.12	-0.13^{**}
	(0.08)	(0.06)
Num. obs.	8803	23977
R^2	0.80	0.85

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Note: The table shows the coefficients of Equation 3.2 pooled for 1 to 4 years after upzoning and 5 to 7 as a second group for Central and Peripheral areas. All regressions include census tract and year fixed-effects and housing controls such as the square footage, construction quality, type of housing, construction year, the land use category, and a dummy variable to account for proximity to other rezoning. Standard errors clustered at the Census Tract level.

the price decrease in central areas. On the other hand, signs of urban renewal such as changes in the population composition, new developments and better amenities could drive prices up in areas where the option value of a housing unit can increase (Clapp et al., 2013; Greenaway-McGrevy & Phillips, 2023). In this section, I test for these mechanisms and their correlation with price changes.

3.5.1 Changes in the built environment

As a first mechanism, I evaluate the relationship between upzoning and different built environment outcomes. For this purpose, I conduct an event study regression based on Equation 3.2 using the following variables:

- The number of housing units and developments per block. I aggregate these variables at the block level rather than using parcels, as large-scale developments can involve demolishing existing structures, affecting multiple parcels simultaneously.
- The number of lots with commercial areas, the number of renovated properties[21], and the average number of floors per lot. I use level measures instead of logarithmic transformations because some lots had no buildings prior to rezoning and are built afterward.

Table 3.6 presents pooled regression results for the overall sample, as well as for central and peripheral areas[22]. The overall sample shows that after upzoning, the treated areas exhibit higher real estate dynamics, as there are more buildings and renovations after five years

[21] I use alterations as a proxy. PLUTO defines them as property changes that significantly affect property values.

[22] For each variable, the event study plots and the detailed regression tables are shown

of the policy. These findings suggest that upzoning stimulates development activities and improvements in existing structures, potentially enhancing the housing supply. However, changes in residential units and floors are less consistent and not always significant. For example, the increase in residential units is only marginally significant in the 5–7 year period (2.23 units per block and 2.72 in upzoned areas), indicating that while there is some addition to the housing stock, the effect is not large.

Table 3.6: Pooled regression of post-treatment PLUTO variables

	Overall		Central		Peripheral	
	Sample	Upzoned	Sample	Upzoned	Sample	Upzoned
Panel A: Residential Units						
Post(1-4 years)	−0.69	−0.45	9.04***	10.01***	−9.04	−8.95
	(3.49)	(3.55)	(3.25)	(3.83)	(9.39)	(9.42)
Post(5-7 years)	2.23*	2.72*	8.12**	9.52**	−0.49	−0.14
	(1.31)	(1.48)	(3.79)	(4.26)	(1.83)	(2.07)
Panel B: Buildings						
Post(1-4 years)	0.68***	0.30	1.06***	0.60	0.82**	0.49
	(0.20)	(0.24)	(0.29)	(0.39)	(0.40)	(0.45)
Post(5-7 years)	1.07***	0.95**	2.02***	1.75**	0.99	1.11
	(0.35)	(0.39)	(0.63)	(0.70)	(0.62)	(0.71)
Panel C: Commercial Areas						
Post(1-4 years)	0.0017**	0.0245***	0.0017	0.0173**	0.0046**	0.0350***
	(0.0009)	(0.0034)	(0.0014)	(0.0072)	(0.0018)	(0.0058)
Post(5-7 years)	0.0012	0.0186***	0.0006	0.0112	0.0042*	0.0291***
	(0.0011)	(0.0032)	(0.0022)	(0.0071)	(0.0023)	(0.0053)
Panel D: Renovations						
Post(1-4 years)	0.0006**	0.0008***	0.0017**	0.0019**	0.0010**	0.0010**
	(0.0003)	(0.0003)	(0.0008)	(0.0008)	(0.0005)	(0.0005)
Post(5-7 years)	0.0009***	0.0010***	0.0017**	0.0022***	0.0015***	0.0015***
	(0.0003)	(0.0003)	(0.0007)	(0.0007)	(0.0005)	(0.0005)
Panel E: Floors						
Post(1-4 years)	0.0026	0.0333***	−0.018	0.027	0.0024	0.0201*
	(0.0044)	(0.0086)	(0.015)	(0.025)	(0.0039)	(0.0105)
Post(5-7 years)	0.0052	0.0333***	−0.030	0.0050	0.0078	0.0233**
	(0.0065)	(0.0092)	(0.022)	(0.027)	(0.0065)	(0.0115)

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Note: The table shows the coefficients of Equation 3.2 pooled for 1 to 4 years after upzoning and 5 to 7 as a second group for the Sample and Central and Peripheral areas. All regressions include census tract and year fixed-effects and housing controls such as the square footage, construction quality, type of housing, construction year, the land use category, and a dummy variable to account for proximity to other rezoning. Standard errors clustered at the Census Tract level.

In central areas, upzoned lots exhibit significant increases in residential units and buildings. They show an increase of approximately 10 residential units in both post-treatment periods.

The number of buildings also increases significantly in the first period by 1.06 and then increasing to 2.02, indicating that new developments are taking place. Furthermore, the event plots of buildings (Figure A3.5 in the Appendix) show that in the first two years after upzoning, upzoned lots experienced negative outcomes, suggesting that some buildings are being demolished to make way for new construction. After year 3, there is a positive increase in buildings, combined with an increase in units, indicating higher building activity in these areas.

Despite these developments, the alterations event plot indicates no parallel trends in central areas (Figure A3.7 in the Appendix), so results must be taken with caution. Overall, the results remain around 0.005 and are not significantly different pre- and post-treatment, suggesting that renovations are not a primary driver of changes in central areas. Instead, the increase in new buildings and residential units points to new construction rather than alterations of existing structures.

While the increase in residential units in peripheral areas is not significant, there are positive changes in commercial areas and renovations in upzoned lots. These results suggest that upzoning is enhancing amenities in peripheral areas, potentially making them more attractive and stimulating economic activity. There is a significant increase in renovations, suggesting improvements to existing structures.

The event plots of buildings show no significant changes in the number of buildings, suggesting that development occurs through renovations rather than new construction. Moreover, given that the average number of units per building is small, changes are not significant in terms of new buildings.

Additionally, commercial event plots suggest greater changes in peripheral areas, where there are less residential units and less commercial space than in central areas. This result also suggest that upzoning is catalyzing the renewal of these neighborhoods. The decreasing numbers across time (Figure A3.6) over time also suggest non-treated engage in building activities after upzoning, potentially indicating effects effects.

All in all, this set of results tend to indicate the presence of higher supply effects in central areas, where more units and developments are significantly added after upzoning. Conversely, peripheral areas seem to experience larger amenity effects as there are more renovations, commercial areas and no significant changes in housing units, contributing to the area's renewal. These correlations can help to explain the divergence of the impacts of upzoning on housing prices from the previous section.

3.5.2 Changes in density

I examine a second mechanism by analyzing changes in density, which can help reconcile the relationship between upzoning and housing prices. Since the land use changes occurred between 2007 and 2013, I compare percentage changes in density between 2000 and 2020 at the block level using a simple model to test for a correlation among the treated areas. The rationale is that if upzoning effectively increases the housing supply, this should result in higher density in the treated areas compared to control areas over this period.

The regression results in Table 3.7 indicate an overall trend of density increases in the treated districts of about 6 percentage points. When analyzing central and peripheral areas separately, the increase is only slightly significant in central areas. This suggests that upzoning leads here to higher densities, which is correlated with a significant increase in housing units and buildings. This change can be perceived as a disamenity due to factors like increased congestion in public spaces, which can contribute to the observed decrease in housing prices in central upzoned areas. In contrast, the lack of significant density changes in peripheral areas may explain why housing prices there don't exhibit the same downward trend. Furthermore, this supports the finding that changes in housing supply in peripheral areas are also non-significant.

Table 3.7: Changes in density

	Sample	Central	Peripheral	Large
TRT	0.064^{**}	0.093^{*}	0.053	0.047
	(0.026)	(0.036)	(0.058)	(0.048)
Num. obs.	4608	1228	1667	1669
R^2	0.160	0.126	0.148	0.158

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

It's important to note that this analysis is based on a correlation observed over 20 years, and further exploration is needed to establish a stronger relationship, which couldn't be done because of data accessibility from the UK to the American Census. Furthermore, due to changes in the methodology, the disaggregation by race also couldn't be done as the 2000 Census separates Hispanics as a different race, while the latest doesn't. However, the observed relationship between higher density and housing prices supports the idea that increased supply through upzoning can impact market dynamics, particularly in central areas.

3.5.3 Option value for replacement

A final mechanism explores the relationship between housing age and housing prices post-upzoning to decompose how amenity and supply effects act on both areas. Prior research by Clapp et al. (2013) and Greenaway-McGrevy et al. (2021) have shown that the option value matters in old properties as they can increase their value when the building potential increases. In the specific case of New York, (Leather, 2023)[23] examines rezoning to estimate an average option of 20% of the property value in Manhattan and 8.5% in Brooklyn, while manufacturing lots identified as likely to rezone experience an average premium of 50% per square foot.

If the option value is high in the upzoning, that would equate to part of the significant impacts in peripheral areas should be related to older properties; similarly, in central areas, this group should counteract to newer properties. On the contrary, if the opposite happens, and newer units are more valued in peripheral areas, then the amenity value should be more latent here; on the same direction, if older dwellings decrease their value in central areas, that could also point to supply effects as these areas experience a higher influx on new properties and units.

To test this hypothesis, I divide the sample by the median property age (1928) to subsample between older and newer homes and analyze the effects separately for upzoned areas. The results are presented in Table 3.8, which I compare to the baseline results from Table 3.4.

As shown in Table 3.8, the appreciation of newer homes is more pronounced in peripheral areas. Specifically, in the post-5 to post-7 period, newer homes (built between 1929 and 2010) in upzoned areas exhibit significant positive price changes of 28% and 29% for the 0–150 meters and 150–500 meters bands, respectively. This finding suggests that the amenity value associated with newer constructions is more influential than the redevelopment value of older properties, which shows a smaller and less significant effect[24]. Furthermore, this result aligns with previous results about a nuanced supply effect that translates into non-significant impacts.

Conversely, in central areas, older homes (built between 1798 and 1928) show significant negative price changes after upzoning, while the other group doesn't exhibit any impacts. This depreciation suggests that the redevelopment potential is not high, as in that case, older units should face a larger price increase due to the building potential they have.

[23] Although this paper also studies rezoning, the author doesn't focus on distinguishing between upzoning or downzoning.

[24] The event study plots are shown in Figure XX

Table 3.8: Pooled regression of housing prices by property's age.

	0-150 mts			150-500 mts		
	Sample	Peripheral	Central	Sample	Peripheral	Central
Panel A: below median age (1798 - 1928)						
Post(1-4 years)	-0.07^{***}	-0.01	-0.19^{**}	-0.03	0.02	-0.10^{*}
	(0.03)	(0.02)	(0.08)	(0.02)	(0.02)	(0.05)
Post(5-7 years)	-0.13^{***}	0.08	-0.37^{***}	-0.14^{***}	0.12^{**}	-0.33^{**}
	(0.05)	(0.06)	(0.11)	(0.05)	(0.05)	(0.14)
Num. obs.	14355	6283	3643	26146	8556	10544
R^2	0.69	0.60	0.73	0.78	0.65	0.81
Panel B: above median age (1929 - 2010)						
Post(1-4 years)	-0.03	-0.02	-0.04	-0.03	0.06	-0.07
	(0.03)	(0.04)	(0.08)	(0.02)	(0.04)	(0.07)
Post(5-7 years)	-0.01	0.28^{***}	0.00	-0.07^{**}	0.29^{***}	-0.04
	(0.04)	(0.07)	(0.08)	(0.03)	(0.06)	(0.07)
Num. obs.	13380	4449	3839	30627	8377	15041
R^2	0.71	0.57	0.78	0.82	0.64	0.87

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Note: The table shows the coefficients of Equation 3.2 pooled for 1 to 4 years after upzoning and 5 to 7 as a second group for the Sample and Central and Peripheral areas. All regressions include census tract and year fixed-effects and housing controls such as the square footage, construction quality, type of housing, construction year, the land use category, and a dummy variable to account for proximity to other rezoning. Standard errors clustered at the Census Tract level.

On the contrary, this aligns with significant correlations between more developments and units, making older units less valued as there is less scarcity.

3.6 Additional results: Affordable Housing

As an additional analysis, I use the Furman Center dataset to test whether there are differences in the provision of affordable housing, as this is one of the immediate policy goals of upzoning. As seen in Figure 3.6, there are noticeable short-run policy responses over time. Firstly, there is a positive short-run effect in the initial years following the policy implementation. It appears that in peripheral areas, the first two years create a stimulus to increase the number of affordable units, a pattern that is replicated in central areas in the third year. This can also relate to the addition of commercial spaces as most of the developments in New York include communal and commercial areas in the ground floor. However, five years after upzoning, the results indicate that the number of new affordable housing projects tends to decrease, driven mainly by peripheral areas. These results align with price behavior, as the provision of affordable housing decreases following price increases.

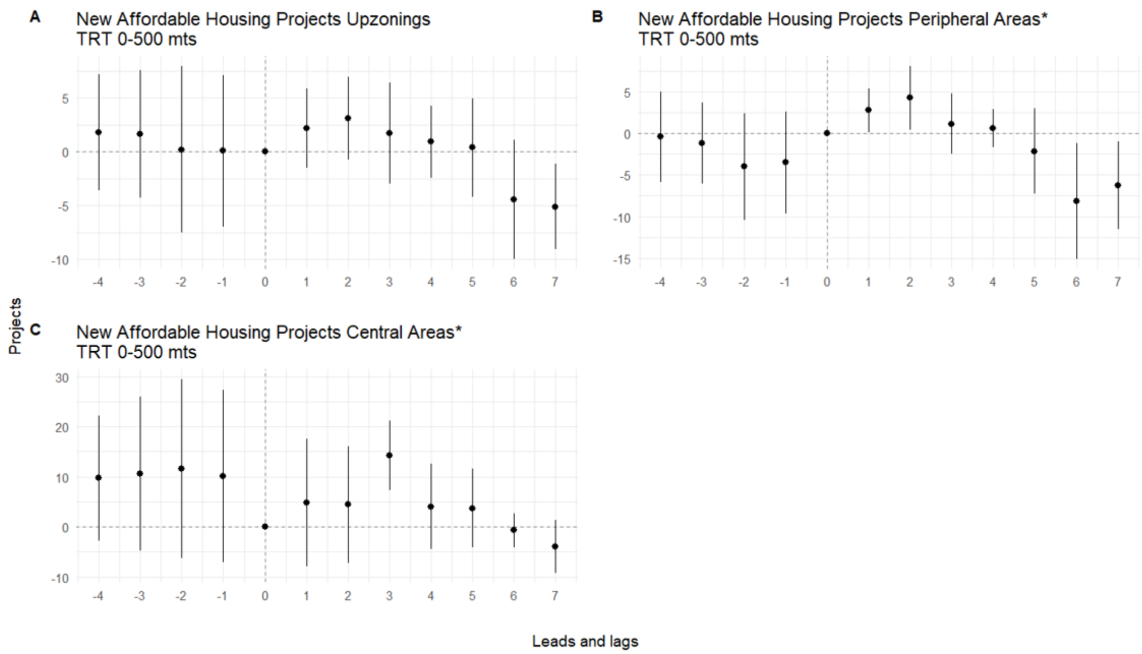


Figure 3.6: Event study on affordable housing

Note: The figure shows the coefficients of the event study regression based on Equation 3.2. This uses year and rezoning fixed effects. Clustered standard errors at the rezoning level.

This results also suggest that neighborhood changes are primarily driven by market-rate units, which aligns with Rodriguez-Pose and Storper (2020) claim that some areas might drive gentrification when their building capacity increases as they encompass neighborhood change.

3.7 Conclusions and Policy Recommendations

This paper examines how upzoning impacts housing prices and explores the mechanisms behind these effects, adding a geographic dimension by exploiting spatial heterogeneity in policy application. The findings reveal that upzoning has differential impacts across New York City, leading to unintended consequences such as price increases in peripheral areas where housing is generally more affordable than in central areas. This highlights that there are no silver bullets to housing affordability issues, even within the same city, and highlights the importance of considering local effects when implementing upzoning policies.

As a direct consequence of this chapter, the illustrating discussion held between Rodriguez-Pose and Storper (2020) and Manville et al. (2022) illustrate how both hypotheses can occur, even within the same city. While upzoning overall tends to reduce housing prices, the empirical analysis demonstrates that it can produce varied outcomes within the city. In peripheral areas, relaxing building restrictions can stimulate urban renewal processes that increase amenity values and, consequently, housing prices at the local level. In contrast, central areas—already characterized by taller and denser buildings—do not experience this effect. Instead, adding more units in these areas helps alleviate price pressures due to increased zoning parameters, and the introduction of new housing stock reduces the prices of older, more affordable units.

Supply and amenity effects act heterogeneously across different urban contexts, being location one relevant factor in understanding these dynamics. In central areas with high development potential and densely built environments, upzoning primarily enhances housing supply, exerting downward pressure on prices. Conversely, in peripheral areas with lower initial densities and development potential, upzoning can significantly alter neighborhood character, increasing amenity values and leading to higher housing prices.

These findings reconcile countervailing results from similar studies. In thriving, developed areas like New York City (X. Li, 2019) and San Francisco (Pennington, 2021), existing infrastructure and transportation-oriented developments make neighborhoods less sensitive to amenity effects. In these contexts, the supply effect of upzoning outweighs demand pressures, resulting in decreased rents and prices. Conversely, in areas farther from the Central Business District or lacking amenities (Freeman & Schuetz, 2017), upzoning can enhance neighborhood attractiveness, increasing demand and housing prices.

From a policy perspective, the heterogeneous effects of upzoning highlight the importance of considering location and development potential when formulating housing policies. Policymakers should recognize more that urban context matters, as private developers will respond differently based on these factors. Upzoning can be an effective tool to enhance housing affordability in central areas where the supply effect dominates due to existing high densities and infrastructure. However, the same policy may lead to increased housing prices in peripheral areas by enhancing amenity values and attracting higher-income residents, potentially leading to gentrification. Similarly, affordable housing goals are also met only in the short run, as when more developments arise, this option seems to vanish.

In consequence, implementing upzoning policies should involve a nuanced approach that accounts for local conditions. In peripheral areas, complementary measures such as affordable housing incentives or community benefits agreements could mitigate the risk of displacing existing residents and ensure that development benefits are more equitably distributed. Given the risk of losing affordable housing stock in these areas, policies aimed at preserving existing affordable units or incentivizing the inclusion of affordable housing in new developments can help. This could involve zoning incentives, subsidies, or regulatory measures that encourage developers to provide affordable options.

As a caveat, the results of this paper represent the local equilibrium effects of upzoning in different places within the city. They do not capture the general equilibrium conditions of New York City as a whole. The observed heterogeneity presents an opportunity to evaluate the city's general equilibrium dynamics due to the significant variations across time and space.

Despite advancing the understanding of zoning policies, there are avenues for further exploration. Future research could investigate the political economy of zoning processes. As highlighted, this process often faces downzoning in others; hence, they also warrants further understanding, especially when interacting with upzoning. Diminishing the building capacity can be a response to increasing it in a neighborhood, something that needs more research. Similarly, they also have a spatial pattern regarding affluent and peripheral areas, which might exacerbate housing price issues. Additionally, development patterns merit further research, as the heterogeneity observed in this case can help in understanding their impact on land values, stock replacement, and more detailed developer responses. Exploring the political, economic, and social dimensions of zoning policies will further enhance our ability to create equitable and sustainable urban environments.

3.8 Appendix: Additional Tables and Figures for Chapter 3

3.8.1 Tables

Table A3.1: Baseline regression of housing prices after upzoning - Sample

	0-150 mts	150-500 mts
TRT x lead4	0.00	−0.00
	(0.03)	(0.03)
TRT x lead3	−0.01	−0.03
	(0.03)	(0.03)
TRT x lead2	0.01	−0.02
	(0.03)	(0.03)
TRT x lag0	−0.03	−0.01
	(0.03)	(0.03)
TRT x lag1	−0.06*	−0.05*
	(0.03)	(0.03)
TRT x lag2	−0.02	−0.02
	(0.03)	(0.03)
TRT x lag3	−0.08***	−0.03
	(0.03)	(0.02)
TRT x lag4	−0.09***	−0.06**
	(0.03)	(0.02)
TRT x lag5	−0.05	−0.14***
	(0.05)	(0.05)
TRT x lag6	−0.10***	−0.12***
	(0.04)	(0.04)
TRT x lag7	−0.05	−0.20***
	(0.07)	(0.07)
Num. obs.	27735	56773
R^2	0.69	0.79

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Note: The table shows the coefficients of the event study regression based on Equation 3.2. All regressions include census tract and year fixed-effects and housing controls such as the square footage, construction quality, type of housing, construction year, the land use category, and a dummy variable to account for proximity to other rezoning. Standard errors clustered at the Census Tract level.

Table A3.2: Baseline regression of housing prices after upzoning – Heterogeneity by location

	0-150 mts		150-500 mts	
	Peripheral	Central	Peripheral	Central
TRT x lead4	−0.02	−0.04	−0.04	−0.12
	(0.03)	(0.03)	(0.07)	(0.07)
TRT x lead3	−0.00	−0.01	−0.12	-0.16^{**}
	(0.04)	(0.03)	(0.09)	(0.08)
TRT x lead2	0.02	0.01	0.06	−0.11
	(0.03)	(0.03)	(0.09)	(0.09)
TRT x lag0	−0.02	−0.02	−0.09	-0.15^{**}
	(0.03)	(0.03)	(0.11)	(0.06)
TRT x lag1	−0.00	0.01	-0.17^{**}	-0.20^{***}
	(0.03)	(0.03)	(0.07)	(0.06)
TRT x lag2	−0.00	0.06^{**}	−0.07	-0.19^{**}
	(0.03)	(0.02)	(0.09)	(0.10)
TRT x lag3	-0.07^{*}	−0.02	-0.20^{**}	−0.10
	(0.04)	(0.03)	(0.08)	(0.09)
TRT x lag4	−0.02	0.03	-0.25^{***}	-0.25^{***}
	(0.03)	(0.03)	(0.08)	(0.07)
TRT x lag5	0.20^{**}	0.22^{***}	-0.28^{**}	-0.43^{**}
	(0.09)	(0.06)	(0.14)	(0.17)
TRT x lag6	0.10	0.20^{***}	-0.34^{***}	-0.31^{***}
	(0.08)	(0.07)	(0.07)	(0.08)
TRT x lag7	0.25^{***}	0.20^{***}	−0.13	-0.25^{***}
	(0.08)	(0.06)	(0.09)	(0.09)
Num. obs.	10732	16933	7482	24944
R^2	0.58	0.64	0.73	0.81

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Note: The table shows the coefficients of the event study regression based on Equation 3.2. All regressions include census tract and year fixed-effects and housing controls such as the square footage, construction quality, type of housing, construction year, the land use category, and a dummy variable to account for proximity to other rezoning. Standard errors clustered at the Census Tract level.

Table A3.3: Baseline regression of housing prices after upzoning – Larger upzoning

	0-150 nts	150-500 mts
TRT x lead4	−0.03	−0.05
	(0.04)	(0.04)
TRT x lead3	−0.04	−0.00
	(0.04)	(0.05)
TRT x lead2	0.03	0.03
	(0.04)	(0.04)
TRT x lag0	−0.11**	0.02
	(0.05)	(0.06)
TRT x lag1	−0.04	0.03
	(0.04)	(0.04)
TRT x lag2	−0.04	0.05
	(0.04)	(0.04)
TRT x lag3	−0.13***	−0.02
	(0.04)	(0.04)
TRT x lag4	−0.07	−0.02
	(0.05)	(0.05)
TRT x lag5	−0.09	−0.13*
	(0.09)	(0.08)
TRT x lag6	−0.30**	−0.13*
	(0.12)	(0.07)
TRT x lag7	−0.06	−0.05
	(0.24)	(0.09)
Num. obs.	8803	23977
R^2	0.80	0.85

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Note: The table shows the coefficients of the event study regression based on Equation 3.2. All regressions include census tract and year fixed-effects and housing controls such as the square footage, construction quality, type of housing, construction year, the land use category, and a dummy variable to account for proximity to other rezoning. Standard errors clustered at the Census Tract level.

Table A3.4: Housing prices after upzoning – Heterogeneity by age (1798 - 1928)

	0-150 nts	150-500 mts
TRT x lead4	0.03	0.01
	(0.04)	(0.04)
TRT x lead3	-0.04	-0.07^{*}
	(0.05)	(0.04)
TRT x lead2	-0.01	-0.07^{**}
	(0.05)	(0.04)
TRT x lag0	-0.05	-0.05
	(0.05)	(0.04)
TRT x lag1	-0.07	-0.06^{*}
	(0.05)	(0.03)
TRT x lag2	-0.07^{*}	-0.06
	(0.04)	(0.04)
TRT x lag3	-0.10^{***}	-0.05^{*}
	(0.03)	(0.03)
TRT x lag4	-0.08^{*}	-0.07^{**}
	(0.04)	(0.03)
TRT x lag5	-0.13^{*}	-0.17^{**}
	(0.07)	(0.07)
TRT x lag6	-0.16^{***}	-0.15^{***}
	(0.05)	(0.05)
TRT x lag7	-0.09	-0.26^{***}
	(0.09)	(0.08)
Num. obs.	14355	26146
R^2	0.69	0.78

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Note: The table shows the coefficients of the event study regression based on Equation 3.2. All regressions include census tract and year fixed-effects and housing controls such as the square footage, construction quality, type of housing, construction year, the land use category, and a dummy variable to account for proximity to other rezoning. Standard errors clustered at the Census Tract level.

Table A3.5: Housing prices after upzoning – Heterogeneity by age (1929 - 2010)

	0-150 nts	150-500 mts
TRT x lead4	−0.02	−0.01
	(0.03)	(0.04)
TRT x lead3	0.02	0.01
	(0.04)	(0.03)
TRT x lead2	0.06	0.01
	(0.05)	(0.04)
TRT x lag0	0.01	0.02
	(0.04)	(0.04)
TRT x lag1	−0.01	−0.03
	(0.04)	(0.04)
TRT x lag2	0.05	−0.00
	(0.03)	(0.03)
TRT x lag3	−0.03	−0.02
	(0.04)	(0.04)
TRT x lag4	-0.08^{**}	−0.03
	(0.04)	(0.03)
TRT x lag5	0.05	-0.07^{*}
	(0.05)	(0.04)
TRT x lag6	−0.06	−0.06
	(0.05)	(0.05)
TRT x lag7	−0.01	−0.07
	(0.10)	(0.10)
Num. obs.	13380	30627
R^2	0.72	0.82

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Note: The table shows the coefficients of the event study regression based on Equation 3.2. All regressions include census tract and year fixed-effects and housing controls such as the square footage, construction quality, type of housing, construction year, the land use category, and a dummy variable to account for proximity to other rezoning. Standard errors clustered at the Census Tract level.

Table A3.6: Housing prices after upzoning – Heterogeneity by age and location (1798 - 1928)

	0-150 mts		150-500 mts	
	Peripheral	Central	Peripheral	Central
TRT x lead4	−0.00	−0.03	−0.01	−0.13
	(0.04)	(0.04)	(0.10)	(0.10)
TRT x lead3	0.01	−0.09**	−0.21	−0.21*
	(0.06)	(0.04)	(0.14)	(0.11)
TRT x lead2	0.04	−0.00	−0.17	−0.37***
	(0.05)	(0.06)	(0.14)	(0.09)
TRT x lag0	−0.05	−0.05	−0.09	−0.20**
	(0.05)	(0.04)	(0.13)	(0.09)
TRT x lag1	−0.02	−0.05	−0.22*	−0.22***
	(0.04)	(0.03)	(0.13)	(0.08)
TRT x lag2	−0.01	0.05	−0.26**	−0.30**
	(0.04)	(0.03)	(0.13)	(0.13)
TRT x lag3	−0.04	−0.03	−0.26**	−0.14
	(0.04)	(0.03)	(0.10)	(0.09)
TRT x lag4	0.02	−0.00	−0.32***	−0.27***
	(0.05)	(0.04)	(0.11)	(0.09)
TRT x lag5	0.11	0.17*	−0.56***	−0.54**
	(0.09)	(0.09)	(0.19)	(0.24)
TRT x lag6	0.04	0.11	−0.43***	−0.36***
	(0.09)	(0.08)	(0.10)	(0.08)
TRT x lag7	0.11	0.08	−0.27**	−0.32***
	(0.08)	(0.06)	(0.13)	(0.10)
Num. obs.	6283	8556	3643	10208
R^2	0.60	0.65	0.73	0.80

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Note: The table shows the coefficients of the event study regression based on Equation 3.2. All regressions include census tract and year fixed-effects and housing controls such as the square footage, construction quality, type of housing, construction year, the land use category, and a dummy variable to account for proximity to other rezoning. Standard errors clustered at the Census Tract level.

Table A3.7: Housing prices after upzoning – Heterogeneity by age and location (1929 - 2010)

	0-150 mts		150-500 mts	
	Peripheral	Central	Peripheral	Central
TRT x lead4	−0.07	−0.06	−0.08	−0.06
	(0.05)	(0.05)	(0.08)	(0.07)
TRT x lead3	−0.02	0.06	0.02	−0.03
	(0.07)	(0.05)	(0.09)	(0.07)
TRT x lead2	0.01	−0.01	0.20*	−0.03
	(0.05)	(0.04)	(0.10)	(0.13)
TRT x lag0	0.00	−0.03	−0.05	−0.06
	(0.06)	(0.05)	(0.11)	(0.07)
TRT x lag1	0.02	0.06	−0.05	−0.13
	(0.06)	(0.04)	(0.10)	(0.09)
TRT x lag2	−0.02	0.04	0.25*	−0.05
	(0.06)	(0.04)	(0.13)	(0.09)
TRT x lag3	−0.10	−0.05	−0.18	−0.04
	(0.08)	(0.06)	(0.14)	(0.20)
TRT x lag4	−0.07	0.05	−0.15	−0.15
	(0.05)	(0.04)	(0.14)	(0.10)
TRT x lag5	0.33**	0.28***	0.09	−0.06
	(0.15)	(0.09)	(0.12)	(0.06)
TRT x lag6	0.19**	0.30***	−0.15	−0.16
	(0.09)	(0.09)	(0.14)	(0.15)
TRT x lag7	0.57***	0.38***	0.02	−0.01
	(0.19)	(0.14)	(0.12)	(0.10)
Num. obs.	4449	8377	3839	14736
R^2	0.57	0.65	0.78	0.86

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Note: The table shows the coefficients of the event study regression based on Equation 3.2. All regressions include census tract and year fixed-effects and housing controls such as the square footage, construction quality, type of housing, construction year, the land use category, and a dummy variable to account for proximity to other rezoning. Standard errors clustered at the Census Tract level.

Table A3.8: Events study regression coefficients on Affordable Housing

	New Projects - Affordable Housing		
	Sample	Peripheral	Central
TRT x lead4	1.64	-1.20	10.62
	(3.02)	(2.98)	(9.33)
TRT x lead3	0.19	-4.01	11.58
	(3.96)	(3.89)	(10.82)
TRT x lead2	0.07	-3.51	10.11
	(3.58)	(3.70)	(10.43)
TRT x lead1	2.14	2.74^{*}	4.84
	(1.89)	(1.60)	(7.71)
TRT x lag1	3.11	4.23^{*}	4.42
	(1.96)	(2.32)	(7.06)
TRT x lag2	1.71	1.13^{*}	14.25^{***}
	(2.39)	(2.22)	(4.21)
TRT x lag3	0.91	0.56	4.05
	(1.69)	(1.39)	(5.14)
TRT x lag4	0.37	-2.14	3.74
	(2.34)	(3.11)	(4.75)
TRT x lag5	-4.48	-8.18^{*}	-0.65
	(2.83)	(4.23)	(2.05)
TRT x lag6	-5.10^{**}	-6.27^{*}	-3.93
	(2.01)	(3.22)	(3.18)
TRT x lag7	-5.13^{**}	-7.12^{*}	-3.53
	(2.26)	(3.67)	(3.57)
Observations	326	202	124
R^2	0.15	0.41	0.34

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Note: The figure shows the coefficients of the event study regression based on Equation 3.2. This uses year and rezoning fixed effects. Clustered standard errors at the rezoning level.

Table A3.9: Baseline regression of housing prices after upzoning – Sample without sqft control

	0-150 mts	150-500 mts
TRT x lead4	0.00	−0.00
	(0.03)	(0.03)
TRT x lead3	−0.00	−0.04
	(0.03)	(0.03)
TRT x lead2	0.01	−0.01
	(0.04)	(0.03)
TRT x lag0	−0.03	−0.00
	(0.04)	(0.04)
TRT x lag1	−0.05*	−0.07**
	(0.03)	(0.03)
TRT x lag2	−0.01	−0.02
	(0.03)	(0.03)
TRT x lag3	−0.07**	−0.02
	(0.03)	(0.03)
TRT x lag4	−0.08***	−0.06**
	(0.03)	(0.03)
TRT x lag5	−0.04	−0.12**
	(0.05)	(0.05)
TRT x lag6	−0.10***	−0.10**
	(0.04)	(0.04)
TRT x lag7	−0.05	−0.17**
	(0.07)	(0.07)
Num. obs.	27735	56773
R^2	0.68	0.74

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Note: The table shows the coefficients of the event study regression based on Equation 3.2. All regressions include census tract and year fixed-effects and housing controls such as the square footage, construction quality, type of housing, construction year, the land use category, and a dummy variable to account for proximity to other rezoning. Standard errors clustered at the Census Tract level.

Table A3.10: Baseline regression of housing prices after upzoning – Heterogeneity by location without sqft control

	0-150 mts		150-500 mts	
	Peripheral	Central	Peripheral	Central
TRT x lead4	-0.02	-0.04	-0.04	-0.11
	(0.03)	(0.03)	(0.07)	(0.08)
TRT x lead3	-0.00	-0.01	-0.13	-0.23^{***}
	(0.04)	(0.03)	(0.10)	(0.08)
TRT x lead2	0.02	0.02	0.09	-0.05
	(0.03)	(0.03)	(0.09)	(0.07)
TRT x lag0	-0.02	-0.02	-0.03	-0.08
	(0.03)	(0.03)	(0.13)	(0.14)
TRT x lag1	-0.00	0.01	-0.14^{*}	-0.23^{***}
	(0.03)	(0.03)	(0.08)	(0.07)
TRT x lag2	-0.00	0.06^{**}	-0.04	-0.17
	(0.03)	(0.02)	(0.10)	(0.10)
TRT x lag3	-0.07^{*}	-0.02	-0.18^{**}	-0.10
	(0.04)	(0.03)	(0.09)	(0.09)
TRT x lag4	-0.02	0.04	-0.24^{***}	-0.23^{***}
	(0.03)	(0.03)	(0.09)	(0.08)
TRT x lag5	0.20^{**}	0.22^{***}	-0.25^{**}	-0.36^{***}
	(0.09)	(0.06)	(0.13)	(0.13)
TRT x lag6	0.10	0.20^{***}	-0.34^{***}	-0.34^{***}
	(0.08)	(0.06)	(0.08)	(0.09)
TRT x lag7	0.24^{***}	0.20^{***}	-0.14	-0.17^{**}
	(0.08)	(0.06)	(0.09)	(0.08)
Num. obs.	10732	16933	7482	24944
R^2	0.58	0.64	0.71	0.67

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Note: The table shows the coefficients of the event study regression based on Equation 3.2. All regressions include census tract and year fixed-effects and housing controls such as the square footage, construction quality, type of housing, construction year, the land use category, and a dummy variable to account for proximity to other rezoning. Standard errors clustered at the Census Tract level.

3.8.2 Figures

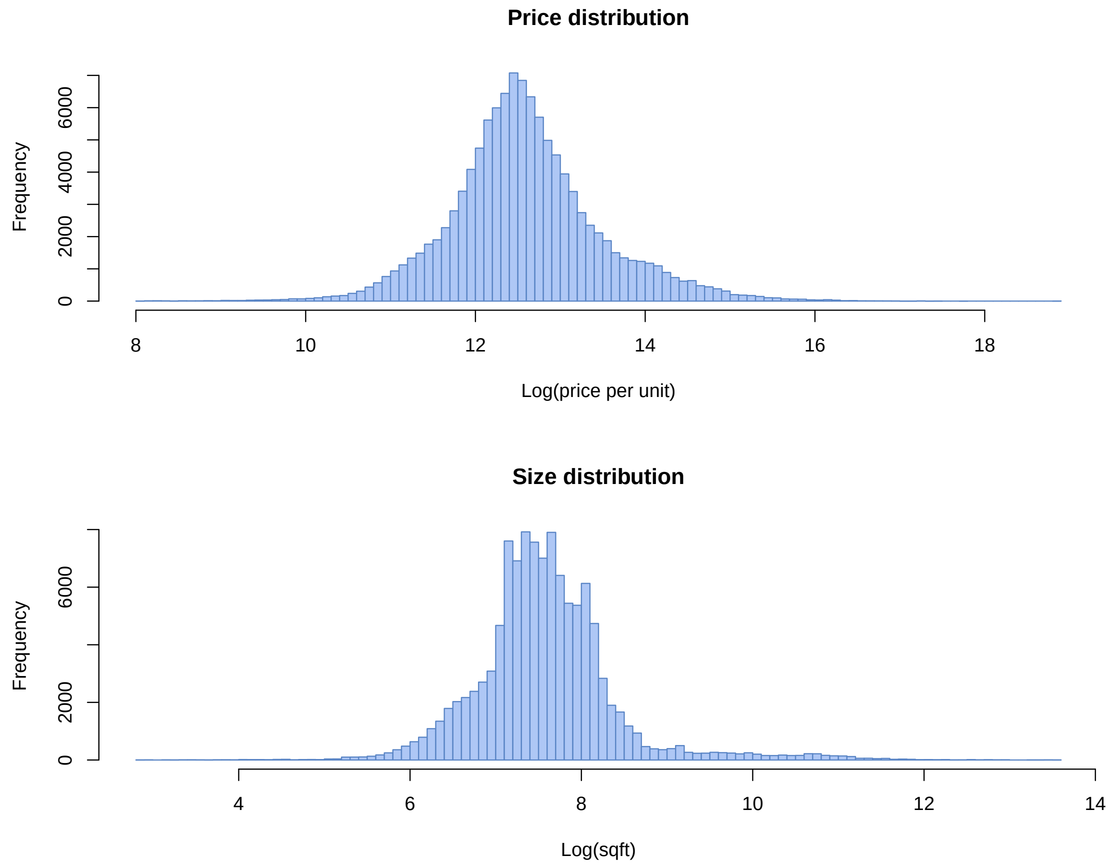
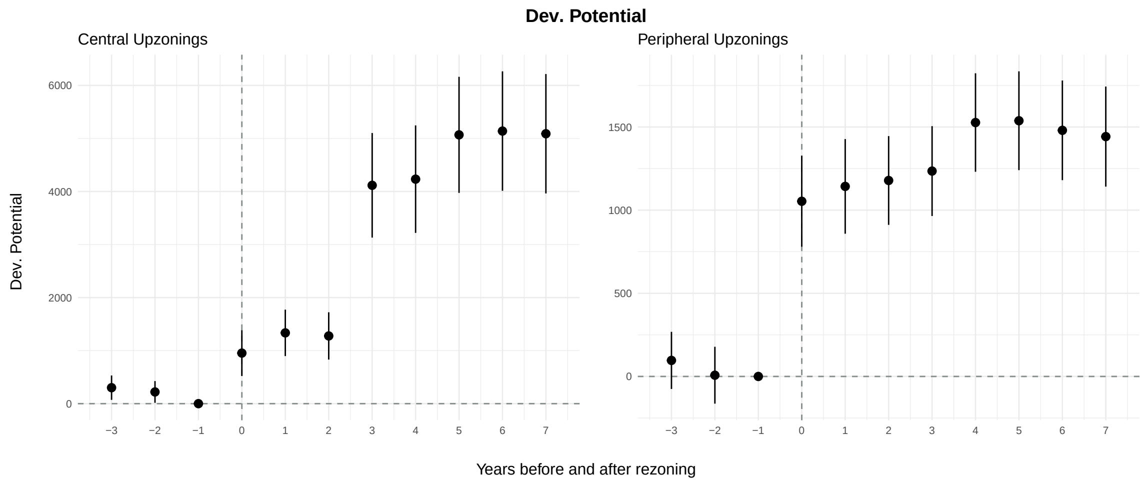


Figure A3.1: Histogram of housing prices and size. Logged variable



This figure shows the regression results for Equation 3.1 on the **Logarithm of the difference between the current and maximum FAR times the lot size for peripheral and central upzoning**. The coefficient plotted is the interaction between the TRT and each lead and lag. The equation considers Fixed Effects at the Census Tract level, the interaction between the calendar year and the borough, and standard errors clustered by census tract.

Figure A3.2: Changes in Development Potential per lot

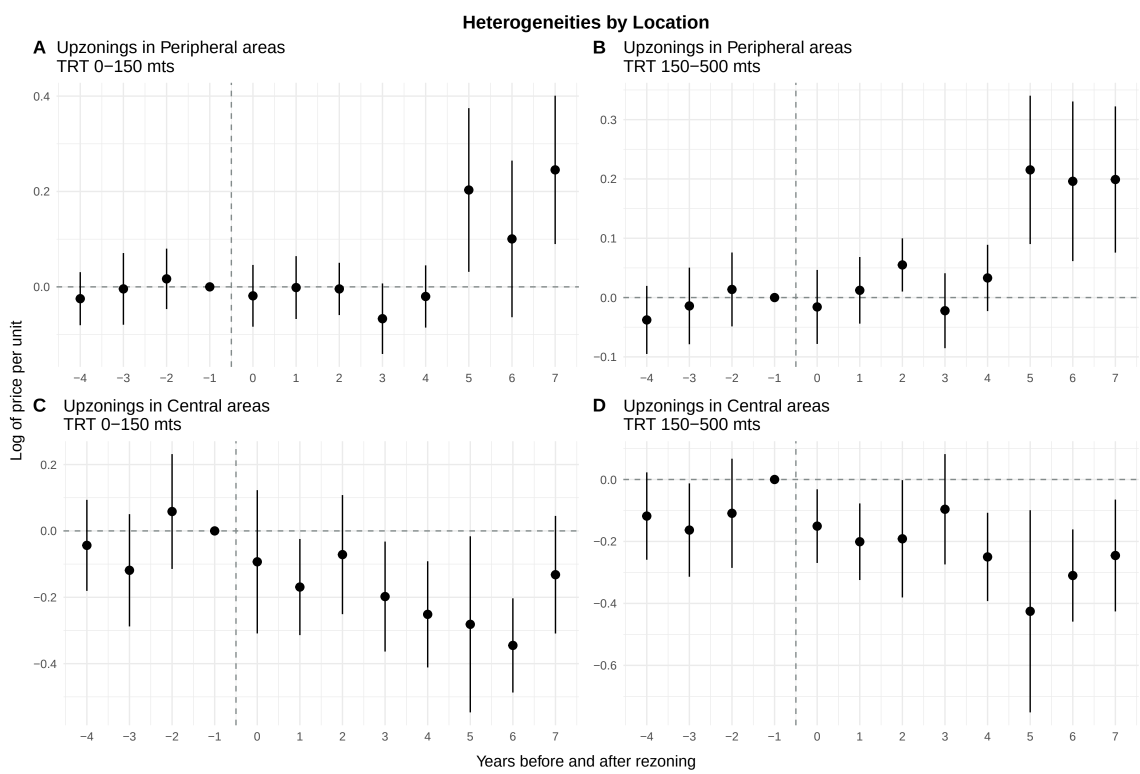


Figure A3.3: Event study plots of Upzoning in Central and Peripheral neighborhoods

This figure shows the regression results for Equation 3.2 on the **Logarithm of Housing Price per unit for peripheral and central upzoning**. The coefficient plotted is the interaction between the TRT and each lead and lag. The equation considers Fixed Effects at the Census Tract level, the interaction between the calendar year and the borough, and standard errors clustered by census tract.

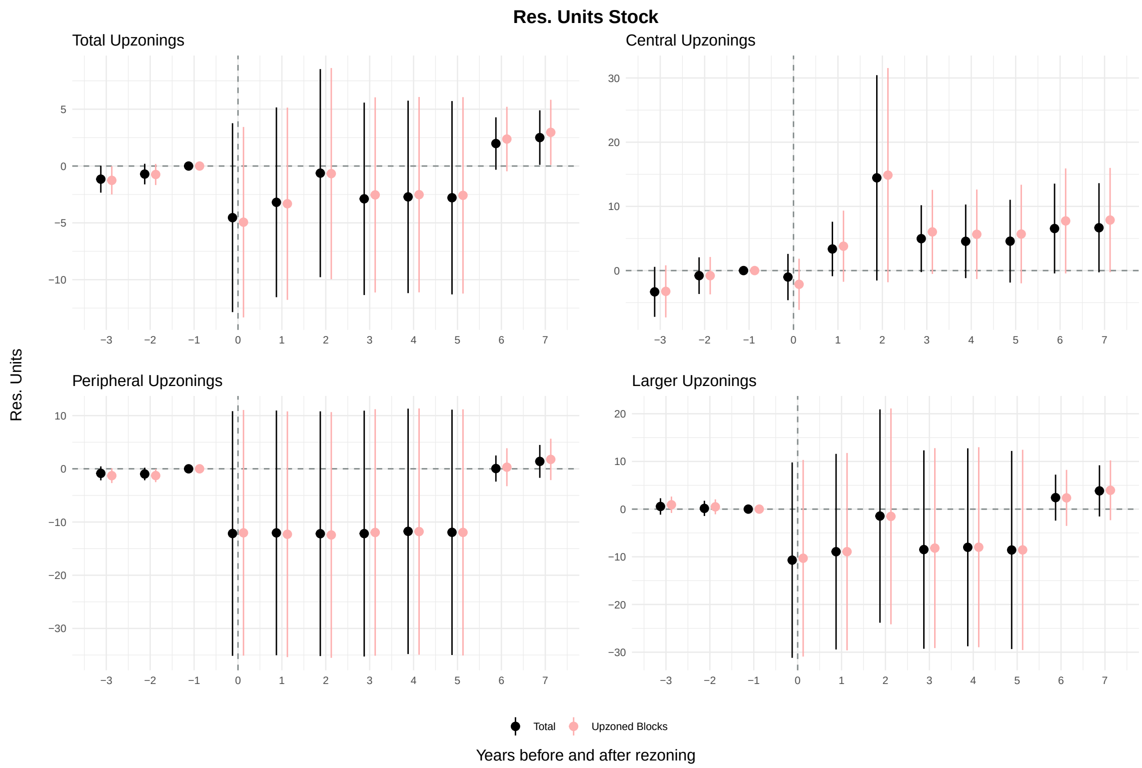


Figure A3.4: Event study plots of the housing stock

This figure shows the regression results for Equation 3.2 on the **Number of Units per block** for the overall sample in black and only the upzoned plots in red. The coefficient plotted is the interaction between the TRT and each lead and lag. The equation considers Fixed Effects at the Census Tract level, the interaction between the calendar year and the borough, and standard errors clustered by census tract.

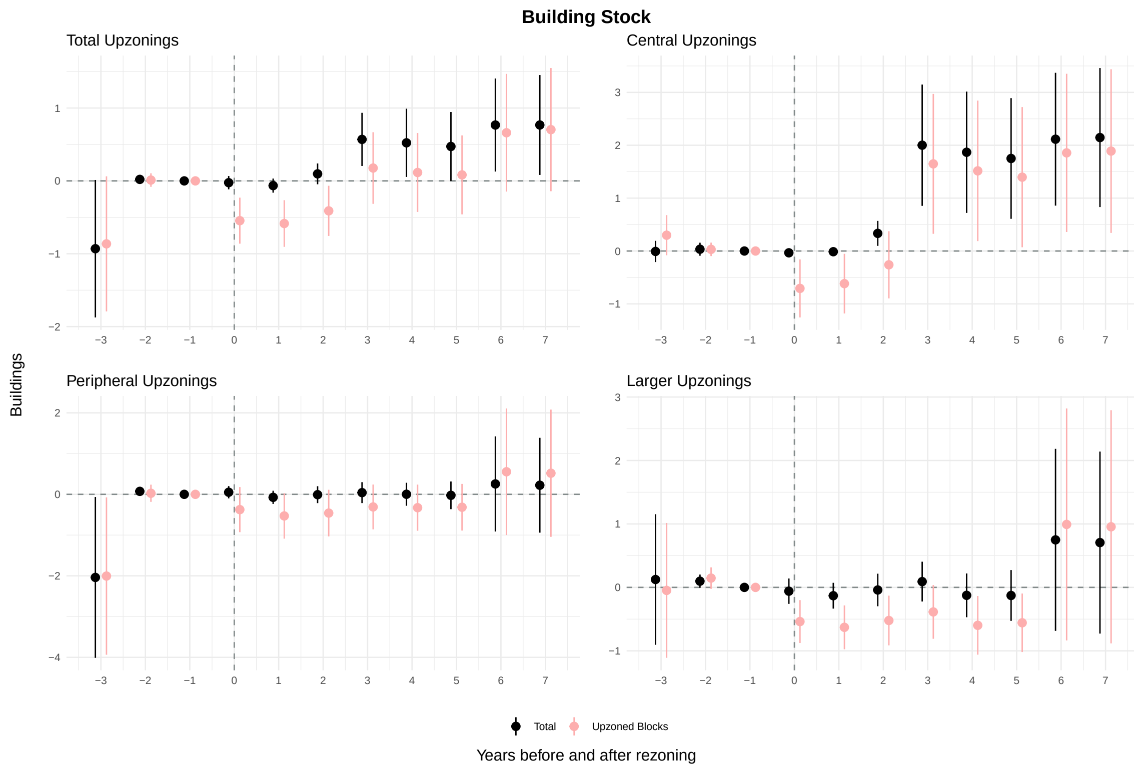


Figure A3.5: Event study plots of the building stock

This figure shows the regression results for Equation 3.2 on the **Number of Buildings per block** for the overall sample in black and only the upzoned plots in red. The coefficient plotted is the interaction between the TRT and each lead and lag. The equation considers Fixed Effects at the Census Tract level, the interaction between the calendar year and the borough, and standard errors clustered by census tract.

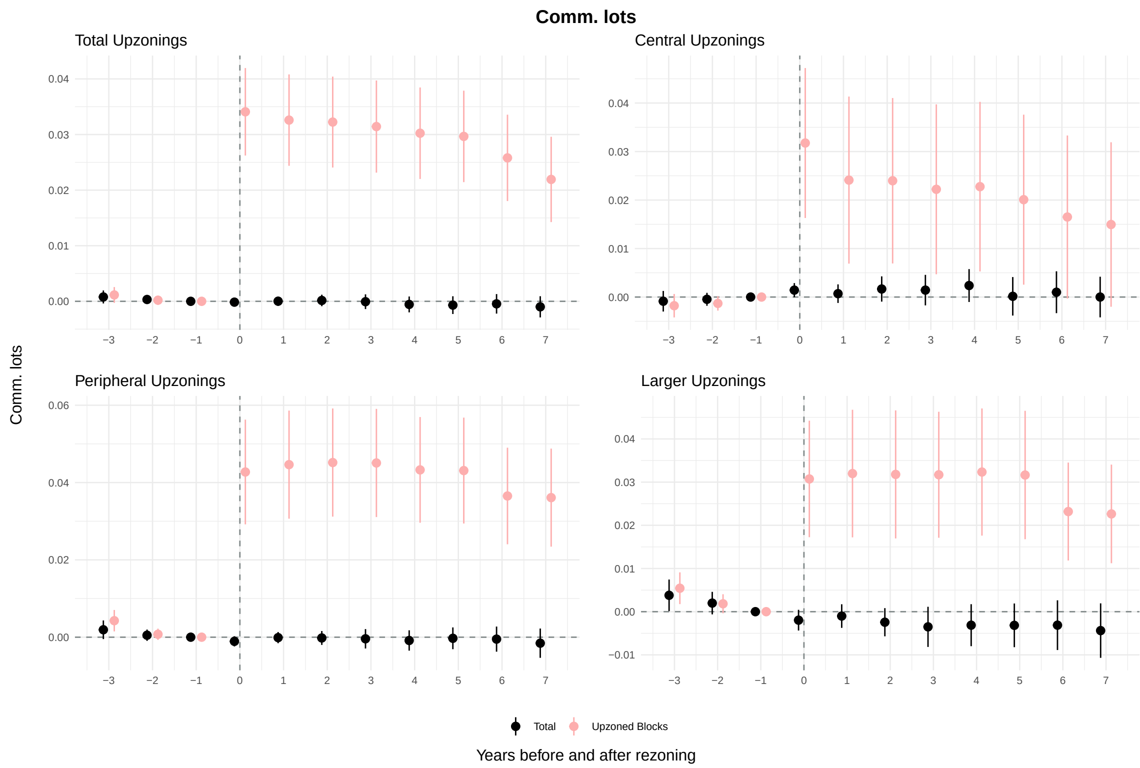


Figure A3.6: Event study plots of commercial plots

This figure shows the regression results for Equation 3.2 on the **Number of lots with commercial areas** for the overall sample in black and only the upzoned plots in red. The coefficient plotted is the interaction between the TRT and each lead and lag. The equation considers Fixed Effects at the Census Tract level, the interaction between the calendar year and the borough, and standard errors clustered by census tract.

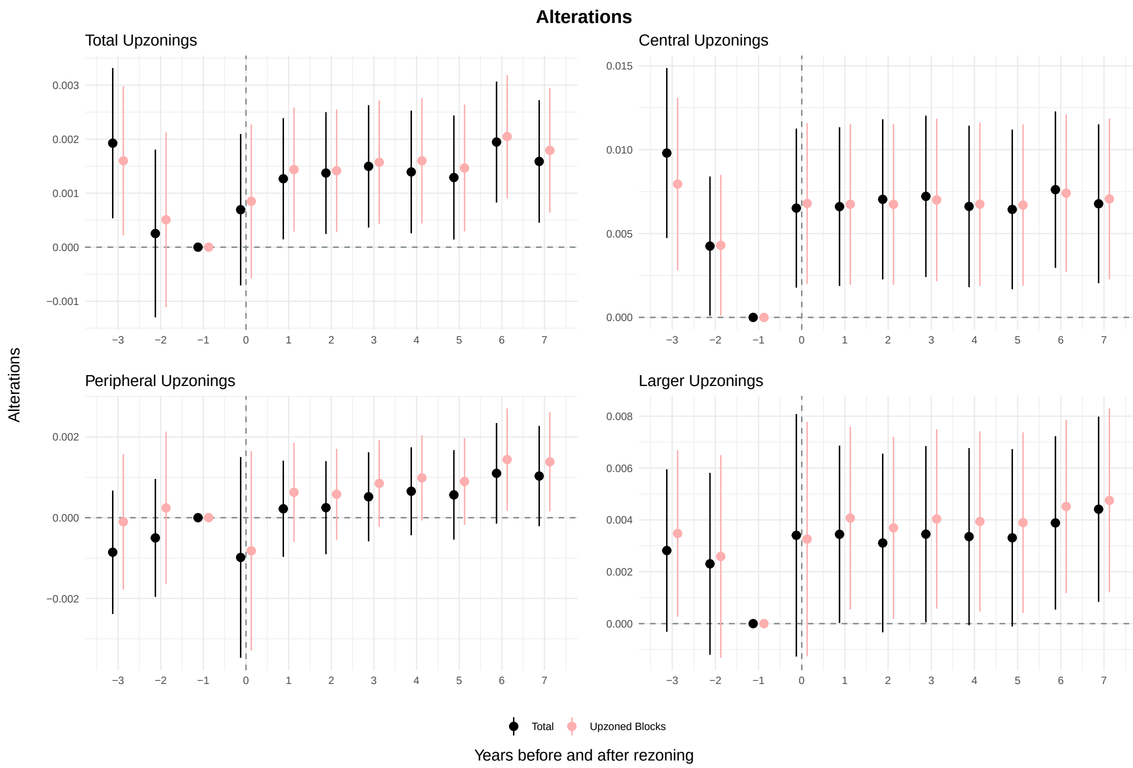


Figure A3.7: Event study plots of alterations

This figure shows the regression results for Equation 3.2 on the **Number of lots that made an alteration** for the overall sample in black and only the upzoned plots in red. The coefficient plotted is the interaction between the TRT and each lead and lag. The equation considers Fixed Effects at the Census Tract level, the interaction between the calendar year and the borough, and standard errors clustered by census tract.

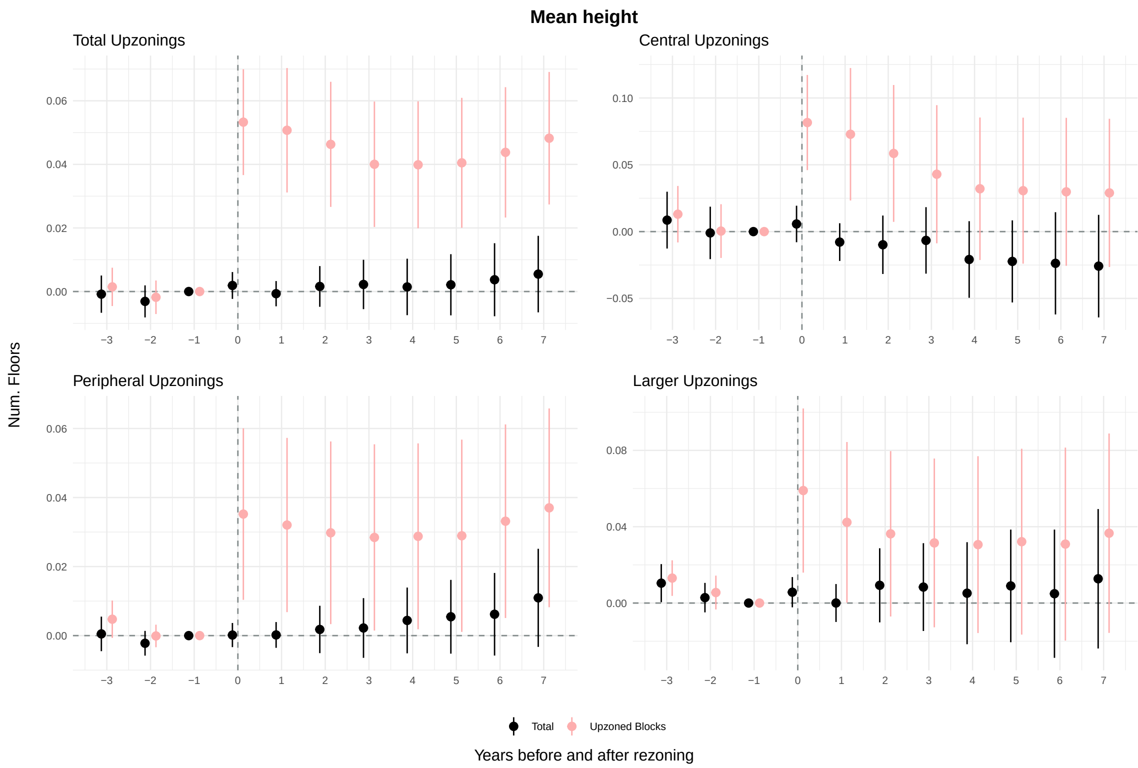


Figure A3.8: Event study plots of changes in average heights

This figure shows the regression results for Equation 3.2 on the **Number of Floors per lot** for the overall sample in black and only the upzoned plots in red. The coefficient plotted is the interaction between the TRT and each lead and lag. The equation considers Fixed Effects at the Census Tract level, the interaction between the calendar year and the borough, and standard errors clustered by census tract.

Chapter 4

Paying for integration. The impacts of a mixed-income housing demand voucher in Chile

4.1 Introduction

Policymakers have increasingly focused on social integration as a strategy to address various societal challenges, as living in distressed neighborhoods is associated with reduced social and economic mobility, health disparities, and fewer job opportunities (Chetty et al., 2016; H. Li et al., 2013; Miltenburg et al., 2018; Schwartz et al., 2006). These issues warrant particular attention as residential segregation has been escalating in cities across Europe and the United States (Borsdorf & Hidalgo, 2010; Musterd et al., 2017; Watson, 2009). Consequently, many countries have included social integration as part of their urban agenda, yet the outcomes of such policies still need to be determined due to unclear causal links (Cheshire, 2007).

I examine the Chilean housing policy DS-19 to contribute to this discussion. The program aims to catalyze social integration by creating a pecuniary incentive through additional subsidies for would-be buyers in mixed-income affordable housing developments –most of them located in peripheral areas–. Essentially, it pays for integration. Nevertheless, unlike previously evaluated policies, such as Moving to Opportunity (MTO) and HOPE, which were designed to enable low-income families to move to better neighborhoods, this brings more affluent families to less desirable areas.

Over recent decades, Chile has relied on a market-driven approach, featuring private homeownership developments and demand vouchers, which has effectively reduced informal settlements and housing shortages while also expanding access to water, sewage, and electricity across the nation (CNDU, 2014; Ducci, 1997). A key factor influencing for-profit developers is low land values[1], which offset the opportunity cost of fixed subsidies. This dynamic has led to the concentration of low-income families in the outskirts, often lacking adequate public services and amenities (Agostini et al., 2016; Gil, 2018; Sabatini & Brain, 2008).

Although DS-19 has not been able to change the affordable housing location pattern, which might impose a disamenity on households, the amenities mandated by the policy could enhance neighborhood quality, attracting middle-income buyers, especially in metropolitan areas where the scarcity of affordable housing is higher. To illustrate, Figure 4.1 shows the difference between the existing stock and the amenities introduced through the new developments in the same street.

Note: The figure shows how new developments change the building stock in the same street. The DS-19 development faces the north of the street, while the south shows the existing constructions. Source: Google Street View.

Figure 4.1: Amenities

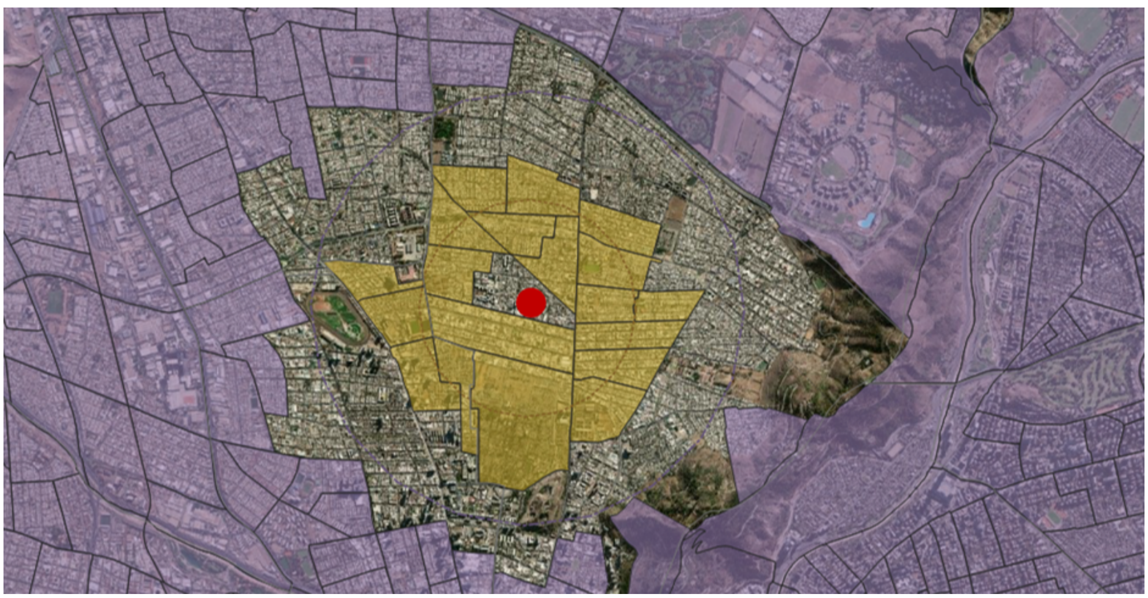
The impacts of neighborhood improvements on urban dynamics impose empirical challenges, as its effectiveness remains with mixed results. While affluent families generally exhibit a higher willingness to pay for renovated projects and enhanced neighborhood amenities (Bayer et al., 2007; Diamond, 2016; Diamond & Mcquade, 2019; Handbury, 2021), the intensity of such treatments and the specific groups targeted may not always lead to positive outcomes (González-Pampillón et al., 2020).

Alongside the potential effects on social integration, the spillover effects of these interventions represent another gap in the literature. DS-19 developments often incorporate green spaces and commercial areas into neighborhoods, which can serve as drivers of neigh-

[1]Usually, land is defined as a residual value between property prices and development cost. Hence, when subsidies are fixed, profit-seeker developers tend to locate their projects in areas where land has a lower value.

borhood change for potential buyers. Consequently, in the presence of spillovers, the policy could serve as a tool for neighborhood revitalization. Given that the effects can vary between cities and markets, a nationwide program offers the opportunity to examine whether the impacts differ across regions.

I leverage the introduction of the DS-19 policy in 2015 using a difference-in-difference strategy to study demographic dynamics at the census tract level, which are approximated by *Zonas Censales* in the Chilean Census. Given the potential spillover effects beyond the developments, I estimate the policy's impact separately on (i) the treated and (ii) the surrounding areas within 1 kilometer of the new projects, as illustrated in Figure 4.2. Lastly, to mitigate spillovers in the specification, I define the potential control group in a ring beyond 2 km from each project.



Note: The figure shows the strategy to define regression groups. The red dot shows the Census Tract that received a DS-19 development, and the adjacent tracts are in yellow. Then, after a 2 Km. Buffer, all the remaining tracts are potential controls. Source: Google Street View.

Figure 4.2: Treated areas

Although the location of developments is not random, the adjacent areas can indirectly receive a quasi-random treatment effect. To avoid any contamination between groups, I define the potential control group in a ring beyond 2 km from each project. Then, I employ propensity score matching based on location attributes and policy requirements to address developers' self-selection, household sorting, and neighborhood heterogeneity.

Furthermore, I contrast the results with the not-yet-treated projects[2] as a second control group in my robustness checks.

The results suggest that DS-19 positively impacts neighborhood dynamics by increasing households with a college degree (30%) at a higher rate than those with a high-school diploma (15%) in the neighborhoods that received the treatment. The spillover effects are slightly significant in the group with higher education (9%). Moreover, the results are heterogeneous across cities, showing three to four percent extra points in metropolitan areas. Similarly, adjacent tracts exhibit a significant effect, with a 13% additional influx of educated households compared to the controlled group.

Since the study uses census tracts rather than blocks, I first check that DS-19 drives changes in the built environment. The results show that the treated blocks significantly increased the number of housing units compared to the rest of the tract by approximately 43 more units between 2012 and 2018.

The findings also reveal that DS-19 provides better amenities compared to the existing stock, measured through the UAI-IBT index, which draws on different official sources. The results reveal a notable difference in the number of households, improved security, and enhanced green spaces within the treated blocks. Additionally, I test the impacts on housing prices using IRS data; nonetheless, as part of these developments are highly subsidized there is a significant price decay that is mechanically driven by the policy. To test for the impacts on market prices, I also use real estate appraisals from *Transsa*, a leading company in Chile, which is used for mortgage evaluation. This dataset shows that the projects induce a price increase in metropolitan areas, where the housing supply of affordable housing is scarcer.

These results provide insights into how households respond to the new stock, demonstrating that more affluent families are willing to move to peripheral areas through enhanced amenities, particularly in metropolitan areas where housing prices are higher and availability is limited. Consequently, policies like DS-19 can serve as effective tools for neighborhood revitalization and promoting social integration, even when implemented in peripheral areas of large cities.

The empirical strategy presents caveats on the interpretation of the results. Firstly, the reduced form only captures local effects and does not reflect the general equilibrium conditions of Chile's housing market. Secondly, to ensure comparability over time, I excluded

[2] I use the 2017 Census as post-treatment data to evaluate population dynamics. Then, the not-yet-treated group is formed of DS-19 developments between 2018 and 2019

tracts without population in the early years of observation, typically the most peripheral projects in my sample. Despite their exclusion, a cross-check shows that the share of educated families in these tracts aligns with the overall patterns observed. Thirdly, there are inherent challenges with using Propensity Score Matching techniques; to address this, I also use post-study developments as an alternative control group, showing consistent findings.

Although the DS-19 policy overlaps with other housing vouchers for middle- and low-income families, it possesses a unique element: the social integration bonus, which can double benefits for middle-income households. The subsidy increase is relevant, as it can equate to the downpayment; hence, this is a unique shock to the overall housing market. Moreover, the other policies mainly apply to used units, while this program is exclusive to new units. Meaning that the new influx of population in blocks with newer units can be associated with the policy.

This paper links to previous research on housing and neighborhood dynamics, such as González-Pampillón et al. (2020), who examined the effects of urban renewal policies on neighborhood dynamics in Catalunya, finding minor effects on attracting natives and high-income individuals when investing in public space in deprived areas. Similarly, Diamond (2016) and Baum-Snow and Marion (2009), investigated the effects of affordable housing in low-income neighborhoods. Although they focus on housing prices mostly, they also shed light on how new developments spur housing reconversion while increasing non-minorities and higher-income households.

The paper further investigates the spillover effects of new housing projects in impoverished areas by examining their impacts on adjacent regions. Guerrieri et al. (2013) highlights endogenous patterns of segregation, illustrating how new developments can attract newcomers who opt to move into poorer neighborhoods that directly border more affluent areas. Similarly, Diamond and Gaubert (2022) explore how household sorting is influenced not only by high-wage locations but also by areas with high amenities, which aligns with college-educated households' preferences for amenities and locations (Couture & Handbury, 2023). A novel aspect of this study is its focus on how low-income neighborhoods can attract more affluent families, shifting from the traditional approach of moving low-income households to high-end neighborhoods.

Lastly, the paper contributes to the extensive literature on housing policy evaluations and their impacts on segregation and poverty (Ananat, 2011; Watson, 2009). It investigates whether real estate development can act as a mechanism to reduce segregation and stimulate change in underprivileged areas (Freedman & Mcgavock, 2015; Horn & O'Regan, 2011; Won, 2022). Additionally, this study examines the effects of new housing supply on the built environment (Asquith et al., 2019; X. Li, 2019; Pennington, 2021) and demographic changes within neighborhoods (Boston, 2005; Chetty et al., 2016; Jeffrey Kling et al., 2007). Furthermore, it assesses a unique aspect of housing vouchers in the residential property market. It contrasts with U.S. policies and other international approaches, which often integrate social interventions (Boston, 2005) and the rental market. Lastly, this approach provides a distinct perspective, focusing on the direct and spillover effects of housing initiatives in developing contexts that promote homeownership through vouchers.

Lastly, this paper enriches the discussion on housing policies in developing countries within the global south, particularly in terms of their impact on social integration and the unique challenges and contexts faced by developing countries with more constrained budgets and growth capacities.

The structure of this paper is organized as follows: Section 2 outlines the institutional setting of the policy and discusses theoretical predictions. Section 3 details the data used in the analysis. Section 4 presents the main results and explores their heterogeneities. Section 5 investigates potential mechanisms. Section 6 is dedicated to robustness checks. Finally, Section 7 concludes with a discussion of the policy implications.

4.2 Policy Background and Theoretical Predictions

4.2.1 Policy Background: The DS-19.

Affordable housing became a policy priority after the 2010 earthquake and tsunami that hit the nation due to the extensive need for construction and its significant economic impact (BCN, 2015). Concurrently, a panel of experts recommended addressing urban inequality and residential segregation in the country's first national urban development policy (CNDU, 2014). In response, the Ministry of Housing and Urban Development (MINVU) initiated a policy known as DS-116 (BCN, 2015), later continued under the name DS-19 (BCN, 2016)[3]. This program was designed to stimulate economic growth, reduce the housing deficit and informality, and lessen residential segregation by promoting homeownership through mixed-income developments that integrate low-income families into well-planned and better-located projects (BCN, 2015).

The policy integrates two existing vouchers targeted at low- and middle-income families—DS-

[3] Throughout this research, DS-116 and DS-19 are used interchangeably unless specified otherwise. The differences between these policies are considered insignificant for this paper as the change in mane responds to a revamp instead of to a different policy.

49 and DS-01, respectively—and includes an additional subsidy for purchases within DS-19 projects. For example, a middle-income family could receive a subsidy of UF 275 for a UF 2,200 dwelling if they choose to live in a socially integrated project, a substantial improvement compared to UF 100 in a non-socially integrated development. Similarly, a very low-income family could benefit from UF 900 to pay for a UF 1,100 property, as opposed to UF 700 for a unit purchased outside these developments.[4] Among the key features of the policy, I highlight:

- The results become public once the selection process concludes. It is important to note that only the selected projects are scored, while the non-selected don't receive a score.
- The number of subsidies per region and the annual selection process are centrally managed by MINVU, based on a scoring system that ranks projects until they fulfill the regional quota[5].
- The very-low-income units have a price ceiling of UF 1,100, low-income dwellings range between UF 1,100 and UF 1,400, and middle-income units range from UF 1,400 to UF 2,200. The typical proportion of these dwellings in a development is 20%, 10%, and 70%, respectively.
- Developments are constructed as-of-right on developers' land. There are no zoning benefits.
- The minimum dwelling size is set at 47 m^2 for single-family houses and 52 m^2 for apartments.

About the scoring system, MINVU ranks developments based on the following requirements:

- Projects in municipalities with more than 40,000 inhabitants receive a bonus score.
- There are several location requirements – conditional to the city size – include being less than: (1) 2.5 km away from a health institution; (2) 1 km away from a park, public school, and kindergarten, each assessed separately; (3) 500 meters from a bus stop; and (4) 200 meters from a road. A development needs to meet at least 4 of these criteria.
- There is a bonus for the inclusion of commercial infrastructure, extra green areas, or playgrounds[6].
- The very-low-income dwellings quota is set at 20%. Additionally, projects that in-

[4] UF is a Chilean currency unit indexed to inflation, commonly used in real estate transactions. Currently, 1 UF = 37,834.79 CLP = 29.17 USD = 22.35 GBP

[5] The quota changes per year based on the housing shortage per region and MINVU's budget

[6] Due to the competitive nature of the contest, most of the developments include them

clude low-income units or a higher proportion of very low-income families also receive a bonus score.

Between 2014 and 2017, a total of 606 housing developments resulted in 104,867 units. The largest number of units is distributed among the Biobío, Metropolitana, and Valparaíso regions, accounting for 18.31%, 17.72%, and 14.89%, respectively. Furthermore, most of the new dwellings are concentrated in the metropolitan areas of each region. As shown in Figure 4.3, most of the projects in Greater Santiago, Greater Valparaíso, and Greater Concepción are still situated in the peripheral rings of each city.

Note: The figure shows the location of DS-19 developments for the three main metropolitan areas of Chile: Santiago, Valparaíso and Concepción. Source: Google Street View.

Figure 4.3: Location of DS-19 developments in the three metropolitan areas of Chile

Notwithstanding these developments are on the outskirts, they vary significantly in nature and micro-location. Figure 4.4 illustrates how some of them are single-family condominium projects in undeveloped neighborhoods, while others are multifamily buildings—typically four-story edifices—in denser areas. Old single-family units often surround these developments without new developments beyond DS-19[7].

4.2.2 Related literature and theoretical predictions

In this section, I review the housing literature to understand how policy incentives and renewing the housing stock might influence middle-income households' location preferences, potentially supporting socially integrated developments in deprived areas of a city. I also discuss potential spillover effects and develop arguments concerning the expected outcomes.

Although the policy imposes location restrictions, these requirements are highly contested by local academics, as they are easily met in metropolitan areas (Ruiz-Tagle & Romano,

[7]I provide evidence of this in Section 5.

Note: The figure shows the different urban configurations where DS-19 located. As seen on the left, some are located in peripheral areas zoned for single-family developments, while on the right, denser developments take place in consolidated urban areas. Source: Google Street View.

Figure 4.4: Urban configurations of DS-19 developments

2019). Sabatini et al. (2018) criticize that many projects continue to be located in amenity-poor areas, thus preserving ineffective patterns from previous programs and casting doubt on their ability to achieve social integration. This critique is relevant when discussing the overall achievements of reducing segregation on various social issues (Miltenburg et al., 2018) as this is correlated with lower educational attainment (Bischoff & Reardon, 2014; Chetty et al., 2016; Lichter et al., 2015), increased crime rates (Massey, 1995), both physical and mental health issues (Chetty et al., 2016; Jeffrey Kling et al., 2007), reduced economic mobility, poorer job outcomes (Chetty et al., 2016; H. Li et al., 2013), and greater income inequality and poverty (Ananat, 2011; Watson, 2009). However, the policy's accessibility and architectural requirements introduce amenities like green areas and gated communities, enhancing safety and potentially aiding neighborhood revitalization, as seen in Figure 4.1.

Despite the long-established benefits of policies aimed at social integration, they also present various challenges. Homophily[8] play a relevant role. Low-income households experience more substantial income improvements when they move to integrated developments in middle-income areas rather than in affluent districts due to enhanced social interactions and opportunities for establishing networks (Galster et al., 2010; Miltenburg et al., 2018). Conversely, affluent families tend to follow their socioeconomic group, even to new developments in poorer neighborhoods that border affluent areas (Guerrieri et al., 2013), a phenomenon partially explained by the role of amenities (Couture & Handbury, 2023).

Due to these counteracting forces, it is worth asking what happens when incentives aim to

[8]Homophily is the principle that contact between similar individuals occurs at a higher rate than among dissimilar individuals. This concept explains how similarities in characteristics such as race, age, gender, and socioeconomic status lead to the formation of social ties and networks (McPherson et al., 2001)

attract middle-income and upper-middle-income households to low-amenity neighborhoods located on the outskirts of cities. The DS-19 approach contrasts with the mainstream housing policies, as policymakers usually try to incentivize low-income families to move to better neighborhoods through policies such as HOPE and Moving to Opportunity (MTO) in the U.S. and others targeting social integration in Europe.

The architectural requirements and replacement of the housing stock in DS-19 projects can enhance amenity values, thereby making these developments more attractive by incorporating features such as green spaces and gated communities that improve safety. Although this is not the main objective of the Low-Income Housing Tax Credit (LIHTC), the policy has effectively reduced metropolitan segregation through new affordable housing developments in deprived districts (Freedman & Mcgavock, 2015; Horn & O'Regan, 2011), triggering urban renewal processes and changes in the demographic composition (Baum-Snow & Han, 2019; Diamond & Mcquade, 2019). A key mechanism to explain these changes is that new subsidized housing units tend to replace the old stock or that they are built in underutilized land (Ooi & Le, 2013; Schwartz et al., 2006; Zahirovich-Herbert & Gibler, 2014).

Along with the direct impacts of new affordable housing, the spillover effects also pose an interesting empirical question. If these projects successfully attract more population, the potential for neighborhood transformation increases significantly. Research has indicated that investments in distressed areas can draw higher-income groups seeking improved amenities and renovated spaces (Bayer et al., 2007; Diamond, 2016; Handbury, 2021). However, not all investments guarantee success; for instance, González-Pampillón et al. (2020) observed minimal effects from an urban renewal program in Barcelona that aimed to attract high-income residents to deprived areas, concluding that investments in public spaces alone might be inadequate for achieving social mixture.

Furthermore, suppose the benefits provided by the amenities outweigh the negative aspects and local supply constraints. In that case, increased demand from more affluent families could likely drive local prices up. There is an extensive literature body indicating that housing prices generally rise when place-based policies are enacted in distressed areas (Baum-Snow & Marion, 2009; Diamond & Mcquade, 2019; Hilber & Turner, 2014; Rossi-Hansberg et al., 2010; Schwartz et al., 2006) or when there are subsidies in low- and middle-income neighborhoods bolstering demand(González-Pampillón, 2022). However, Hilber and Turner (2014) and Carozzi et al. (2020) have pointed out that the impacts on prices and the creation of new units are heavily dependent on local factors such as land availability and regulatory constraints.

Thus, a national subsidy applied across various cities simultaneously provides a valuable case study for discussing these dynamics. Since the policy is applied nationwide, the heterogeneity across cities can also be tested. The housing deficit is predominantly concentrated in metropolitan areas where housing prices exceed those in smaller municipalities; hence, this can make DS-19 developments more appealing to educated families with a limited budget. Considering that it takes, on average, more than five years to utilize a housing voucher in Chile, due to the disparity between the limited supply of affordable housing and its high demand[9], the policy can also lead to heterogenous results across the country, being expected that the impacts should be larger in large cities.

In synthesis, through improved amenities, DS-19 can attract more affluent families to underserved districts. If the policy bolsters social integration, it can be expected that the outcomes will be more intense in large cities, where affordable housing is scarcer. In that case, housing prices should also increase due to higher demand and developments with larger amenity values.

4.3 Data

For the empirical analysis, I construct a panel dataset by assembling various geocoded sources. I utilize a georeferenced dataset of DS-19 projects at the block level, which I aggregate and match with socioeconomic census data from the years 2002, 2012, and 2017 at the census tract level[10]. Additionally, I incorporate characteristics of the built environment, such as proximity to different public services, and the *UAI-IBT* index, which normalizes block variables concerning socioeconomics, environment, safety, and access to public services. Finally, I integrate IRS data and *Transsa*'s property appraisals to capture changes in housing characteristics and prices.

4.3.1 Data Sources

The analysis employs geolocated data from DS-19 projects across Chile, detailing the polygon, the number of units, and the year of implementation from 2014 to 2017[11]. Due

[9]More details on interviews to experts can be found here
[10]This is the lower level of aggregated geography available, as data at the block level is not publicly available.
[11]Even though the first application deadline was in 2015, the process allowed to apply developments with less than 25% built

to limitations in other data sources, these were aggregated at the census tract level (*Zonas Censales* in the Chilean Census) to integrate demographic and spatial information.

Sociodemographic data were obtained from 2002, 2012[12], and 2017 Census. This data includes tract-level information on households and individuals, such as educational attainment and family size, among others.

This paper evaluates the first wave of DS-19 developments, as there is no further information about the population after the 2017 Census. I also capitalize on this temporal limitation by using the developments from 2018 to 2021 as the not-yet-treated control group in my robustness checks. Due to the timeframe of the analysis, certain census tracts were omitted since they were not populated—or were inhabited by only a few households—during 2002.

The primary outcome variable in this study is educational attainment, used as a proxy for socioeconomic status that accounts for social capital while avoiding short-term income shocks volatility (Garreton et al., 2020; González-Pampillón et al., 2020; Ruiz-Tagle & López M, 2014). Although educational attainment does not fully explain income in the wealthiest decile, this study primarily focuses on low- and middle-income groups, for which educational attainment is a good proxy (Garreton et al., 2020).

Educational achievements are categorized by the highest level attained by household heads: high-school diploma or less, technicians (similar to a 2-year associate degree in the US), and college graduates or higher. This categorization reflects significant homophily distinctions within Chilean society, where families with college degrees tend to segregate from those with lower educational attainment (Bargsted et al., 2020).

The DS-19 data were cross-referenced with their respective certificates of occupancy to ensure the inclusion of only those implemented before the 2017 Census. Many projects were clustered within the same census tract, reflecting different development phases. Tracts with a population smaller than 1,000 inhabitants were excluded to avoid confounding estimators (Garreton et al., 2020), along with some outliers having more than 8,000 inhabitants. This filtering process resulted in 70 census tracts with DS-19 projects and 502 adjacent tracts. To minimize potential spillovers and confounding factors, I established a 1-kilometer buffer zone between the adjacent tracts and the rest of the cities, resulting in 1,573 potential control areas. The geographic scope of the study spans from the Atacama to Puerto

[12] It's worth mentioning that the 2012 Census was invalidated due to omission errors; nevertheless, this dataset has been used by other academics (Garreton et al., 2020) since the exclusion rates were about 5% on average, meaning that the information contained is more comprehensive than other surveys used in the housing literature

Montt regions, excluding extreme regions that operate with different rules and development trends. This led to the exclusion of 34 out of the 606 projects developed during this period.

To add neighborhood amenities, I use different datasets. First, I utilize the *"Matriz de Bienestar Territorial"* provided by Universidad Adolfo Ibañez (IBT-UAI index), which is a cross-section of normalized block indexes collected from official sources collected in 2017 and then updated by the University team. This dataset includes details such as property crimes, green areas, and housing quality, to name a few.

Additionally, I added geocoded local public goods, specifically green areas, health, education, and transit facilities, sourced from Open Street Maps and processed through QGIS. These amenities are particularly significant as they help to calculate the distance requirements stipulated by the policy. Moreover, the municipalities were categorized by size, with the three largest metropolitan areas in Chile identified in a distinct category.

I integrated the main dataset with data from the Internal Revenue Services (SII in Spanish) at the block level, which geocode was obtained thanks to the *ESE School of Business at Universidad de Los Andes.* This allowed for the calculation of the percentage of available land and commercial areas per census tract. I also utilized this data to track the number of units per block per semester, aiding in observing changes in the built environment over time. For this purpose, I employed the cadaster data from 2012 (prior to the policy implementation) to the first semester of 2018, which updates information until the end of 2017 that aligns closely with the census data used to analyze population dynamics[13].

Lastly, to study the effects of DS-19 on real estate markets I use SII information of housing units per block to understand potential changes in the stock due to the policy. Furthermore, I also use SII information on housing sales. To complement the analysis, and since subsidized sales should mechanically decrease the average, I utilize the dataset provided by *Transsa*, which includes appraisals conducted between 2012 and 2018 for housing that requested a loan. Although these records do not represent actual sales, Transsa holds one of the largest market shares in the residential sector, with mortgage valuations forming a core part of their business. The geolocated dataset encompasses various details such as the municipality, appraisal value, square meters, year of construction, type of housing, and the date of valuation.

[13] I show development trends until 2019, to show the progression of real estate across time; nonetheless, all calculations are done until the end of 2017 to pair with the Census data.

4.3.2 Descriptive Statistics

Table 4.1 outlines the educational composition of the groups before the policy intervention, highlighting a significant increase over time in the proportion of household heads holding a college degree. This trend is likely influenced by the expansion of student loans and various policies aimed at increasing access to higher education through student loans (Gaentzsch & Zapata-Román, 2020). Demographic trends in DS-19 neighborhoods and their adjacent areas appear similar, with a notable prevalence of high-school graduates compared to potential control tracts. Interestingly, the share of college graduates in these areas is about half that of the potential control group, indicating a large disparity in educational attainment.

Table 4.1: Pre-trend descriptive statistics

	DS-19 Tracts [N=70]	**Adjacent Tracts [N=502]**	**Pot. Control [N=1,573]**
Pctg. High School 2002	78.6	77.64	69.61
Pctg. High School 2012	80.56	79.48	68.57
Pctg. Technicians 2002	5.7	6.2	7.82
Pctg. Technicians 2012	7.32	7.32	8.38
Pctg. College Degree 2002	6.8	8.01	15.7
Pctg. College Degree 2012	12.12	13.2	23.05
Dist. Green Area	1.07	0.94	0.83
Dist. Kindergarten	0.58	0.46	0.63
Dist. Health	1.11	0.77	0.88
Dist. School	0.58	0.38	0.41
Dist. Bus Stop	6.65	3.53	1.68
Pctg. Commercial	6.36	5.77	9.98
Pctg. Undeveloped	44.03	26.99	18.1
Pctg. Residential	48.33	66.14	68.04
m2 Green Area Munic.	2.41	2.75	3.9
m2 Green Area Tract	10.68	5.45	6.29
Tract density 2002	23.28	58.68	68.32
Tract density 2012	31.05	67.61	72.78
Tract Pop 2002	2,669.36	2,980.35	3,074.56
Tract Pop 2012	3,671.23	3,473.25	3,269.71
Average Sale 2012-2014	1,370	1,086	1,570
Size (m2)	63.1	61.1	71.2

While there are convergences in the distance to public goods and the share of commercial areas between the study groups, more pronounced differences are observed in access to green spaces and health institutions. However, despite these disparities, the average distances to overall amenities still meet the DS-19 location requirements for all groups, as these criteria are consistently met across a significant percentage of urban areas in various regions (Ruiz-Tagle & Romano, 2019). A crucial distinction among the groups is the percentage of undeveloped land and population density. DS-19 areas, having more available land and lower density, exhibit a higher ratio of square meters of green space per inhabitant at the tract level.

The population growth in areas that received the intervention surpasses that in adjacent and other tracts, which show more stability over time. Structural differences between the groups suggest that they are not directly comparable, indicating that traditional methods like the ring approach may not be the most effective strategy for this analysis. Housing prices significantly differ between groups. Although the DS-19 and its adjacent tracts exhibit a similar trend in sales and size, the rest of the districts show higher prices and larger average household. Such structural differences between the groups suggest they are not directly comparable, indicating that traditional analytical methods like the ring approach may not yield the most accurate insights for this analysis.

Lastly, as shown in Figure 4.5, the number of housing units also shows disparities between treated and their adjacent blocks and tracts after enacting the DS-19 policy. As seen in the figure, there is a steady trend of units between 40 and 50 units per block; however, after the policy, the treated blocks increased their stock up to 80 dwellings on average, suggesting the arrival of new developments there.

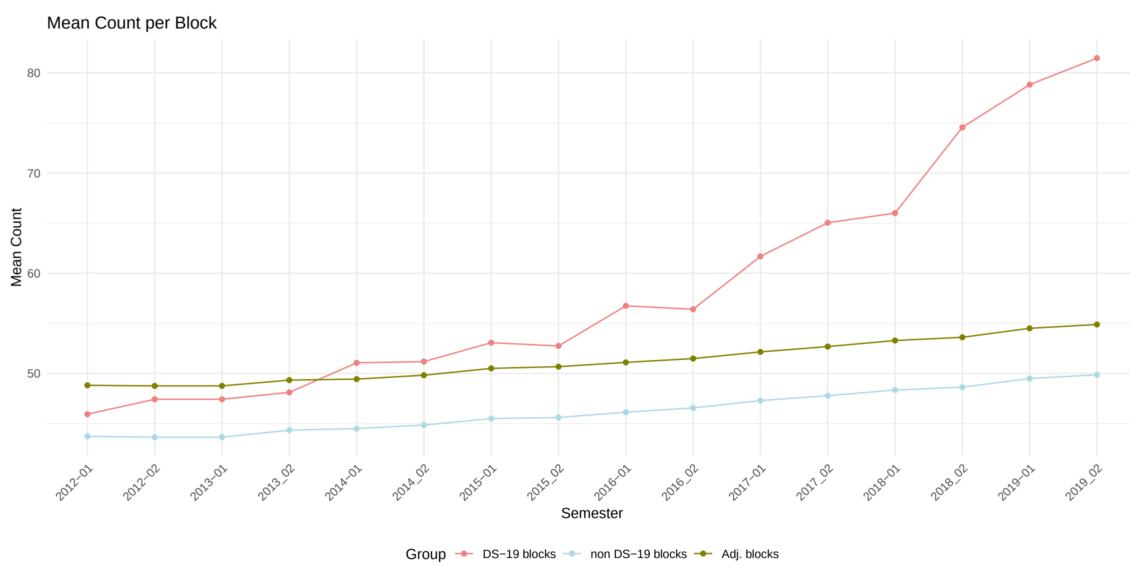


Figure 4.5: Mean number of housing units per block

4.4 Empirical Strategy

Before advancing to my main specification to assess the causal impacts of DS-19 on population dynamics, I first verify that DS-19 projects drive the observed changes within the treated tracts. This preliminary analysis employs a simple regression, using block-level data within tracts, to determine whether changes in housing units are attributable to the policy intervention. This approach helps establish a basis for assuming that any observed changes in population dynamics are also linked to these new units. To this end, I employ the following baseline model:

$$Y_{it} = \beta * DS19_i * Post_{t \geq 2015} + \mu_i + \gamma_t + \varepsilon_{it} \tag{4.1}$$

In the model, Y_{it} represents the residential housing stock per year-semester per block. $DS19_i$ is a binary variable, assigned a value of 1 for blocks that received a DS-19 development and 0 for blocks in the same tract; similarly, I run a second set of regressions comparing the non-treated blocks with the adjacent tracts to trace difference outside of these developments too. μ_i represent census tract and γ_t semester-year fixed effects. Finally, the regression clusters standard errors by census tracts to account for potential spatial correlation in the location of affordable housing.

As indicated in Table 4.2, between 2012 and 2017, there was an addition of about 13 units in the DS-19 blocks. In contrast, there are no significant changes between the non-treated blocks and the adjacent tracts. This result suggests that development trends are strongly associated with the implementation of DS-19.

Table 4.2: Change in housing units per block after DS-19

	DS-19 Tracts	Adjacent Tracts
DiD	13.180***	1.072
	(3.085)	(0.771)
Num.Obs.	275,66	176,082
R2	0.243	0.282
Note: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$		

Note: The table shows the regression results of Equation 4.1 on DS-19 blocks within the same tract and when compared non-treated DS-19 blocks with adjacent areas. Semester and Census tract fixed effects.

As shown in Figure A4.4, event study plots strengthen the hypothesis, as the trends for both groups are similar prior to DS-19; nonetheless, there is a steady positive trend in the treated blocks after 2015, which increased up to 40 units on average after three years of implementation. These results support the idea that changes in the housing stock are driven by new elopements that place only in DS-19 areas.

4.4.1 The impact of DS-19 on population dynamics

In this section, I assume that if new affluent households arrive in these neighborhoods, they are more likely to buy in the new developments as these offer better amenities[14] As shown in the previous section, the changes in the housing stock are driven by the policy; therefore, under this assumption, the changes in the demographic composition should also be driven by it.

To measure the effects on population dynamics, I use the logarithm of the absolute number of residents in each group as the primary outcome variable. This variable over percentage-based metrics helps detect differences over time that shifts in group proportions may not be captured. For instance, a decrease in a tract's share could result from residents leaving the area or from an influx of other groups into the area, with both scenarios resulting in similar outcomes when analyzed through percentage-based metrics.

My identification strategy employs a difference-in-differences (DiD) model where the control group is defined using a propensity score matching algorithm. This algorithm accounts for heterogeneous neighborhood characteristics potentially correlated with developers' site selection and households' preferences for different amenities. This process is conducted separately for tracts that receive DS-19 projects and their adjacent neighborhoods, allowing for precise control group definitions for each. The baseline model for this analysis is specified as follows:

$$Y_{it} = \beta * TRT_i * Post_{t=2017} + \mu_i + \gamma_t + \varepsilon_{it} \tag{4.2}$$

In the model, Y_{it} represents one of the following variables: the logarithm of household heads holding (a) a high-school degree, (b) a technician qualification, or (c) a college degree. The treatment assignment variable, TRT_i, is dichotomous, assigned a value of 1 for (i) DS-19 areas and, separately, for (ii) their adjacent tracts, and is defined as 0 for each respective control group. $Post_{t=2017}$ is a binary indicator for the period following the policy implementation. The fixed effects μ_i account for place-specific differences across municipalities, such as budget allocations, socioeconomic status, and engagement in affordable housing and public goods provision. Additionally, γ_t represents time fixed-effects to control for

[14] I test this assumption in the next section.

macroeconomic variables and temporal trends, such as changes in educational attainment over time. The coefficient of interest is β.

As highlighted in the previous section, tracts that received the policy have specific characteristics that are relevant from developers' perspectives when developing affordable housing, such as density, available land, the presence of low-income households, and housing prices. Due to self-selection, the location of developments is likely to be non-random, influenced by these neighborhood characteristics (Diamond & Mcquade, 2019; Freedman & Mcgavock, 2015; González-Pampillón et al., 2020; Won, 2022). Similarly, households exhibit heterogeneous preferences that influence their location choices (Ahlfeldt et al., 2017; Baum-Snow & Marion, 2009).

To address these self-selection issues and the systematic differences between treated areas and the rest of each city, I employ a propensity score matching approach. This approach considers the likelihood of treatment conditional on program requirements such as location thresholds and municipal size.[15] The counterfactual scenario also considers neighborhood characteristics and municipal variables that serve as proxies for developers' and households' preferences, such as the percentage of land used for residential and commercial purposes, available land for development, population density, and green areas among others[16].

This matching process creates a modified sample in which systematic differences in observed covariates are minimized by accounting for the relationship between neighborhood attributes and treatment assignment (Austin, 2011; Won, 2022). As noted, this procedure is conducted separately for DS-19 tracts and their adjacent areas. The following equation defines the model for treatment selection:

$$Pr(TRT_i \mid X_i) = f(DS19_i, GA_i, Undev_i, Comm_i, Pop_{it},\ Pop\ dens_{it}, City_i, City\ pop_i) \tag{4.3}$$

Within the model, $DS19_i$ is a vector of location attributes defined by policymakers to grant DS-19 status, including distances to green areas, health centers, schools, kindergartens, and bus stops. GA_i represents the square meters of green areas per inhabitant at both the census tract and municipality levels. $Undev_i$ refers to the proportion of undeveloped land within the tract, while $Comm_i$ denotes the percentage of land used for commercial purposes in the neighborhood. Pop_it captures the population of the tract in 2012 as well as the population change from 2002 to 2012. $Pop\ dens_{it}$ measures population density for

[15]From a policy perspective, this variable is of interest because each project receives a score boost when placed in municipalities with a population above 40,000 inhabitants.
[16]I don't use housing prices as I test the impacts of the new developments on this variable.

the year 2012 and the change in density from 2002 to 2012. $City_i$ is a vector of binary variables distinguishing between metropolitan, medium, and small cities, and $City\ pop_i$ indicates the municipality's population in 2012, which is used to assign additional scores in DS-19. These variables aim to control for pre-treatment neighborhood dynamics and location attributes, providing a counterfactual that reflects development trends over time.

Figure A4.4 illustrates the spatial distribution of the control group matched to the treatment areas, while the demographic and neighborhood characteristics are detailed in Table 4.3. Most variables are well-balanced between the treatment and control groups, with the notable exception of green areas per tract. This discrepancy is significant, as it potentially influences developers' and households' preferences for space. The presence of large green areas in peripheral locations of DS-19 projects—primarily consisting of undeveloped land rather than formal parks—is illustrated in Figure 4.4. Further details on balancing and covariate densities for both treatment groups are provided in the appendix.

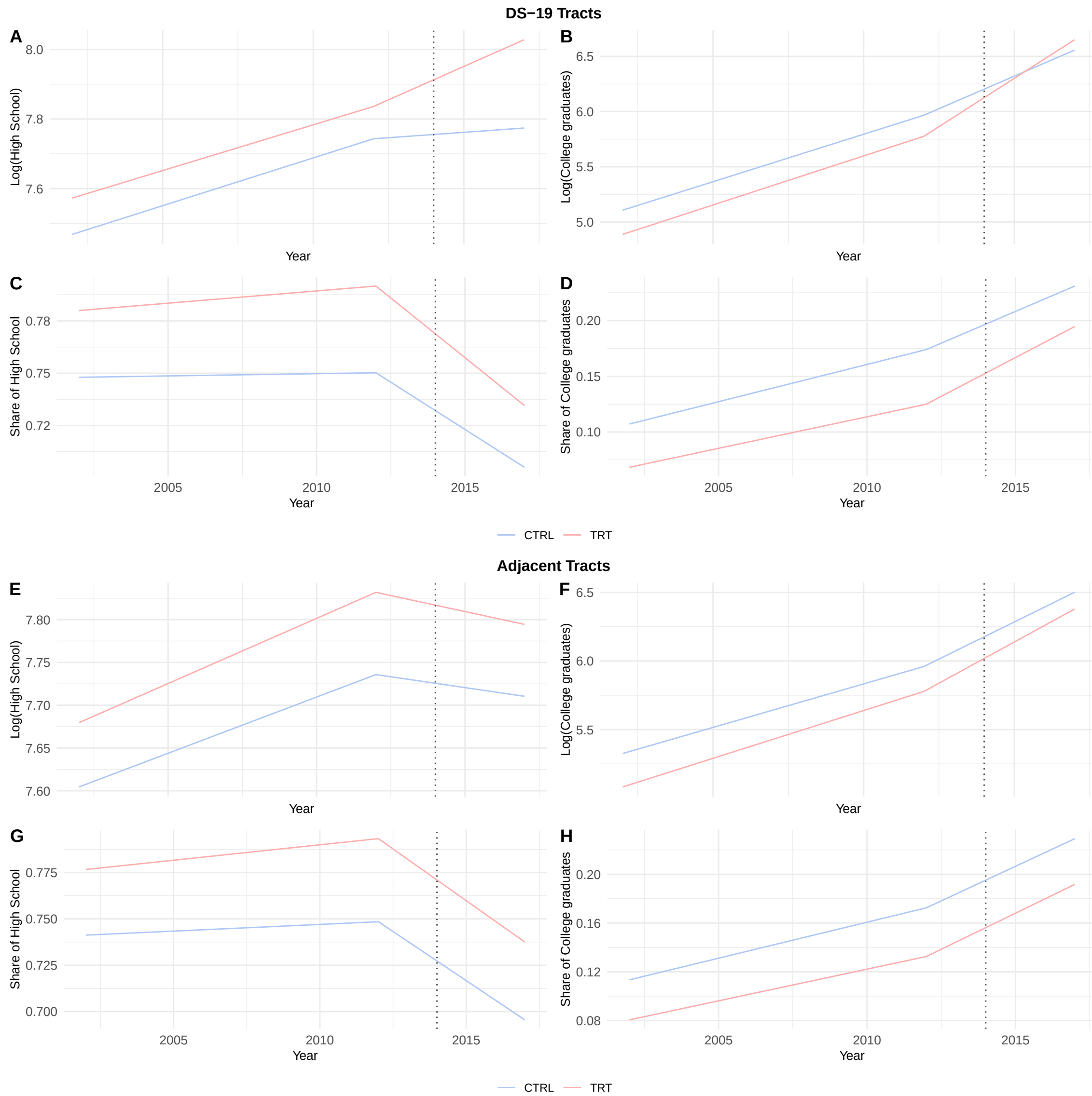
Table 4.3: Balanced sample for the DS-19 and the adjacent tracts

	DS-19 [N=63]			**Adjacent [N=441]**		
	TRT	**CTRL**	**t-test**	**TRT**	**CTRL**	**t-test**
Dist. Green Area	1.11	1.38	0.13	0.93	0.96	0.54
Dist. Kindergarten	0.64	0.71	0.49	0.48	0.5	0.37
Dist. Health	1.17	1.25	0.69	0.93	0.98	0.68
Dist. School	0.57	0.65	0.37	0.38	0.4	0.27
Dist. Bus Stop	6.76	6.46	0.9	4.26	5.26	0.23
Pctg. Commercial	6.3	5.61	0.62	5.89	6.16	0.66
Pctg. Undeveloped	39.21	42.47	0.54	23.34	24.25	0.62
m2 Green Area Munic.	2.39	2.33	0.88	2.76	3.03	0.21
m2 Green Area Tract	11.22	5.47	0.05	5.3	5.23	0.91
Tract density 2002	24.24	23.66	0.89	59.81	55.52	0.15
Tract density 2012	30.47	30.97	0.92	67.18	62.81	0.19
Tract Pop 2002	2,717.60	2,595.08	0.54	3,986.52	2,975.53	0.88
Tract Pop 2012	3,498.08	3,343.73	0.48	3,396.26	3,368.73	0.71

I begin by presenting graphs that show reasonably parallel pre-intervention trends between treated tracts and control groups, establishing a stable baseline for comparison (Figure 4.6). Before the DS-19 policy implementation in 2015, population percentages and logged variables exhibited similar behavior across both groups.[17] However, after the policy was introduced, the trends suggest an influx of residents into DS-19 neighborhoods compared to controls, as highlighted in panels A and B of Figure 4.6. Lastly, the adjacent tracts

[17] A placebo test conducted on these pre-policy periods confirmed no significant pre-existing differences in the variables of interest.

exhibit similar behavior between treated and control groups. In the following sections, I present reduced-form estimates of the magnitudes of these effects.



Note: The plot shows the average value for the share and logarithm of college and high-school graduates in the treated and adjacent tracts.

Figure 4.6: Population trends

Table 4.4 summarizes the results from estimating equation (1) on population dynamics within the treated groups. There is a 30% increase in individuals with a college degree moving to these areas compared to their counterfactual—a rate that doubles that of high-school diploma holders and slightly exceeds that of technicians; both findings are statistically significant. These dynamics align with the DS-19 projects' design, which includes a quota of 20% to 30% for low-income units. This suggests that for every household with a high-school degree moving into these neighborhoods, nearly two college graduates or technicians are also relocating there. This pattern also supports the idea of the projects predominantly driving the changes in the treated neighborhoods. Interestingly, adjacent tracts show minimal significant changes, with a slightly significant 9% increase in the influx of more educated households, indicating a modest spillover effect from the policy.

Table 4.4: Regression on population dynamics.

	Log(Coll)	Log(Tech)	Log(HS)
Panel A: DS-19 Tracts			
TRT*Post	0.298***	0.236***	0.155***
	(0.103)	(0.07)	(0.06)
Observations	378	378	378
R^2	0.605	0.444	0.257
Panel B: Adjacent Tracts			
TRT*Post	0.091*	0.029	-0.002
	(0.052)	(0.024)	(0.02)
Observations	2,646	2,646	2,646
R^2	0.373	0.105	0.035
Note:	*p<0.1; **p<0.05; ***p<0.01		

Note: The Table shows regression results for Equation 4.2. It uses census tract and year fixed effects.

Given that the policy is implemented simultaneously across various Chilean cities, subsequent subsections will explore the heterogeneity of these effects by examining different city sizes and delving deeper into the dynamics among college graduate groups.

4.4.2 Heterogeneities by City size

Given the heterogeneity among Chilean cities, I refined the analysis from Table 4.4 by excluding small cities, which are generally less populated and less segregated than larger cities (Garreton et al., 2020). Moreover, according to the CASEN[18] survey, the housing shortage during the study period was predominantly concentrated in Chile's major metropolitan areas[19]. This suggests that in more constrained urban contexts, the willingness to move to new DS-19 projects might be greater compared to smaller cities where there is more available space to build new developments[20].

[18] The CASEN survey is the primary socioeconomic instrument developed by the Chilean government to provide a socioeconomic characterization of the population, with the housing shortage being one of the main results derived from it.

[19] More details about the housing shortage can be found in CASEN's official website: More details here

[20] I test for these differences in the mechanism section.

As shown in Table 4.5, the regression results are similar to those in Table 4.4, yet the effects are approximately three to four percentage points larger. Additionally, the spillover effect regarding the influx of educated individuals is statistically significant in larger cities, indicating a greater overall impact of the program in these areas.

Table 4.5: Regression on population dynamics for Metropolitan and mid-size cities.

	Log(Coll)	Log(Tech)	Log(HS)
Panel A: DS-19 Tracts			
TRT*Post	0.335***	0.283***	0.185***
	(0.116)	(0.078)	(0.064)
Observations	330	330	330
R^2	0.584	0.416	0.272
Panel B: Adjacent Tracts			
TRT*Post	0.130**	0.053**	0.012
	(0.053)	(0.023)	(0.021)
Observations	2,463	2,463	2,463
R^2	0.363	0.097	0.035
Note:	*p<0.1; **p<0.05; ***p<0.01		

Note: The Table shows regression results for Equation 4.2. It uses census tract and year fixed effects.

4.4.3 Heterogeneities by college degree

A second analysis categorizes college graduates to reflect the structure of Chile's higher education system. Chilean tertiary education varies significantly in duration across different fields of study. For example, degrees in law, engineering, and business administration typically require at least five years of study, compared to the four-year standard Bachelor of Science or Education degrees. Similarly, graduates from *Institutos Profesionales*[21] also generally study for four years and earn less than their counterparts from the longer programs.

Table 4.6 presents the results of these regressions, indicating that the policy impacts are more pronounced than previously observed, particularly in the adjacent tracts. Here, the influx of educated individuals with at least five years of college education is nearly equivalent to that in the DS-19 neighborhoods from Table 4.4. Moreover, these results align with those in Table 4.5, showing that the impacts in metropolitan areas are larger than in the overall sample.

[21] These are second-tier colleges where students receive a professional degree without obtaining a bachelor's degree

Table 4.6: Highly educated share of population – DS-19 tracts.

	DS-19 areas Log(Coll)	DS-19 Met. areas Log(Coll)
Panel A: DS-19 Tracts		
TRT*Post	0.312*	0.385**
	(0.167)	(0.183)
Observations	378	330
R^2	0.654	0.638
Panel B: Adjacent Tracts		
TRT*Post	0.218***	0.278***
	(0.082)	(0.084)
Observations	2,646	2,463
R^2	0.5	0.492
Note:	*p<0.1; **p<0.05; ***p<0.01	

Note: The Table shows regression results for Equation 4.2. It uses census tract and year fixed effects.

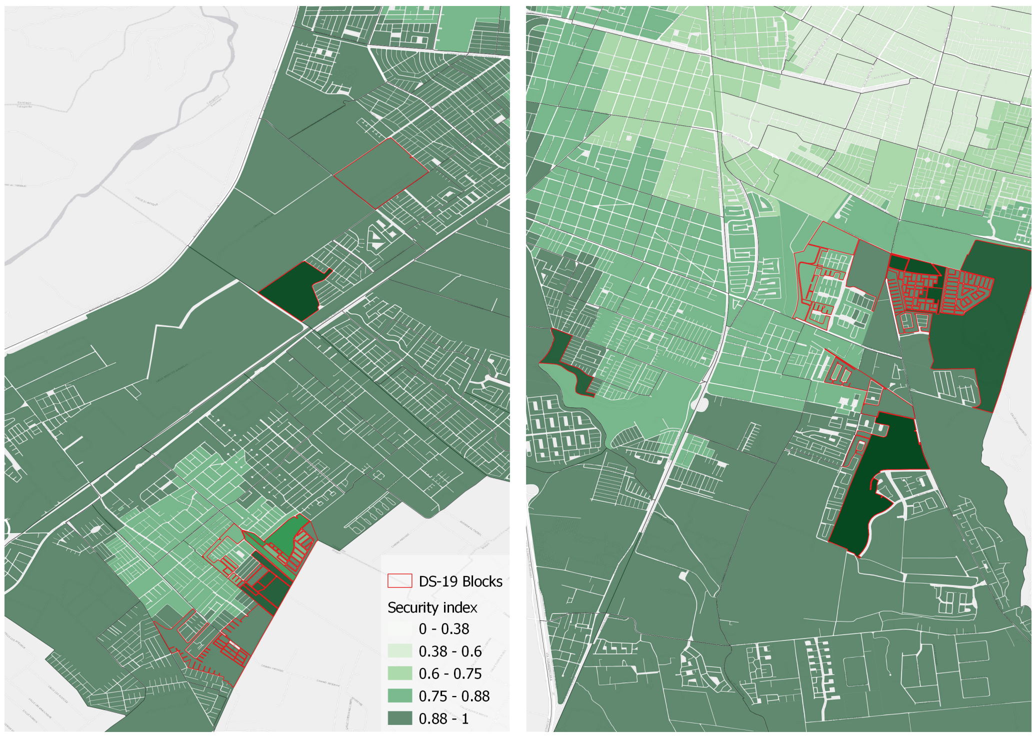
4.5 Mechanisms

In this section, I study two potential mechanisms to explain the impacts of DS-19 as well as the heterogeneities between city sizes. Specifically, I examine two potential drivers: differences in neighborhood amenities and the role of city size and supply constraints. First, I explore if the new developments are associated with better amenities, something that can help explain why more educated families would be willing to relocate to peripheral neighborhoods. Second, I study systematic differences between city size and their relationship to affordable housing, such as the probability of finding areas that comply with policy requirements about prices and size. If Garreton et al. (2020) hypothesis holds, then smaller cities should be less segregated; hence, social housing can be more scattered across a city, helping to explain why the results are less significant there.

4.5.1 Amenity improvements

To explore whether neighborhood amenities serve as a mechanism influencing more educated families to relocate to primarily peripheral developments, I utilized the UAI-IBT dataset, which provides detailed descriptions of various amenities at the block level, which are typically normalized from 0 to 1.

A significant limitation of the indexes is the cross-sectional nature, which does not permit an analysis of changes over time. Nonetheless, as demonstrated in the previous section, the modifications in the housing stock are driven by DS-19 projects, indicating that these initiatives likely induce new amenities as well. To further analyze this, I focus on variables associated with new developments, such as enhanced security features (e.g., gated communities), additional green areas, and improved housing quality. As illustrated in Figure 4.7, many blocks that received treatment show improved indexes compared to adjacent properties.



Note: The Figure shows the plot of the *IAU IBT index* for security levels per block. In red, the treated DS-19 blocks.

Figure 4.7: Security index per block

To test the differences between these groups, the following equation is used:

$$Y_{it} = \beta * DS19_i + \mu_i + \varepsilon_{it} \tag{4.4}$$

Within the regression model, Y_i represents the dependent variable, which could be any of the following: the security index reflecting property crimes and burglaries, the percentage of green areas per block, and housing quality. The treatment indicator, TRT_i, is a binary variable that takes a value of 1 for blocks within DS-19 treated areas and 0 for blocks within the next 250 meters to capture immediate differences. Then, the analysis also extends to compare the immediate blocks with the next 250 meters as a test for potential differences outside the DS-19 developments. Additionally, μ_i is included to account for tract fixed effects, which control for the inherent heterogeneity among treated areas.

Table 4.7 shows the results of estimating equation (4.4), showing that treated blocks enhance their security, add more green areas and slightly improve building quality. Consequently, DS-19 projects are a driving force behind the changes observed in the studied areas, contributing to demographic changes in these areas and in their vicinity. This improvement can relate to Guerrieri et al. (2013) hypothesis on how amenity improvements can attract more affluent families, which then make demographic changes endogenous as they also attract more educated households.

Table 4.7: Differences in Amenities

	Security		Green Areas	
	TRT-250 mts	0-500 mts	TRT-250 mts	0-500 mts
TRT	0.02^{***}	0.001	0.11^{***}	-0.011^{**}
	(0.003)	(0.002)	(0.01)	(0.005)
Observations	1,126	4,508	1,126	4,508
R^2	0.94	0.94	0.32	0.36
	Housing Quality			
	TRT-250 mts	0-500 mts		
TRT	0.01^{*}	0.002		
	(0.003)	(0.001)		
Observations	1,126	4,508		
R^2	0.24	0.32		
Note:			*p<0.1; **p<0.05; ***p<0.01	

Note: The Table shows regression results for Equation 4.4. It uses census tract fixed effects.

4.5.2 City size and supply-constraints

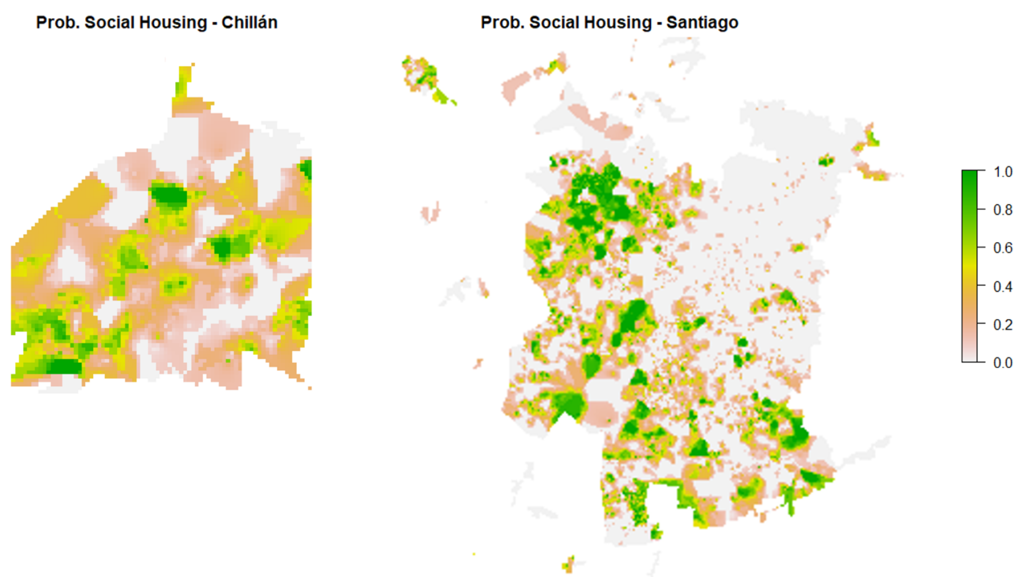
Given the heterogeneity among Chilean cities, I compare city sizes, as smaller cities are generally less populated and less segregated than metropolitan areas (Garreton et al., 2020). As shown in Table 4.8, there are significant differences between large cities and smaller municipalities, with the former having nearly triple the population size, as well as higher land scarcity and density.

As mentioned before, the housing deficit is concentrated in Chile's major metropolitan areas. To illustrate the systematic differences between groups, I analyzed residential sales data from 2017 in Santiago, the capital of Chile and Chillán, a smaller city with a high concentration of DS-19 developments. As depicted in Figure 4.8, the likelihood of finding

Table 4.8: Comparative statistics between different city sizes.

	Large	**Small**	**t-test**
Population 2012	215,195.30	86,207.73	***
Population 2017	232,511.40	111,401.40	***
Density 2012	79.1	33.68	***
Density 2017	81.42	34.52	***
Pctg. Commercial	8.88	7.51	***
Pctg. Office	3.2	1.94	***
Pctg. Available Land	18.8	29.48	***
Per capita m^2 green area	3.59	3.18	***

a housing unit with a sale price under UF 2,200 and a minimum size of 47 m^2 is higher and more widespread in Chillán compared to Santiago, where such options are primarily concentrated in peripheral areas outside the Central Business District (CBD) and the *Sector Oriente*, Chile's wealthiest region.



Note: The Figure plots the probability of housing sales below UF 2.200 and size over 47m^2. The plot is an IDW extrapolation. Sales are categorized as 1 if they meet both criteria and 0 if not.

Figure 4.8: Probability of DS-19 in Chillan and Santiago

The spatial distribution of likely places suitable for affordable housing suggests that smaller cities like Chillán, which are less segregated and have more development opportunities, may experience less pronounced impacts from the DS-19. In these cities, average housing prices already align closely with those targeted by the policy. Conversely, in larger cities where land scarcity and housing shortages are more acute, there may be a greater willingness to move to new DS-19 projects. This aligns with theories that supply-constrained cities—proxied by limited land availability— experience higher price appreciations and, as shown in Chapter 2, they tend to concentrate in specific areas of the city. In contrast, smaller conurbations with more available land experience less price variation and affordable housing is more scattered.

4.6 Changes in housing prices

Lastly, given the new amenities and the arrival of more affluent families in these areas, a question remains about the impact of these projects on housing prices. To address this, I use IRS transaction data from 2012 to 2018 to study the impacts between treated and control areas, as well as the local effects between DS-19 blocks and the rest of the tract. Additionally, I examine potential spillover effects by comparing DS-19 blocks to the surrounding areas.

It is important to note that mechanical changes in DS-19 blocks are likely, as at least 20% of the new units are highly subsidized, which could drive prices down due to lower sale amounts. To test potential effects on market transactions, I also use Transsa's dataset on appraisals for the same period. Although these records do not represent actual sales, Transsa holds a significant share in the residential market, with mortgage valuations being a core part of their business.

To analyze the potential changes in property values, I employ a hedonic price model combined with a difference-in-differences approach structured as follows:

$$\ln(P_{it}) = \beta * DS19_i * Post_{t>DS-19} + X_i + \mu_i + \gamma_t + \varepsilon_{it} \tag{4.5}$$

In the model, $Ln(P_{it})$ represents the logarithm of housing sales prices for residential properties. $DS19_i$ is a dichotomous variable assigned a value of 1 for blocks within DS-19 projects and 0 for those on the outside. $Post_{t>DS-19}$ is a binary factor set to zero the month following the completion of a DS-19 project; μ_i accounts for place fixed-effects at the block level, capturing invariant local amenities, while γ_t denotes quarterly fixed-effects to adjust for time-specific variations. X_i includes specific characteristics of each property such as size (unit and land), age of the house, and building materials. Standard errors are clustered at the block level. The parameter of interest is β.

The regression results shown in Panel A and B of Table 4.9 reveal no significant effect in the overall sample for both the treated and adjacent tracts. However, when studying the local impacts on the treated blocks, there are interesting results that confirm the hypothesis about subsidized versus non-subsidized units. The IRS data shows a significant decrease in housing prices within these blocks, whereas Transsa's dataset shows the opposite trend. The nature of the datasets can explain this discrepancy: the IRS data includes transactions of highly subsidized units (with subsidies covering about 90% of the unit price), which drives reported prices down due to the low amounts paid. In contrast, Transsa's data relates to mortgage valuations, which are likely associated with properties receiving none or smaller subsidies as families seek financing to purchase their homes.

These results suggest that the new, more educated families are likely to appreciate the amenity enhancements brought by DS-19 projects, leading to higher property values in the market-rate segment and potentially triggering neighborhood transformation while attracting residents with higher educational levels. Interestingly, no spillover effects were observed in the surrounding blocks, indicating that the amenity value was captured solely by the new market-rate units within DS-19 projects.

4.7 Robustness checks

To address validity concerns regarding the results, I conduct three sets of robustness checks. First, I perform a placebo test excluding post-treatment observations from 2017 to check for any pre-existing trends. Next, to mitigate potential biases, I revisit the analysis in Table 4.4 by excluding projects developed during 2017, as these were completed near the time of the Census and could skew the results. Lastly, I re-run the same set of regressions using an alternative control group. Instead of employing a control group derived from a propensity score matching algorithm, I use projects that were not developed yet by the time of the Census as these tracts can help to avoid the self-selection challenges described before.

In the placebo experiment, I focus solely on pre-trend variations between the treatment and control groups prior to the policy implementation. The results, as displayed in Table A4.1, indicate that most of the dependent variables examined did not experience significant changes between 2002 and 2012. This consistency across time suggests that the policy's intensity did not vary significantly in most scenarios. The only exception was a marginally significant change in the share of high-school-educated individuals in the adjacent tracts; however, these estimates were minor and demonstrated low statistical power. Furthermore, the main group of interest is college graduate households.

Subsequently, I revisit the analysis in Table 4.4 by excluding all census tracts that received the treatment in 2017, close to the Census date. This adjustment allows more time for new

Table 4.9: Housing Prices

	Sample	Metropolitan	Non-metropolitan
Panel A: DS-19 tracts			
DiD	0.01	-0.02	0.02
	(0.04)	(0.08)	(0.05)
Observations	33,252	13,504	19,748
R^2	0.70	0.78	0.57
Panel B: Adjacent tracts			
TRT*Post	0.01	0.01	0.01
	(0.03)	(0.04)	(0.03)
Observations	137,553	78,685	58,868
R^2	0.69	0.72	0.65
Panel C: DS-19 Blocks (IRS)			
TRT*Post	-0.16**	-0.15**	-0.10
	(0.08)	(0.07)	(0.11)
Observations	17,798	4,633	13,165
R^2	0.73	0.81	0.69
Panel D: DS-19 Blocks (Transsa)			
TRT*Post	0.06	0.01**	0.002
	(0.04)	(0.005)	(0.02)
Observations	1,105	485	620
R^2	0.97	0.97	0.96
Panel E: Spillover			
TRT*Post	0.03	-0.02	0.04
	(0.06)	(0.08)	(0.07)
Observations	9,742	2,160	7,582
R^2	0.73	0.82	0.70
Note:		*p<0.1; **p<0.05; ***p<0.01	

Note: The Table shows regression results for Equation 4.5. It controls for housing characteristics such as size, building quality, construction materials. It uses blocks and time fixed effects. Standard clustered errors at the blocks level.

inhabitants to settle after project completion. The results, presented in Table A4.2, are highly consistent with the baseline findings, demonstrating that excluding them does not significantly alter the outcomes. The influx of more educated individuals remains nearly double that of those with only a high-school diploma or less, reinforcing the patterns observed in earlier results.

In a final robustness check, I replicate the analysis using projects developed after the 2017 Census as the not-yet-treated group, which share similar developer and household selection patterns. The results shown in Table A4.3 tend to be slightly higher than previously observed but consistent in the pattern of college graduates almost doubling high-school household heads. However, as indicated in Table A4.4, this sample is less balanced than the PSM approach. As can be seen, the distances to different amenities are similar; however, population dynamics are a bit different as the control group, the not-yet-developed areas tend to be denser and more populated and with more commercial areas, which might sign for more consolidated areas than those selected through matching algorithms. Hence, the first set of results is preferred.

4.8 Conclusion and Policy Implications

This chapter studied the short-run impacts of a pecuniary incentive in affordable housing policy on population dynamics and the built environment at the neighborhood level. The results show that the policy's incentives successfully attract more educated individuals to peripheral neighborhoods, with minor spillover effects observed among college graduates in adjacent areas. However, the efficacy of DS-19 is notably higher in metropolitan areas, where significant effects are seen across all groups, particularly among the most educated. This heightened impact can be attributed to land scarcity and the challenges associated with acquiring affordable housing in these regions.

The distinction between metropolitan and smaller cities emphasizes the importance of contextual factors in policy effectiveness. In larger cities, where supply constraints and higher demand intensify competition for housing, the DS-19 incentives appear to be more effective in attracting middle-income families to peripheral areas. This suggests that similar policies might need to be tailored to local market conditions to achieve optimal outcomes in different urban settings. These results are consistent with findings from Carozzi et al. (2020) and Hilber and Turner (2014) that also highlight how market conditions are relevant when discussing housing policy effectiveness.

In terms of mechanisms, the new projects appear to enhance neighborhood amenities such as security, green areas, and housing quality, which, in turn, lead to higher property prices in metropolitan regions where the housing deficit is most acute. These findings are consistent with studies by Baum-Snow and Marion (2009) and Diamond and Mcquade (2019), which suggest that building middle-income housing in economically disadvantaged areas can effectively reduce segregation, at least in the first wave of new developments. Additionally, the response of families to monetary incentives is particularly pronounced in areas facing higher levels of affordable housing scarcity and segregation; i.e., in metropolitan areas. The new amenities in the DS-19 projects not only benefits new residents but also has the potential to improve the quality of life for existing low-income households. However, a remaining question is if the different households interact as expected, which can be developed in further papers.

Overall, this study contributes to the housing and place-based policy literature. As opposed to the Neighborhood Act in Catalonia, which failed to attract high-income residents to deprived areas through investments in public spaces (González-Pampillón et al., 2020), the DS-19 policy has facilitated spillover effects to adjacent communities, enhancing neighborhood amenity values and influencing population dynamics and development trends. This can shed light on how new developments and investing in housing can help towards social integration, at least in the first wave of developments. Nevertheless, these results should be interpreted with caution, as they represent localized effects and do not encapsulate the general equilibrium conditions of the broader housing market in Chile. It is conceivable that these local effects might precipitate changes in other neighborhoods or cities, which are not captured in this analysis.

Future research could explore the long-term effects of the DS-19 policy on social integration and economic mobility, which was not possible by the time of this dissertation as the 2022 Census was postponed due to the pandemic and the social unrest in Chile[22]. While the short-run impacts are promising, it remains to be seen whether these changes lead to sustained improvements in residents' socioeconomic status and whether they can mitigate systemic issues such as segregation and inequality. Additionally, examining the policy's influence on other factors like education outcomes, employment opportunities, and health indicators could provide a more comprehensive understanding of its effectiveness.

[22]The 2022 Census is expected to be released in 2025-2026.

4.9 Appendix: Additional Tables and Figures for Chapter 4

4.9.1 Tables

Table A4.1: Placebo population - DS-19 areas.

	Log(Coll)	Log(Tech)	Log(HS)
Panel A: DS-19 Tracts			
TRT	0.394*	0.433***	0.313***
	(0.222)	(0.144)	(0.118)
Post	0.860***	0.483***	0.275***
	(0.061)	(0.067)	(0.053)
DiD	0.028	0.092	-0.012
	(0.102)	(0.096)	(0.072)
Observations	252	252	252
R^2	0.391	0.364	0.198
Panel B: Adjacent Tracts			
TRT	-0.121	0.006	0.084*
	(0.104)	(0.067)	(0.046)
Post	0.634***	0.305***	0.131***
	(0.033)	(0.031)	(0.022)
DiD	0.062	0.067	0.021
	(0.055)	(0.042)	(0.032)
Observations	1,764	1,764	1,764
R^2	0.18	0.103	0.04
Note:	*p<0.1; **p<0.05; ***p<0.01		

Note: The Table shows regression results for Equation 4.2. It uses census tract and year fixed effects.

Table A4.2: Drop in tracts with only projects developed in 2017 - DS-19 areas.

	Log(Coll) (48)	Log(Tech) (49)	Log(HS) (50)
TRT	0.466*	0.457***	0.249**
	(0.251)	(0.161)	(0.12)
Post	1.455***	0.596***	0.300***
	(0.083)	(0.063)	(0.047)
DiD	0.321***	0.234***	0.157**
	(0.108)	(0.074)	(0.065)
Observations	360	360	360
R^2	0.609	0.43	0.237
Note:	*p<0.1; **p<0.05; ***p<0.01		

Note: The Table shows regression results for Equation 4.2. It uses census tract and year fixed effects.

Table A4.3: Regression Results for DS-19 Areas - Not-yet-treated group

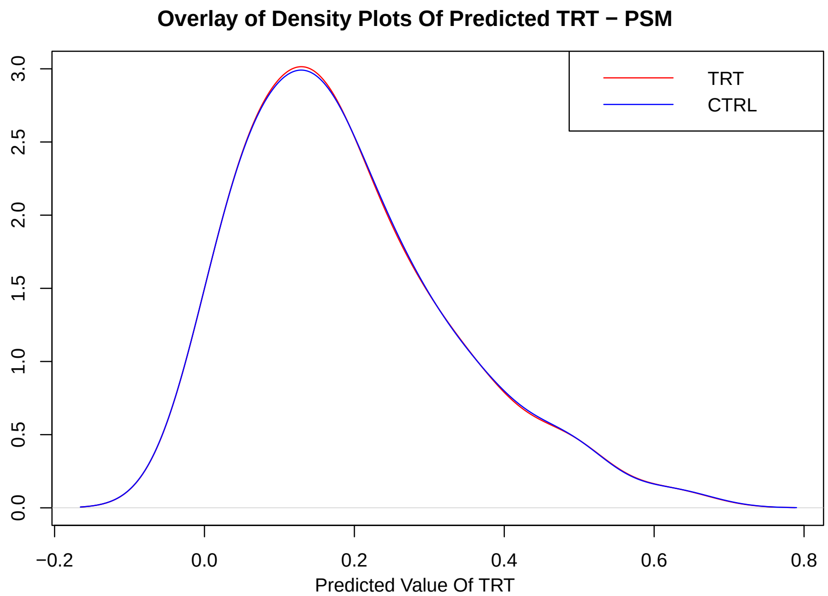
	Log(Coll)	Log(Tech)	Log(HS)
TRT	-0.267	-0.065	0.232**
	(0.17)	(0.155)	(0.096)
Post	1.41***	0.561***	0.236***
	(0.085)	(0.081)	(0.064)
DiD	0.371***	0.320***	0.238***
	(0.105)	(0.086)	(0.067)
Observations	372	372	372
R^2	0.675	0.395	0.262
Note: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$			

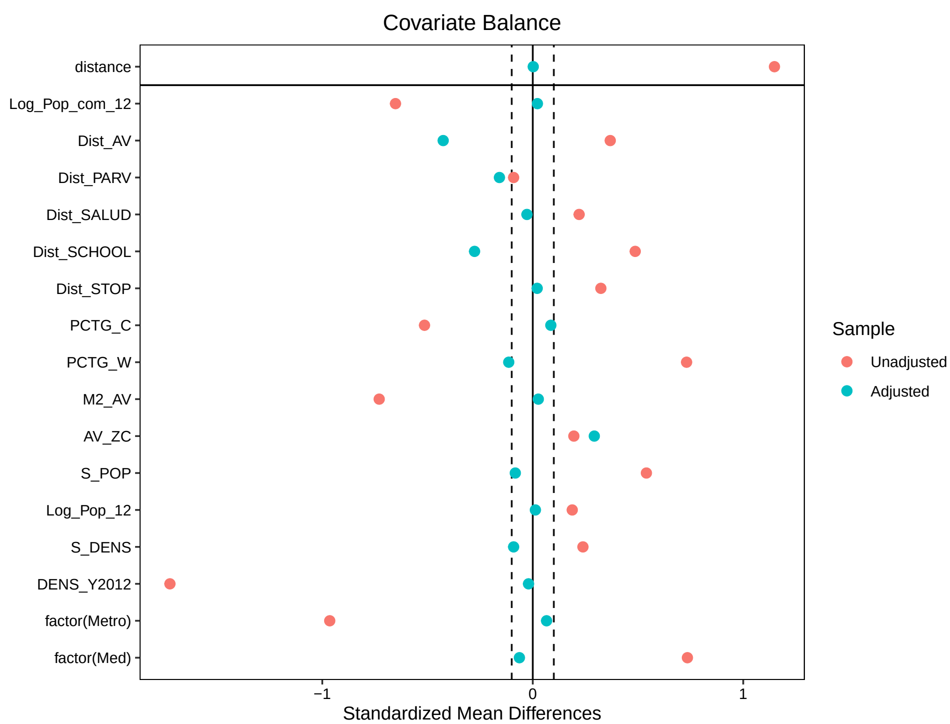
Note: The Table shows regression results for Equation 4.2. It uses census tract and year fixed effects.

Table A4.4: Balanced sample for the non-yet-treated group

	Mean TRT	**Mean CTRL**	**t-test (p-value)**
Dist. AV	1.11	1.38	0.4703
Dist. PARV	0.62	0.64	0.8973
Dist. Health	1.64	1.31	0.4831
Dist. Bus Stop	6.68	5.65	0.6937
Dist. School	0.57	0.55	0.8473
Pctg. Commercial	6.18	9.39	0.0994
Pctg. Undeveloped	44.17	36.82	0.1739
m2 Green Area	2.21	3.50	0.0339
m2 Green Area ZC	28,772.93	42,660.05	0.3993
DENS (2002)	21.62	32.38	0.0504
Log Pop (2002)	11.11	11.48	0.0305
DENS (2012)	29.23	36.81	0.2535
Log Pop (2012)	11.40	11.70	0.0817

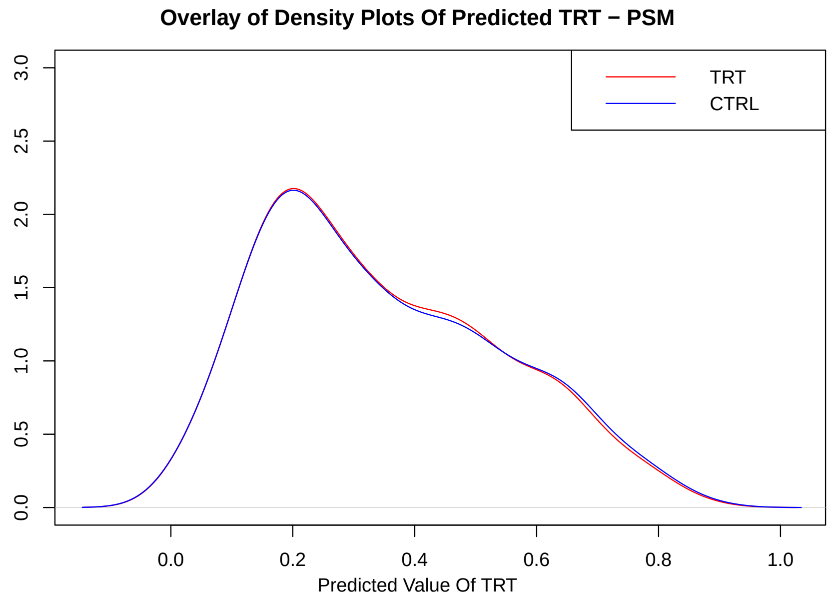
4.9.2 Figures

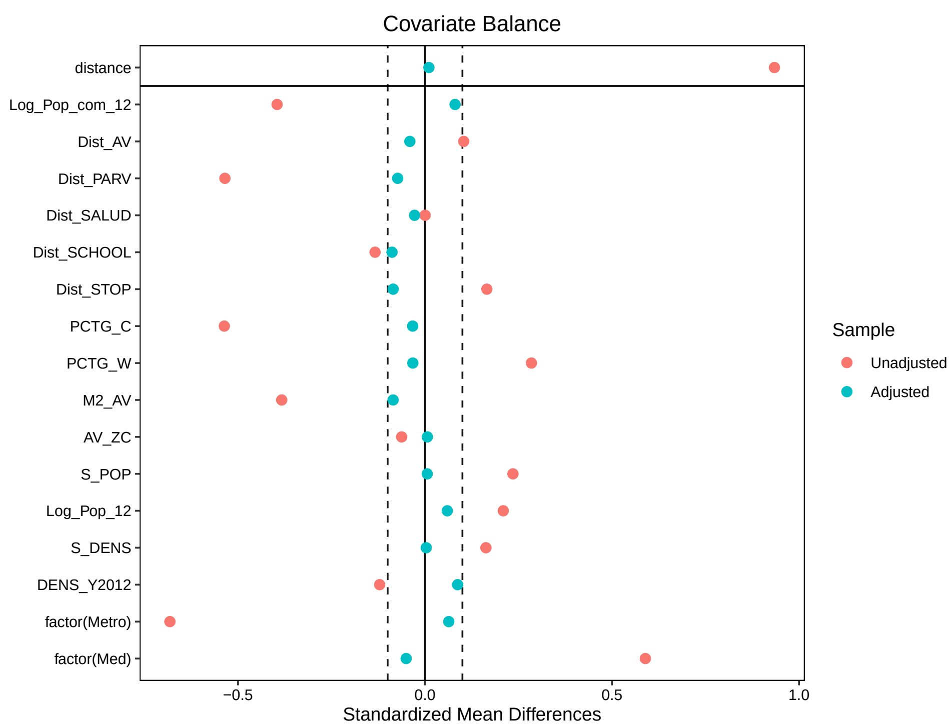




Note: The Figure shows the balancing test PSM. It shows the overlayed density plots between treated and controlled groups and the standardized differences of mean for the covariates.

Figure A4.1: Propensity Score Matching Results - DS-19 Tracts





Note: The Figure shows the balancing test PSM. It shows the overlayed density plots between treated and controlled groups and the standardized differences of mean for the covariates.

Figure A4.2: Propensity Score Matching Results - Adjacent Tracts

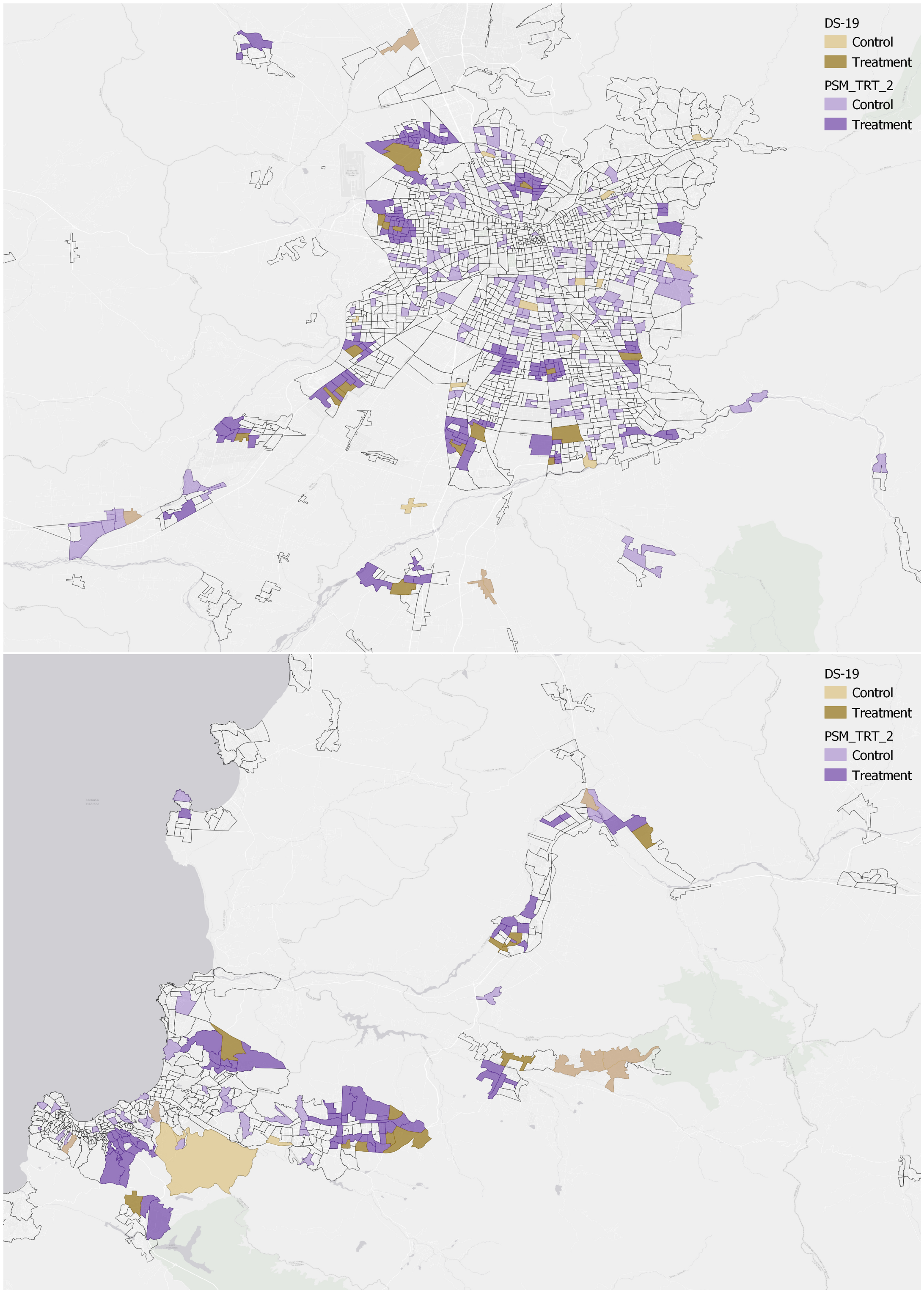
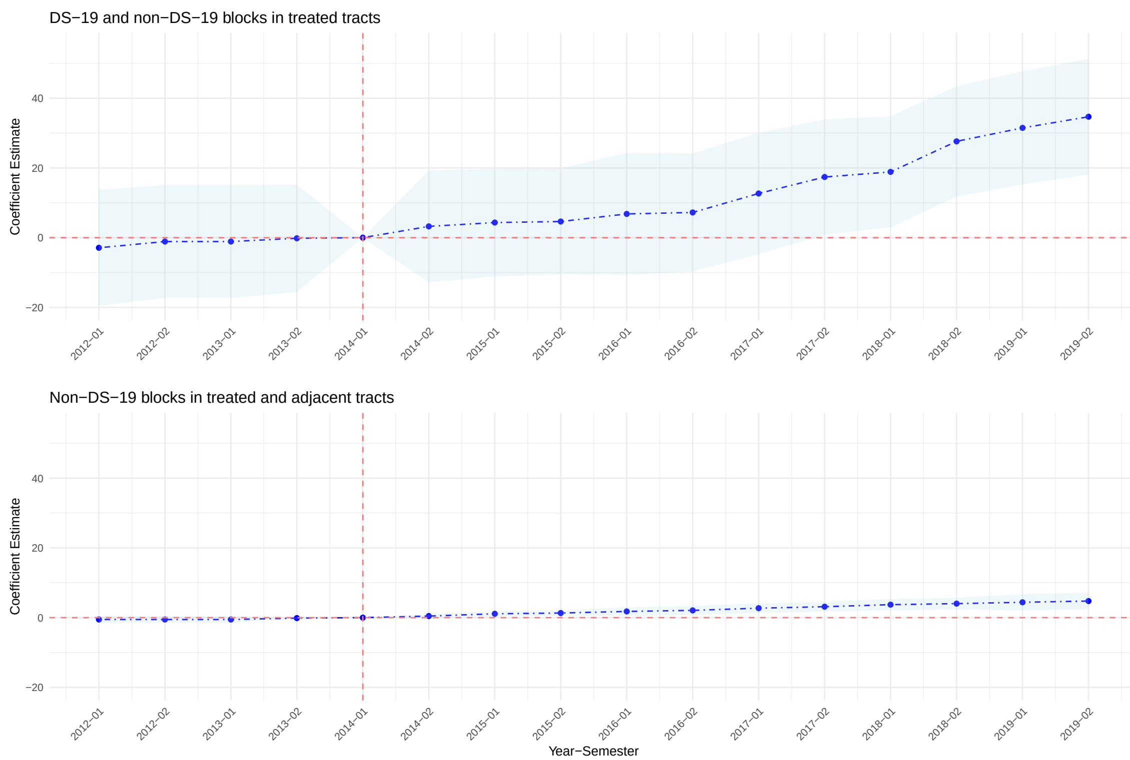


Figure A4.3: PSM Results in Region Metropolitana and Valparaiso



Note: The Figure shows the regression results of Equation 4.1 on DS-19 blocks within the same tract and when compared non-treated DS-19 blocks with adjacent areas. Semester and Census tract fixed effects. Standard cluster error at the Census Tract level.

Figure A4.4: Event study plot - Residential Units per block

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