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Abstract

Urban land-use regulations often balance environmental preservation with economic development, yet empirical evidence on their spillover effects remains limited, particularly in developing contexts. Since 2004, Tehran's municipal council has regulated construction on **private gardens** through two key policies: the Tower-Garden Act (2004–2017) and the House-Garden Act (2019–present). While officially intended to preserve urban greenery and generate municipal revenues, these regulations often accelerated garden destruction and dense construction.

Using a difference-in-differences framework applied to granular property transaction data from 2010 to 2019, linked with garden permit records at the 5-digit postal zone level, we find that garden destruction and redevelopment significantly capitalize into higher adjacent property prices. A one-hectare increase in destroyed garden area over a three-year horizon raises neighboring property values by approximately 2.9%, with long-term effects up to 4.7%. After controlling for local amenities and time trends, the effect attenuates to 1.4% but remains positive and statistically significant. Heterogeneity analyses reveal stronger positive effects in lower-income neighborhoods and for smaller gardens, suggesting that **private gardens** may function more as disamenities (e.g., due to neglect and insecurity) than amenities in certain contexts. These findings highlight the unintended consequences of permissive land-use policies in rapidly urbanizing cities, where economic incentives for redevelopment often outweigh environmental goals. Our study contributes novel evidence on **private green space** externalities, informing urban policy debates in land-scarce environments.

Keywords: Land-use regulation, urban green spaces, externalities, residential property values, Staggered difference-in-differences

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1. Introduction

Rapid urbanization in developing countries has intensified land-use conflicts, particularly between preserving urban green spaces and meeting housing demand (Brueckner, 2000; Glaeser and Kahn, 2010). Urban green areas provide important ecosystem services—such as air purification, noise reduction, and recreational opportunities—and are often regarded as "the lungs of the city" (Lin et al., 2018). Yet, in land-scarce and densely populated cities, these spaces are increasingly viewed as underutilized assets, attracting pressures for conversion into more economically valuable uses. Understanding how such land-use changes affect local property markets is critical for evaluating the trade-offs faced by policymakers and urban residents.

Tehran, Iran's capital and one of the most densely populated metropolises in the developing world, provides a unique case for studying these tensions. Private gardens have historically constituted a large share of the city's greenery, particularly in the northern districts. Over the past decades, however, these gardens have been subject to growing redevelopment pressure. To regulate conversions, Tehran's municipal council introduced the Tower-Garden Resolution (2004–2017) and subsequently the House-Garden Resolution (2019–present). Both policies sought to preserve greenery by restricting lot coverage (e.g., 30% under Tower-Garden, later reduced to 15% under House-Garden) while simultaneously generating municipal revenue through permit fees. In practice, critics argue that these regulations accelerated rather than prevented garden destruction, with the city's green coverage declining from around 5,000 hectares in 1959 to less than half by 2019.

Despite the importance of urban gardens in many developing cities, empirical evidence on their economic spillovers remains scarce. The urban economics literature has extensively documented capitalization effects of public green amenities such as parks and open spaces (e.g., Czembrowski and Kronenberg, 2016; Trojanek et al., 2018). However, much less is known about private green spaces, which differ in accessibility, maintenance, and social function. Unlike public parks, private gardens are often inaccessible to non-owners and may even impose negative externalities if neglected or insecure (Wolch et al., 2014). These distinctive features raise the question of whether the destruction of private gardens represents an unambiguous loss to urban welfare, or whether redevelopment may sometimes enhance neighborhood desirability.

This paper addresses this gap by providing causal evidence on the external effects of private garden destruction in Tehran. Leveraging spatial and temporal variation in municipal permits for garden conversion, combined with detailed property transaction data at the neighborhood level, we estimate how redevelopment of these green spaces affects adjacent residential property values. The quasi-experimental setting created by policy-induced conversions allows us to isolate the net spillover effects of garden loss, advancing our understanding of private green space externalities in rapidly urbanizing contexts.

Our contributions are threefold. **First**, we provide the first causal evidence on the economic spillovers of private urban garden destruction, extending the green space valuation literature beyond its traditional focus on public amenities. **Second**, we document how these effects vary across income levels and garden sizes, showing that the amenity value of green space is highly context-dependent. **Third**, we contribute to the broader literature on land-use regulation in developing cities by demonstrating how well-intentioned policies can generate unintended incentives for redevelopment. Together, these findings shed new light on the complex role of private ownership in shaping urban environmental outcomes.

The remainder of the paper is organized as follows. Section 2 reviews the related literature. Section 3 describes the data. Section 4 outlines the empirical strategy. Section 5 presents the results, heterogeneity, and robustness checks. Section 6 concludes with policy implications.

2. Literature Review

Land-use regulation has long been a central pillar of urban planning and economic policy, shaping not only the physical structure of cities but also the welfare of their residents. Early research emphasized how zoning laws, floor-area ratio (FAR) restrictions, and related regulatory tools affect density, housing supply, and urban form (Brueckner, 2000; Glaeser et al., 2005; Brueckner et al., 2017). While such policies were often intended to preserve urban landscapes or manage growth, empirical evidence shows that they can have unintended consequences, including higher housing costs, reduced affordability, and welfare disparities across neighborhoods (Quigley and Swoboda, 2007; Turner et al., 2014). More broadly, place-based policies—ranging from enterprise zones to affordable housing programs—have been shown to generate heterogeneous effects on local development, property markets, and social outcomes, sometimes improving welfare but often failing to achieve their intended goals (Neumark and Simpson, 2015; Rossi-Hansberg et al., 2010; Diamond and McQuade, 2019).

Within this broader literature, a large body of work has examined the role of urban amenities, particularly green spaces, in shaping property values and neighborhood welfare. Public parks, forests, and open spaces are consistently associated with positive capitalization into housing prices (Czembrowski and Kronenberg, 2016; Trojanek et al., 2018; Łaszkiewicz, 2023). Hedonic pricing models provide strong evidence that proximity to green amenities increases residential property values, with marginal willingness to pay varying by size, shape, and accessibility of green areas (Jim and Chen, 2009; Liebelt, 2017; Ramírez et al., 2023). For instance, Voicu and Been (2008) showed that community gardens in New York City raised property values, particularly in low-income neighborhoods, while Wen et al. (2015) and Trojanek et al. (2018) demonstrated that both environmental quality and spatial proximity to parks significantly affect land prices in Chinese and Polish cities, respectively.

These positive externalities, however, are not uniform. Several studies highlight that green amenities may also impose negative spillovers depending on their condition and context. Neglected or insecure green spaces can reduce neighborhood desirability by attracting crime or limiting social cohesion (Anderson and West, 2006; Wolch et al., 2014). Environmental justice research further suggests that urban greening policies can paradoxically increase housing costs and trigger displacement in disadvantaged areas, undermining equity objectives (Wolch et al., 2014; Branas et al., 2010).

Despite this growing literature on public green amenities, little empirical work has focused on private green spaces, such as urban gardens, which often dominate green coverage in cities of the Global South. Unlike public parks, private gardens are typically inaccessible to outsiders, and their welfare implications are ambiguous: they may function as environmental assets when maintained, or as disamenities when neglected or converted. The destruction of private gardens through land-use policies thus presents an underexplored but highly relevant case for understanding the trade-offs between environmental preservation and housing development. This study builds on three strands of research: (1) the economic effects of land-use regulation and place-based policies (Glaeser and Gottlieb, 2008; Neumark and Simpson, 2015); (2) the valuation of urban green spaces and their heterogeneous externalities (Voicu and Been, 2008; Trojanek et al., 2018; Łaszkiewicz, 2023); and (3) the mechanisms through which environmental amenities or their removal affect local housing markets. By focusing on Tehran's garden-to-building conversion policies, the paper contributes novel causal evidence on the spillover effects of private green space destruction—an area where existing studies remain scarce.

3. Data and Context

In this study, we compiled a dataset that integrates several sources of urban information for Tehran. Specifically, we collected housing transaction records, the geographic locations of urban gardens, the timing of their destruction and subsequent redevelopment, as well as the location and timing of newly opened public parks and metro stations. In the following section, each dataset will be described in greater detail.

3.1. Gardens Data

Dataset 1: Gardens and Construction Permits:

One of the key administrative procedures concerning urban gardens in Tehran is the process of filing and reviewing cases by the Gardens Commission (Article 7). Upon verification of the legal requirements (outlined earlier), the property is classified as a "garden." Once this classification is established, and if the owner initiates the process of obtaining a construction permit, demolition of the garden and subsequent construction activities may proceed, subject to relevant regulations. One of the decisive conditions in this process is the approval of the City Council, based on the supporting documents submitted by the property owner. In practice, all cases are referred to the Council, meaning that this dataset captures the universe of applications in which garden owners submit documentation to the municipality, leading to a final ruling on whether or not the property qualifies as a garden.

Dataset 2: Permits issued for gardens

The second dataset consists of construction permits issued for gardens during the period 2013–2024 , obtained from the Tehran Municipality's Center for Urban Studies. These records document the cases in which, following a "garden" ruling, property owners requested building permits and the municipality subsequently issued the relevant licenses. Common identifiers, such as case numbers and property identification codes, were used to link these data with the rulings dataset.

Dataset 3: Construction permits issued by the Deputy for Urban Development

A major challenge was the mismatch between the time horizons of the two datasets above. To address this, a third dataset was obtained from the Tehran Municipality's Deputy for Urban Development, covering all building permits issued across Tehran from 2001 to 2021. By merging these data, and again relying on shared identifiers, we were able to track properties that received a garden/non-garden ruling during 2002–2024, as well as properties in which actual construction occurred.

In order to enhance the accuracy and robustness of the analysis, properties that received a "non-garden" ruling but nonetheless undertook construction were treated as a **placebo group**. This strategy allows for a more precise identification of the effects associated with the garden-permit process, by contrasting legally recognized gardens with non-garden properties that nevertheless entered the construction pipeline. The descriptive analysis reveals that, given the regulatory framework for gardens, property owners face incentives to portray their assets as gardens. This behavior can be attributed to the relative legal advantages and regulatory leniencies embedded in the construction approval process for gardens. Compared with ordinary properties, the permitting rules for gardens appear to create incentives for strategic misrepresentation.

Moreover, it seems plausible that such properties possessed characteristics—geographic location, land-use type, legal status, or even visual similarity to genuine gardens—that led their owners to expect a higher likelihood of successfully obtaining a garden ruling. These properties therefore represent a distinct subgroup, offering important insights into how the institutional framework of permit issuance shapes owner behavior and strategic responses.

Dataset 4: The Garden Registry of Tehran

According to municipal regulations (as noted in the introduction), one of the responsibilities of municipalities is to compile a registry of urban gardens. In 2016 (1395), Tehran Municipality partially completed this registry. By merging these records with the datasets on rulings and building permits, we were able to construct an approximate profile of Tehran's urban gardens. Furthermore, these data were incorporated into the design of the study's indicators.

Data integration

Although the status of gardens and their corresponding permits can be identified for the entire period 2002–2024, our analysis window is constrained by data availability on real estate transactions in Tehran, which is only accessible for 2010–2019. Accordingly, the empirical study focuses on this period. Nevertheless, the descriptive statistics in the following section are reported both for the full dataset (2002–2024) and for the study period (2010–2019).

Finally, for the construction of the final database, property addresses were geocoded into spatial coordinates using the municipality's registry system. By integrating these geocoded properties with postal code boundaries and the garden datasets, we were able to identify the specific five-digit postal zones in which each garden is located, and to match them with corresponding real estate transaction data.

Limitations

One of the key limitations of this study is that while the precise locations of gardens are known, the exact spatial locations of property transactions are not. This limitation prevents an assessment of how the distance of real estate transactions from demolished gardens might affect market outcomes through spatial spillovers. Table 1 reports the summary statistics of variables related to gardens and construction activities over the period 2010–2019.

Table1 : Summary statistics of gardens data

Panel A (Gardens data 2010–2019)					
Variable	Obs	Mean	Std. dev.	Min	Max
Construction	4,129	0.21	0.40	0	1
Garden area (m^2)	4,125	2,612	6,826	104	272,401
Number of floors	518	10.85	4.69	1	30
Constructed size	518	40	52	0	426
Excess size	518	23	33	0	321
FAR (%)	468	41.55	16.06	4	100
Total number of gardens	4,129	16.60	13.47	1	78
Total area of garden (m^2)	4,129	43,589.54	80,640.67	240	487,594
Total number of constructions	4,129	3.24	3.62	0	21
Total area of construction (m^2)	4,129	9,781	23,777	0	182,936
Total rate of construction (number) (%)	4,129	18.65	18.54	0	100
Total rate of construction (area) (%)	4,129	19.12	20.98	0	100
Total rate of distruction (%)	4,129	1.08	1.45	0	10.39

Figure 1 illustrates the spatial distribution of gardens across Tehran, where garden sizes are classified into five categories and represented using a distinct color gradient. According to this map, the gardens under study are located within 711 unique postal zones, out of a total of 1,740 zones in the city, implying that approximately 41 percent of Tehran's postal zones contain at least one garden. The color-based classification by size further highlights patterns in the distribution of garden areas across the city. Larger gardens appear to be predominantly concentrated in the northern and northwestern districts of Tehran.

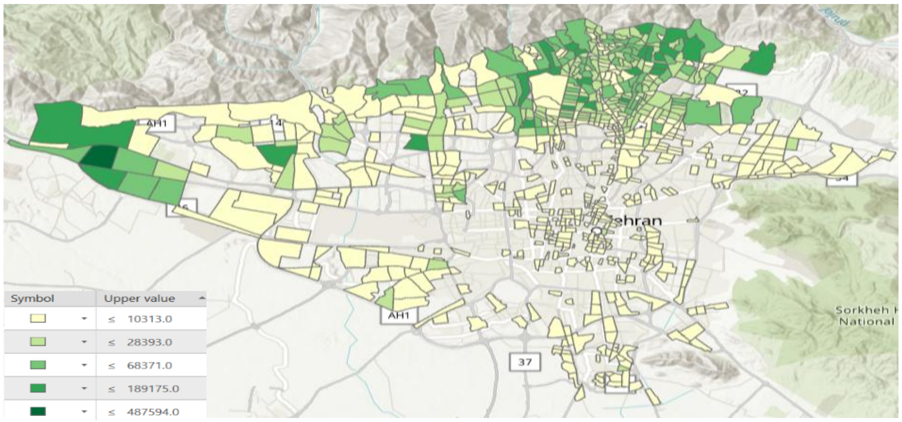

Figure 1: Spatial distribution of private gardens in Tehran by five-digit postal code.

Figure 2 depicts the spatial pattern of garden demolitions in Tehran at the level of postal zones. Red zones (317 in total) indicate the occurrence of at least one demolition during the study period, whereas green zones represent areas with no recorded demolitions. The spatial analysis suggests that garden demolitions have been disproportionately concentrated in the northern parts of the city.

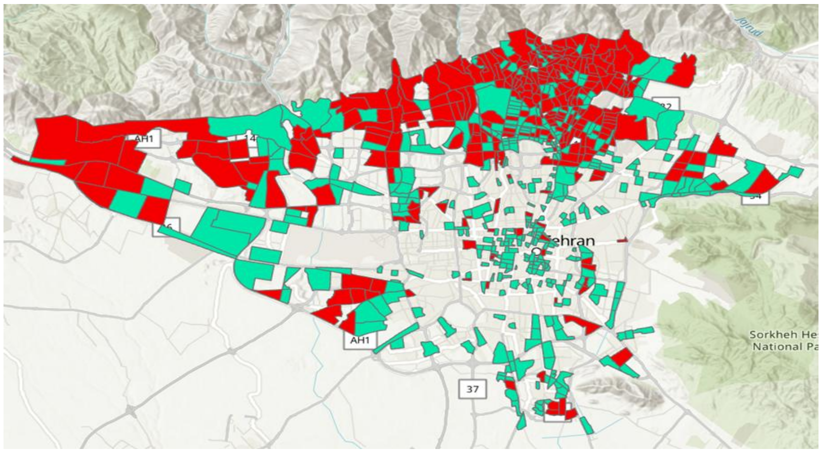

Figure 2 :Spatial distribution of demolished gardens in Tehran at the five-digit postal code level during 2010–2019.

Table 2 presents the distribution of garden sizes in Tehran under the framework of the 'Borj-Bagh' (Tower-Garden) regulation, indicating that a distinct pattern has emerged in the spatial allocation of garden areas.

Table2 : Classification of garden sizes

Area Range	Number	Percentage
<500	39	0.94
500-1999	3,028	73
2000-4999	631	15.28
>=5000	431	10.44

The majority of gardens (73 percent of the total) fall within the size range of 500 to 1,999 square meters, a concentration that is likely driven by regulatory advantages granted to this category. According to changes in municipal regulations, the permissible floor area ratio (FAR) for larger gardens has been reduced, creating incentives for owners of large properties to subdivide their land and bring parcels into this intermediate size range in order to benefit from higher allowable construction density.

Figure 3 presents the distribution of permits issued during the period 2010–2019. The figure shows that the highest concentration of permits was granted in 2013 and 2014.This surge can plausibly be explained by the sharp increase in housing prices in 2012–2013, combined with the typical administrative delays in the permitting process. In practice, the issuance of construction permits is usually subject to a lag of one to two years after application.

Figure :3 Issuance of construction permits for gardens in Tehran over the period 2010–2019

3.2. Housing Transactions:

The housing transaction data for the city of Tehran were obtained from the Ministry of Roads and Urban Development, covering the period March 21, 2010– March 19, 2020. The dataset contains detailed information on each transaction, including the unit price per square meter, the total transaction value, the age of the building, the exact date of the transaction, the size of the unit, the postal code of the property (or its first six digits), building type, transaction code, construction material, land use, as well as the province and city in which the transaction occurred.

Given the focus of this study, we restrict our sample to transactions involving r**esidential apartments** in Tehran during the study period. To address potential outliers, we first excluded observations with invalid postal codes. In addition, we removed the top and bottom one percent of observations with respect to unit price, price per square meter, size, and building age.

Table 3 presents the summary statistics of the cleaned housing dataset.

Table3 : Summary statistics of residential properties

Panel B (House transactions data 2010–2019)					
Variable	Obs	Mean	Std. dev.	Min	Max
Real Price per square meter (Mill. Rialls per square meter)	1,323,076	490.70	247.84	10	1,500
Real Price (Mill. Rialls)	1,323,076	44,978.50	39,041.68	282.02	300,000
Area (square meter)	1,323,076	83.34	36.03	10	500
House age (year)	1,323,076	9.15	9.09	0	60

Comments: Real prices are deflated to the base year 2016 (1395) using data from the Central Bank of Iran.

As in other regions of Iran, postal codes in Tehran consist of 10 digits. Since precise geographic coordinates are not available at the individual code level, we aggregate the data to the 6-digit postal code level, treating all properties within each area as sharing the same coordinates. The postal code information is obtained from the National Post Company of Iran.

Tehran's postal code system divides the city into 1,740 segments at the 5-digit level, although each individual property is assigned a 10-digit code. For better presentation, Figure 4 displays the average housing prices across all properties in our sample, aggregated by 5-digit regions. Real prices are deflated to the base year 2016 (1395) using data from the Central Bank of Iran.

Figure 4 displays the maps of Tehran's 5-digit postal zones, along with the number of housing transactions recorded in each zone during the period 2010–2019.

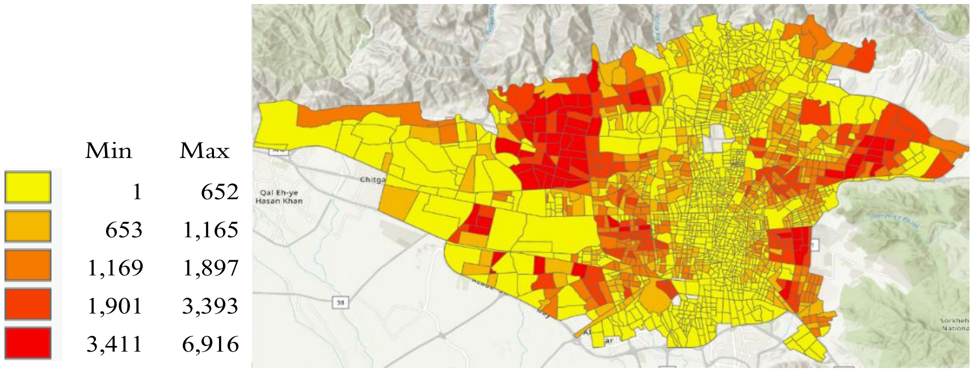

Figure 4: Number of housing transactions recorded in Tehran from 2010 to 2019. The numbers have been calculated for 5-digit regional divisions.

The color gradients in the figures represent the number of transactions across postal zones. Darker shades indicate higher transaction volumes, meaning that postal zones shaded in dark red correspond to areas with relatively higher numbers of transactions within the city.

Figure 5 displays the average housing prices per square meter across Tehran, adjusted for inflation to 2016. The numbers have been calculated for 5-digit regional divisions.

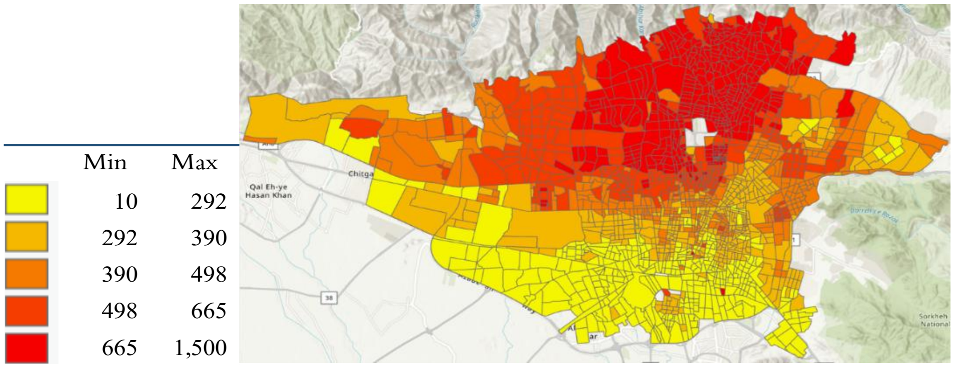

Figure 5: Average housing prices per square meter across Tehran, adjusted for inflation to 2016. The numbers have been calculated for 5-digit regional divisions.

The color gradients in the figures represent the average price per square meter within each postal zone. Darker shades correspond to higher average transaction prices of apartments.

3.3. Parks and Green Spaces Data:

One of the key datasets employed in this study concerns information on parks and green spaces in Tehran. Given the functional similarity between gardens and parks, controlling for this variable is crucial. More specifically, in postal zones where gardens have been demolished and redeveloped, the presence of a park in the same area may exert a differentiated impact on neighboring property values. This is because gardens and parks both provide comparable recreational amenities, and the benefits they generate for surrounding areas are to a large extent homogeneous.

The role of parks and green spaces in shaping urban housing values has been widely examined in the literature. For instance, Czembrowski and Kronenberg (2016) investigate the impact of various types of urban green spaces in Łódź, Poland, on apartment prices. Using the hedonic pricing method, they identify how much households are willing to pay for different forms of green amenities. Their findings suggest that large green areas, such as forests and major parks, have the strongest positive effects on apartment prices, while medium- and small-sized green spaces have limited impacts.

Similarly, Shiva and Seifi (2024) assess the economic value of urban green spaces—particularly parks—and their impact on housing prices in Tehran. Employing both the hedonic pricing method and a difference-in-differences framework, they demonstrate that proximity to parks in affluent neighborhoods is associated with a 1.4 to 2.3 percent increase in housing prices. In contrast, in less developed areas, proximity to parks results in a 2.2 to 4.3 percent decline in housing values, likely due to concerns about safety and potential crime in these public spaces.

Figure 6 illustrates the spatial distribution of Tehran's parks and green spaces over the period 1949–2019.

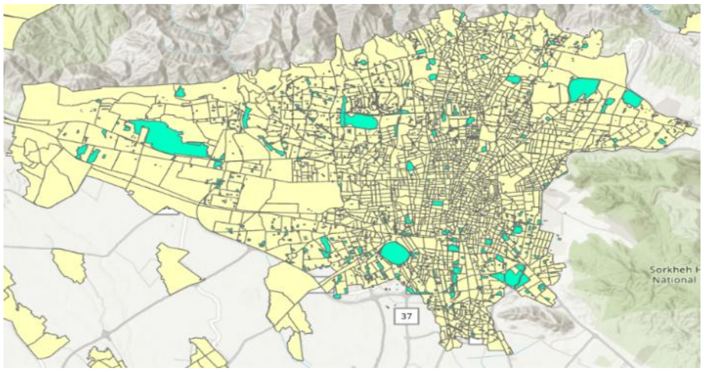

Figure 6: Spatial distribution of parks in Tehran by five-digit postal code.

Table 4 presents the categorization of Tehran's urban parks according to their surface area.

Table4 : Summary statistics of parks

Panel C (Parks data 1328-1398)

Variable	Obs	Mean	Std. dev.	Min	Max
Region	2,234	9.70	6.97	1	22
Park area (m2)	2,234	13,600	40,382	86	550,011
Total_parkarea_stock_2010 (m2)	2,234	622,603	514,324	6,933	1,806,374

3.4. Metro Infrastructure data:

Given the prominent role of public transportation in facilitating access to various parts of the city and reducing travel time costs, the presence of metro stations can directly impact neighborhood attractiveness and, consequently, increase housing prices. For instance, Yazdanfar et al. (2019) demonstrated that the inauguration of new metro stations in areas with less developed infrastructure led to an increase in housing prices ranging between 2% and 11%. In contrast, in areas with extensive existing metro infrastructure, this effect diminishes to less than 2%.

In summary, access to metro stations is a significant determinant of housing value in Tehran. However, the magnitude of this effect varies depending on the socio-economic conditions of the area. Therefore, in this study, proximity to metro stations was controlled for as a key explanatory variable.

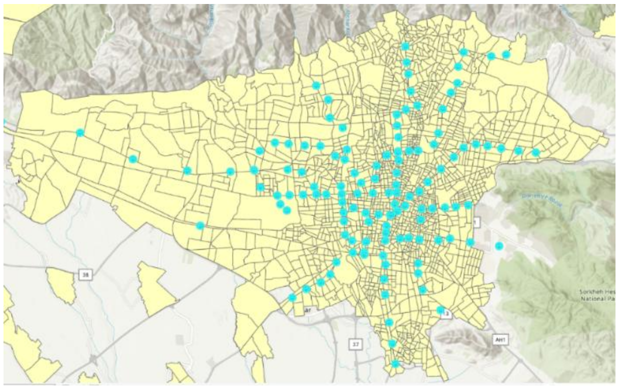

Figure 7: Geographical distribution of metro stations across Tehran.

3.5. Geospatial Integration of Data

The compiled dataset consists of 157,000 spatio-temporally disaggregated observations. Approximately twenty percent of these observations pertain to the treatment group. The control group has been further subdivided into two distinct subsets: postal districts without any gardens and those with gardens (with no history of demolition). This approach facilitates a more precise comparative analysis between the treatment and control group conditions.

Table5 : Distribution of Observations Across Treatment and Control Groups

Group Category	Number of Observations	Percentage (%)
Control Group (with garden)	31,935	20.34
Control Group (without garden)	94,288	60.06

Treatment Group	30,754	19.59

Upon merging and sorting the data, we identified the initial year of demolition for each postal district observation within the treatment group. We then extracted and analyzed the count of unique postal districts that experienced demolition for the first time in 2010 and in each subsequent year.

Figure 8 illustrates that a significant number of postal districts in the treatment group underwent demolition for the first time in 2013 . However, by the final year of the study period, the number of postal districts experiencing their first demolition declined markedly. This reduction is attributable to the revocation of the Tower-Garden permit policy and a consequent decrease in the number of development permits issued.

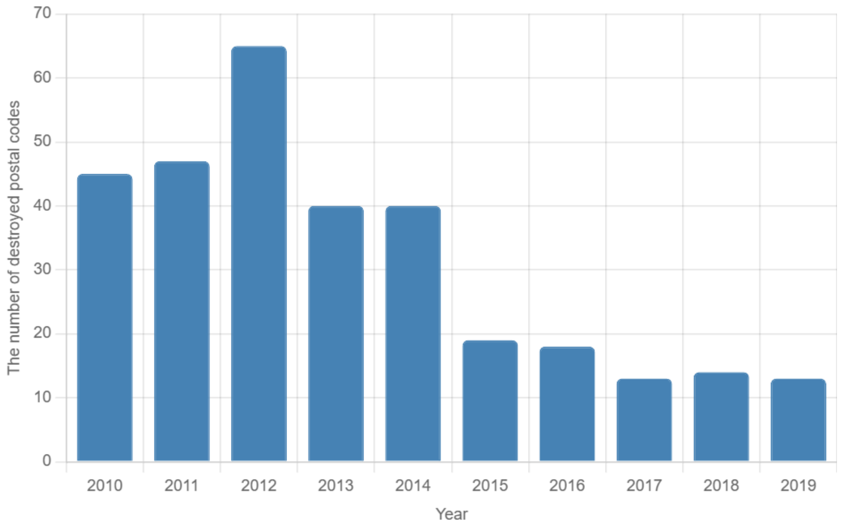

Figure 8 :The number of destroyed postal codes in the treatment group, broken down by year.

Figure 9 illustrates the trend of normalized housing prices (real price per square meter of residential apartments) across three groups: the treatment group, the control group (without gardens), and the control group (with gardens). As observed, the price trends are nearly parallel across all three groups at the beginning of the study period, supporting the parallel trends assumption. Although demolition and construction permits in garden areas were issued starting from the first year of the study (2010), but majority of permits were granted after 2013. This temporal pattern explains why housing prices across the groups followed parallel trends until this point, after which a significant increase in permit issuance led to divergent price paths.

As elaborated earlier, since the demolition of postal codes with gardens did not occur simultaneously but unfolded gradually over time, the analysis in this study is conducted at two levels: first, for the entire time period, and second, for three distinct sub-periods. This approach allows for a more precise examination of the temporal effects of the permit policies.

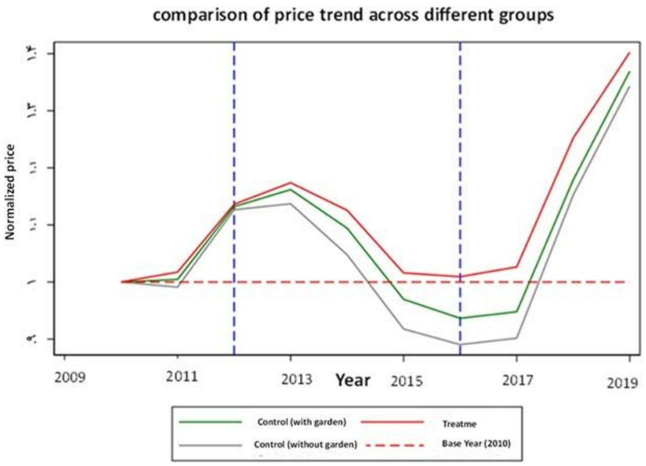

Figure 9. Evolution of normalized prices in different groups.

4. Empirical Framework

To achieve the objectives of this research, a **Difference-in-Differences (DiD)** specification within a **hedonic regression model** will be employed. This approach first requires the definition of treatment and control groups to enable the examination of potential heterogeneous effects over time.

Hedonic regression models explain the sale price of a property as a function of its structural characteristics (such as lot size and building age) and its neighborhood attributes. This specification necessitates a comparison between property prices in neighborhoods where gardens were demolished and developed, and the counterfactual scenario—prices in those *same neighborhoods* had the demolition *not* occurred.

In essence, the analysis requires estimating a counterfactual comparison: what housing prices would have been in the **5-digit postal codes** where gardens were demolished and developed, had the demolition *not* taken place. The ideal scenario would be to observe residential property prices in the treatment postal codes simultaneously with and without the intervention. While this direct counterfactual is inherently unobservable, the Difference-in-Differences design provides a robust methodological framework to approximate it.

To account for temporal shocks and time-invariant unobserved heterogeneity across locations, the model will include **year fixed effects** and **postal code fixed effects**.

The baseline specification models the growth of the dependent variable—the price per square meter of a property—and estimates the effect of garden demolition and subsequent development on this price. The initial specification is as follows:

$$\log\left(P_{pt}\right) = \alpha + \beta\ X_{pt} + \varphi \boldsymbol{Destruction\_indicator_{pt}} + \lambda_t + \mu_p + \varepsilon_{pt} \qquad (1)$$

- The dependent variable, $\log(P_{pt})$, is the logarithm of the transacted property price per square meter at the five-digit postal code (p) during time period (t), measured in months.
- X_{pt} is a vector of property characteristics, including its age and size.
- λ_t represents the time fixed effect, measured in years.
- μ_p represents the spatial fixed effect at the postal code level.
- Destruction_indicatorpt is the destruction indicator

We employ neighborhood fixed effects to mitigate omitted variable bias in our baseline specification. These fixed effects absorb time-invariant, unobserved heterogeneity across spatial units — such as geographic endowments, historical development patterns, or persistent structural differences between neighborhoods — thereby allowing us to identify *within-neighborhood* variation in housing prices over time. This strategy enhances the internal validity of our estimates by isolating the local impact of demolition activity from confounding spatial heterogeneity.

In addition, we include time fixed effects to control for common temporal shocks or macro-level trends — such as national economic fluctuations, monetary policy shifts, or sector-wide regulatory changes — that affect all neighborhoods uniformly. This ensures that our estimates are not confounded by aggregate cyclical or policy-driven dynamics.

In this study, the demolition-related indicators listed in Table 6 serve as our primary measures of physical destruction. In the results section, we identify a subset of these indicators as our preferred specifications and present regression estimates based on their inclusion, allowing for robustness checks and comparative interpretation of the localized price effects of demolition.

Table :6 Demolition Indicators: Definition and Empirical Specification

Row	Definition
1	Cumulative Area of constructions over 3 Year
2	Cumulative Area of constructions in 1 Year
3	Destruction Rate (based on count in 1 Year)
4	Cumulative PC-Destruction Rate (up to End of Study Period)

In this study, we construct four distinct indicators to measure the localized effects of garden demolition within each five-digit postal walk (neighborhood). These indicators are categorized into two groups based on the temporal horizon over which demolition effects are assumed to operate:

Group I: Short-to-Medium-Term Impact (3-Year Window)

These indicators capture the effect of demolition occurring within a three-year (36-month) window following the issuance of construction permits. The choice of this temporal lag is motivated by empirical evidence on the average duration between permit issuance and project completion in Tehran’s residential construction sector — reflecting the typical gestation period for housing supply responses.

Group II: Cumulative Long-Term Impact (Full Study Period)

These indicators measure the cumulative impact of demolition activities from the date of permit issuance up to the end of the observation period. They are designed to capture persistent structural changes in neighborhood land use and housing stock composition.

Indicator Definitions:

- Indicators 1 & 3: Represent the total demolished garden area, measured in hectares, within each neighborhood over the respective time windows (3-year vs. full-period).
- Indicators 2 & 4: Represent the demolition intensity ratio, defined as the proportion (in percentage terms) of demolished gardens relative to the total number of gardens originally present in the neighborhood.

In our baseline specification (Equation 1), the coefficient ϕ captures the causal effect of garden demolition — as proxied by our demolition indicators — on residential property prices within treated neighborhoods.

Extended Specification: Controlling for Time-Varying Local Amenities

To address potential confounding and strengthen causal identification, we augment our baseline model with controls for time-varying neighborhood-level amenities. Our extended specification (Equation 2) is as follows:

$$\log(P_{pt}) = \alpha + \beta\ X_{pt} + \gamma N_{pt} + \varphi \boldsymbol{Destruction\_indicator_{pt}} + \lambda_t + \mu_p + \varepsilon_{pt} \qquad (2)$$

- N_{pt} is a vector of time-varying local characteristics, specifically:
  - (i) The number of operational metro stations within the neighborhood, and
  - (ii) The total area (in hectares) of parks and green spaces.
  -

These amenities are included because prior literature in urban economics has consistently demonstrated that proximity to public transit and green infrastructure significantly influences residential property values (e.g., Gibbons et al., 2014; Knaap et al., 2020). Their omission could lead to omitted variable bias, as their expansion may coincide temporally or spatially with demolition activities.

Specification III: The Core Empirical Model

By explicitly controlling for these welfare-enhancing infrastructure variables, we isolate the net effect of garden demolition from concurrent changes in neighborhood desirability driven by public investment. This ensures that our estimated coefficient ϕ reflects the pure impact of land-use transformation — not conflated with amenity-driven appreciation.

The third and primary specification of this study is given by:

$$\log(P_{pt}) = \alpha + \beta\ X_{pt} + \gamma N_{pt} + \varphi \boldsymbol{Destruction\_indicator_{pt}} + Postalcode2 \times yeari + \mu_p + \varepsilon_{pt} \qquad (3)$$

In this specification, in addition to property-level controls (*Xpt*) and time-varying neighborhood amenities (*Npt*), we include postal-code-by-year fixed effects — specifically, interactions between two-digit postal codes and calendar years. These interaction terms capture time-varying, neighborhood-specific shocks and allow for distinct time trends across broader spatial units (i.e., districts). This approach enhances identification by absorbing unobserved heterogeneity that evolves differently across districts over time — such as localized policy shifts, infrastructure rollouts, or demographic transitions.

Standard errors are clustered at the postal walk-by-year level to account for potential within-cluster correlation of error terms — a standard practice in panel data models where observations within the same spatial-temporal unit may exhibit serial or cross-sectional dependence.

he coefficient of interest, ϕ, directly addresses the first research question outlined in Section 2. For ϕ to be interpreted as a causal effect of the policy-induced garden demolition on nearby residential property values, we invoke the parallel trends assumption: in the absence of the policy (and hence, without construction permits issued for garden conversion), the *trend* in housing prices in treatment neighborhoods would have evolved parallel to that in control neighborhoods. To test the causal impact of the policy, we evaluate the null hypothesis $H0:\varphi=0$. Rejection of this hypothesis indicates that the implementation of the policy generated a statistically significant externality — either positive or negative — on adjacent residential property values.

Addressing Potential Threats to Identification

To enhance the internal validity and robustness of our estimates, we implement a multi-pronged strategy to mitigate potential sources of bias. While no empirical design can fully eliminate all threats to causal inference, we explicitly categorize and address the three most salient concerns: reverse causality, omitted variable bias, and sample selection bias.

5. Results

This study employs a dataset comprising **156,969 observations** at the **five-digit postal code-year-month** level to estimate the effects of garden demolition and subsequent development on local property prices. The analysis is conducted using two primary empirical approaches: a **baseline model** and a model incorporating **spatial-temporal trend fixed effects**. The dependent variable across all model specifications is the **natural logarithm of the price per square meter of apartment units**.

5.1.Initial Specification

The following table presents the results of the initial regression analysis (Specification 1). This analysis examines the relationship between housing transaction prices and a set of economic and spatial covariates, estimated across four distinct models.

Table 7 : regression results (Baseline)

regression results (Baseline)				
Dep. Var. $\log(P_{pt})$	Cumulative area of	Cumulative PC-destruction	Cumulative area of constructions	Cumulative PC-destruction rate (

	constructions over 3 year	rate (based on area in 3 year)	up to End of Study Period	up to end of study period)
	(1)	(2)	(3)	(4)
Destruction_indicator	0.0292^{***}	0.0252^{***}	0.0477^{***}	0.0347^{***}
	(0.00880)	(0.00367)	(0.0110)	(0.00443)
Observations	156,969	156,969	156,969	156,969
R-squared	0.734	0.733	0.733	0.733

Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

As illustrated in Table 7, the two primary structural variables—property age and lot size—exhibit the anticipated patterns:

- As evidenced in Table 7, property age demonstrates a strong negative effect (each additional year of age ≈ 1.12% decrease in price), while lot size shows a negative albeit weak effect, potentially attributable to economies of scale in construction or preferences for smaller, more manageable units.
- The coefficient for the cumulative area demolished and redeveloped over a three-year window—which captures the localized stock effect of garden conversion within a postal code—is statistically significant at the 1% level. For each additional hectare of demolished garden area (at the postal code level), the price per square meter of housing increases by approximately 2.9%. When examining the long-term (permanent) cumulative area measure, the corresponding coefficient rises to 4.7%.
- Regarding the intensity-based demolition indicators: a one-percentage-point increase in the three-year cumulative demolition intensity corresponds to a 2.5% rise in the price per square meter, while a one-percentage-point increase in the lifetime cumulative intensity leads to a 3.47% increase.

5.2.Secondary Specification

In this specification, in addition to the previously included variables, two key time- and space-varying local amenity variables were incorporated: the area of public parks and the number of metro stations.

The presence of proximate public green space can play a significant moderating role. In areas with sufficient public parks and green spaces, the demolition of private gardens may have a muted effect on property values. Conversely, in areas where public green infrastructure is limited, this demolition could exert substantial negative externalities on the value of adjacent properties.

Table 8 : Secondary regression results

regression results (With N_{pt} FE)				
Dep. Var. $\log(P_{pt})$	Cumulative area of constructions over 3 year	Cumulative PC-destruction rate (based on area in 3 year)	Cumulative area of constructions up to End of Study Period	Cumulative PC-destruction rate (up to end

				of study period)
	(1)	(2)	(3)	(4)
	0.0120** (0.00480)	0.0155*** (0.00347)	0.0160*** (0.00577)	0.0158*** (0.00309)
Vector of postalcode Characteristics (N_{pt})	Y	Y	Y	Y
Observations	156,969	156,969	156,969	156,969
R-squared	0.738	0.738	0.738	0.738

Robust standard errors in parentheses (*** $p<0.01$, ** $p<0.05$, * $p<0.1$)

Table 8 indicates that the coefficient for the cumulative area demolished and redeveloped over a three-year period—which captures the localized, short-to-medium-term stock effect of garden conversion—is statistically significant at the 5% level. For each additional hectare of demolished garden area (measured at the postal code level), the price per square meter of housing increases by approximately 1.2%. When examining the long-term (permanent) cumulative area measure, the corresponding coefficient is 1.6%.

• Regarding the intensity-based demolition indicators: a one-percentage-point increase in the three-year cumulative demolition intensity corresponds to a 1.5% rise in the price per square meter, while a one-percentage-point increase in the lifetime cumulative intensity also results in a 1.5% increase.

As anticipated, the inclusion of additional controls attenuated the estimated magnitude of the demolition effect. Despite this reduction in effect size, all coefficients remain statistically significant at the 1 percent level.

5.3.Preferred Specification

As previously discussed, the potential for reverse causality constitutes one of the most significant threats to the identification strategy of this study. More precisely, not only might garden demolitions influence housing prices, but price expectations among local residents could also act as a driver for submitting demolition and land-use change permits. This phenomenon occurs when residents, upon observing price trends in adjacent neighborhoods, anticipate that their own neighborhood will also experience price appreciation in the near future. These expectations create an incentive to apply for land-use conversion and garden demolition to capitalize on potential future market opportunities.

Two distinct behavioral patterns can be identified in this context:

a) Anticipatory Growth Pattern:

- This pattern emerges in areas that have not yet undergone significant price appreciation. Residents, drawing on the experiences of comparable areas, predict that their neighborhood will follow a similar growth trajectory. This outlook leads to an increase in demolition permit applications.

b) Momentum Pattern:

- This pattern occurs in areas currently experiencing price growth. Residents expect this upward trend to persist into the future. This belief, in turn, increases the demand for land-use conversion.

Identification Strategy:

To address this endogeneity challenge, the empirical strategy controls for a **linear trend of past prices** at the two-digit postal code level. This variable partially accounts for residents' predictive capacity regarding future trends based on historical price movements.

Table 9 : Main regression results (With Trend FE)

Main regression results (With Trend FE)				
Dep. Var. $\log(P_{pt})$	Cumulative area of constructions over 3 year	Cumulative PC-destruction rate (based on area in 3 year)	Cumulative area of constructions up to End of Study Period	Cumulative PC-destruction rate (up to end of study period)
	(1)	(2)	(3)	(4)
	0.00968^{**}	0.0138^{***}	0.0140^{***}	0.0142^{***}
	(0.00460)	(0.00337)	(0.00540)	(0.00304)
Vector of postalcode Characteristics (N_{pt})	Y	Y	Y	Y
Trend FE	Y	Y	Y	Y
Observations	156,969	156,969	156,969	156,969
R-squared	0.740	0.740	0.740	0.740

Robust standard errors in parentheses (*** $p<0.01$, ** $p<0.05$, * $p<0.1$)

• As is evident from Table 9, the coefficients for both the absolute-area and percentage-based demolition indices have decreased in magnitude; however, all remain statistically significant at the 5 percent level.

• The coefficient for the three-year cumulative area of gardens demolished and redeveloped is statistically significant at the 5% level. It indicates that for each additional hectare of demolition (measured as the mean at the postal code level), the price per square meter of housing increases by approximately 1.0%. The corresponding coefficient for the long-term (permanent) cumulative area measure is 1.4%.

• Regarding the percentage-based (intensity) demolition indices: a one-percentage-point increase in the three-year cumulative demolition intensity corresponds to a 1.4% rise in the price per square meter. The estimated effect for the lifetime cumulative intensity is also a 1.4% increase.

As theoretically anticipated, the inclusion of additional control variables attenuated the estimated magnitude of the demolition effect. Notwithstanding this reduction in effect size, all coefficients retain their statistical significance at the 1 percent level.

5.4.Refinement of Control and Treatment Groups

As outlined previously, the control group was subdivided into two distinct categories: postal codes entirely lacking gardens and those containing gardens (but with no history of demolition). The preceding specifications incorporated both of these sub-groups.

The analysis presented in this section imposes a restriction on the control group, limiting it solely to those postal codes that contain gardens. Implementing this refinement results in the exclusion of approximately 60 percent of the original observations.

Table 10 presents the results of this restricted control group analysis for Specification 3.

Table10: Main regression results (LCG)

Main regression results (LCG)				
Dep. Var. log(P_{pt})	Cumulative area of constructions over 3 year	Cumulative PC-(destruction rate in based on area)3 year	Cumulative area of constructions up to End of Study Period	Cumulative PC-(destruction rate up to end of) study period
	(1)	(2)	(3)	(4)
	0.00995^{**}	0.0132^{***}	0.0135^{**}	0.0128^{***}
	(0.00458)	(0.00339)	(0.00531)	(0.00316)
Vector of postalcode Characteristics (N_{pt})	Y	Y	Y	Y
Trend FE	Y	Y	Y	Y
Observations	62,688	62,688	62,688	62,688
R-squared	0.725	0.725	0.725	0.725

*** p<0.01, ** p<0.05, * p<0.1) (Robust standard errors in parentheses

The results from the modified control group specification indicate that the coefficients for both the short-term and long-term demolition indices remain positive and statistically significant, with only marginal changes in their magnitude.

A notable finding is the convergence of the short-term and long-term effect estimates after controlling for localized price trends and refining the control group. This convergence suggests that the impact of garden demolition on housing prices does not diminish over time but rather stabilizes at a new equilibrium level.

Contrary to the initial expectation that the loss of green space would depress property values, the findings consistently indicate a positive price effect associated with demolition. This seemingly counterintuitive result can be preliminarily explained by several underlying mechanisms, which will be explored in greater detail subsequently:

- Increased Density and Urban Amenities: The demolition of gardens frequently leads to the construction of new residential or commercial units. This densification can enhance local urban amenities and increase the attractiveness of the area, potentially driving up property prices.
- Land-Use Intensification: Vacant garden land, once redeveloped, is often converted to higher-value economic uses, such as commercial spaces or higher-density residential buildings. This intensification of land use can increase the average property value within the postal code.
- Neighborhood Upgrading Channels: The positive effect may operate through several upgrading channels, including improved accessibility and urban aesthetics, enhanced neighborhood appearance and safety, and raised investment expectations. These potential pathways will be investigated further in the following section.

5.5.Examining Heterogeneity in Demolition Effects

As indicated in previous sections, the net impact of garden demolition and redevelopment on adjacent property values is likely shaped by a complex interplay of factors that determine both the magnitude and direction of these effects. This section provides a systematic and in-depth analysis of these determinants.

1. Geographic Location and Neighborhood Income Level

Geographic Location: This serves as a key parameter, analyzable not only in terms of a garden's position within the urban structure (e.g., central vs. peripheral) but also its environmental characteristics. Gardens located in the northern districts of the city may exert a different influence on nearby housing prices compared to those in peripheral areas. This divergence could stem from differential access to urban services, levels of environmental pollution, population density, or the fact that northern gardens may possess a unique ecological value, meaning their demolition could have broader environmental consequences than that of intra-urban gardens.

Neighborhood Income Level: As a second structural factor, resident income generates a distinct pattern of effects. In high-income areas, the demolition of gardens and their conversion into luxury residential complexes may enhance the value of adjacent properties, as residents in these areas often prioritize modern amenities and advanced infrastructure. Conversely, in low-income areas, such changes might be associated with a decrease in property values, as residents often rely on green spaces as one of their few accessible public amenities. From another perspective, derelict gardens in low-income areas can reduce perceived safety; therefore, their demolition and redevelopment could conversely lead to an increase in adjacent property values.

To operationalize and generalize the above patterns, a single composite index that simultaneously captures both "geographic location" and "income level" is necessary. This study introduces an index that classifies postal codes for the base year (2010) based on whether they fall within blocks accounting for a high share of total transactional value. Specifically, postal codes ranked within the top one percent of prices in that year are designated as a sample group. This price pattern exhibits a strong correlation with postal codes beginning with the digits '19' (encompassing most of Districts 1, 2, and 3 of Tehran Municipality). Figure 10 provides a spatial visualization of postal codes possessing this characteristic.

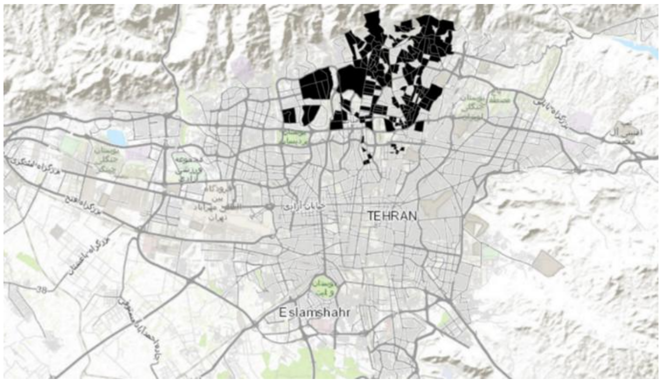

Figure 10. Postalcode with the top 10 percent of property prices in the base year (1389)

The results of estimating the primary regression model for two groups—postal codes in the top ten percent by price (163 distinct postal codes) and all others—are presented in Table 11.

Table 11: regression results for Postalcode with the top 10 percent of property prices

	Postalcode with the top 10 percent of property prices in the base year (1389)	Other postal codes
Dep. Var. $\log(P_{pt})$	(1)	(2)
Cumulative PC-destruction rate (based on area in 3 year)	0.0166^{***}	0.0173^{***}
	(0.00587)	(0.00401)
Cumulative PC-destruction rate (up to end of study period)	0.0171^{***}	0.0241^{***}
	(0.00434)	(0.00570)
Vector of Local Characteristics (N_{pt})	Y	Y
Trend FE	Y	Y
Observations	14,317	142,652
R-squared	0.134	0.718

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The regression results presented in Table 11 indicate that the impact of garden demolition and redevelopment on adjacent property values is 1.6% for the short-term (three-year) variable in the first group and 1.7% in the second group. For the long-term indicators, the coefficients are 1.7% and 2.4%, respectively. However, upon conducting appropriate statistical tests (see

Appendix), we found that the differences between these coefficients across the two groups are not statistically significant.

Group 1: Postal codes in the top 10% of property prices in the base year (2010) – High-income areas (primarily Districts 1, 2, and 3 of Tehran).

The positive and statistically significant coefficients for both short-term and long-term indicators in these areas suggest a positive effect of garden demolition on nearby property prices. This finding aligns with the hypothesis that in high-income areas, the removal of gardens and their replacement with modern luxury residential complexes enhances adjacent property values, as residents in these neighborhoods typically prioritize modern amenities and new infrastructure.

Group 2: All other postal codes (low- and middle-income areas).

The positive coefficients indicate that the effect of garden demolition remains positive in these areas, albeit marginally larger in magnitude than in high-income areas. These results may be attributed to the fact that in some lower-income areas, derelict gardens contribute to reduced safety and quality of life. Their removal and subsequent redevelopment can improve the urban environment and increase property values.

These findings are partially consistent with theoretical expectations. Given the distinct role of green space in high-income areas (primarily northern Tehran) compared to lower-income areas, the ornamental and luxury nature of gardens in northern districts means their demolition and replacement with modern structures has a relatively smaller positive effect (1.7%) on adjacent property values. In contrast, the effect is somewhat larger (2.4%) in other areas, where green spaces may be valued more for functional or practical reasons. This difference may stem from a preference among residents of high-income areas to preserve gardens, whereas residents of lower-income areas may favor the removal of derelict and unsafe green spaces.

2. Number of Floors in New Construction

The number of stories in new construction represents another factor that may yield divergent effects. High-rise developments can potentially reduce natural light exposure and views for adjacent residents, which may negatively impact property values. Conversely, such developments may enhance the neighborhood's image and elevate the level of local services, thereby exerting positive effects on property values.

In accordance with regulations issued by the Supreme Council of Urban Planning and Architecture for cities with populations exceeding 200,000, the categorization adopted in this study distinguishes high-rise buildings from others based on the number of stories—using a threshold of 8 stories for other cities and 12 stories for Tehran. This classification is designed to enable more precise analysis and to meaningfully differentiate between high-rise and low-rise buildings.

Table 12 presents the regression results disaggregated by building height, distinguishing between structures exceeding 12 stories and those with 12 or fewer stories.

Table 12 :regression results disaggregated by building height

	High-rise buildings	Low- to mid-rise buildings
Dep. Var. $\log(P_{pt})$	(1)	(2)
Cumulative area of constructions up to end of study period	-0.0168	0.0321^{**}
	(0.0172)	(0.0158)
Vector of Local Characteristics (N_{pt})	Y	Y
Trend FE	Y	Y
Observations	32,039	32,110
R-squared	0.709	0.709

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Low-Rise Buildings: The demolition of gardens and subsequent new construction has, on average, a positive and statistically significant effect on the price of adjacent properties. This may be attributed to the appeal of new developments in low-density neighborhoods. An increase in the rate of demolition and redevelopment (i.e., the replacement of gardens with low-rise buildings) is associated with a significant appreciation in the value of neighboring properties. This effect is likely driven by neighborhood quality improvements and the provision of new amenities, which enhance property values.

High-Rise Buildings: The effect of garden demolition and new construction is negative and statistically insignificant. This result may stem from the presence of countervailing effects: potential positive impacts (such as neighborhood upgrading) may be offset by negative externalities (including reduced tranquility, diminished natural light, and increased traffic congestion), resulting in a net effect that is indeterminate.

3. Area of Demolished Garden

The area of demolished garden exhibits a **non-linear relationship** with the value of adjacent properties. The demolition of large gardens, which often function as essential **green lungs** for a neighborhood, is likely to impose significant **negative externalities** on surrounding property values. In contrast, the demolition of smaller gardens may have a negligible effect on housing prices or, in some instances, a positive impact due to the potential for new, higher-value development.

A notable complication in assessing the urban planning impacts of such demolition stems from the fact that **zoning regulations** and permissible **floor area ratios (FAR)** for redevelopment are typically contingent upon the original lot size. This creates a significant **identification challenge** in disentangling the effect of garden size from the effect of the scale of subsequent construction permitted by law.

The categorization presented in the following analysis is based on the guidelines outlined in **Article 14 of the Urban Land Law**.

Table 13 presents the results of the regression analysis, **disaggregated** by the size of the demolished garden.

Table 13: results of the regression analysis, disaggregated by the size of the demolished garden.

	Area 500_to_2000		Area 2000_to_5000		Area >5000	
Dep. Var. $\log(P_{pt})$	(1)	(2)	(3)	(4)	(5)	(6)
Cumulative Area of constructions over 3 Year	0.0384^{***}		0.0126^{*}		-0.00816	
	(0.130)		(0.108)		(0.0110)	
Cumulative Area of constructions up to End of Study Period		0.0359^{**}		0.0165^{*}		-0.00419
		(0.163)		(0.112)		(0.0104)
Vector of Local Characteristics (N_{pt})	Y	Y	Y	Y	Y	Y
Trend FE	Y	Y	Y	Y	Y	Y
Observations	113,345	113,345	111,722	111,722	111,655	111,655
R-squared	0.700	0.700	0.699	0.699	0.700	0.700

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

These findings align with theoretical expectations in urban environmental economics: large gardens function as neighborhood-level public goods, providing non-market amenities such as visual relief, microclimate regulation, recreational space, and — critically — enhanced perceptions of safety and tranquility. Their removal represents a net loss of welfare-generating infrastructure, the negative externality of which outweighs any potential positive effects from redevelopment (e.g., increased housing supply or improved building aesthetics).

In contrast, the demolition of smaller gardens (500–2,000 m²) tends to be associated with net positive outcomes. Qualitative evidence and urban design assessments suggest that redevelopment of these parcels often results in new constructions that — when planned appropriately — offer superior architectural quality, better maintenance, and more functional land use than the previously neglected gardens. In many cases, these small gardens had deteriorated into underutilized or even hazardous spaces, contributing to neighborhood blight rather than amenity provision.

Interviews with municipal officials and local residents corroborate these findings and provide institutional context. Under Tehran's current regulatory framework, municipal water allocation for green space irrigation is prioritized toward large public gardens, which are formally recognized as strategic urban assets. Smaller gardens, particularly those on private or semi-public land, often fall outside formal maintenance systems and receive minimal or no municipal support.

Compounding this institutional neglect, declining groundwater levels and the drying up of local wells in recent years have rendered many small gardens unsustainable without external intervention. As a result, numerous small parcels have become derelict — evolving into unsecured, visually degraded, and socially undesirable spaces. Their redevelopment, particularly when executed with attention to urban design and mixed-use functionality, has in many cases improved neighborhood livability, safety, and aesthetic coherence.

These results suggest a critical threshold effect in the urban amenity value of green spaces: while large gardens serve as irreplaceable contributors to neighborhood well-being and property values, small gardens — under current institutional and environmental constraints — may no longer fulfill their intended function. When left unmaintained, they risk becoming liabilities rather than assets.

Thus, urban policy should not treat all green spaces uniformly. Preservation efforts should prioritize large gardens as essential components of urban environmental infrastructure. Conversely, strategic redevelopment of small, deteriorating gardens — when coupled with design-sensitive infill and community input — may enhance urban functionality without sacrificing — and in some cases, even enhancing — neighborhood welfare and property values.

4. Placebo Test

As detailed in the data description , a key procedural step for obtaining a construction permit in garden zones is the filing and review of an application by the Garden Commission (Article 7). Through this process, if the stipulated legal conditions (previously elaborated upon) are verified, the property in question is formally recognized as a garden, and its owner is permitted to initiate the process of obtaining a construction permit. This process entails the demolition of the garden and its replacement with new construction, which must comply with relevant regulations. A primary condition for this process is the approval vote of the City Council members, based on the documentation submitted by the owner. Based on our review, all cases pertaining to gardens are referred to the City Council chamber. Consequently, the dataset utilized in this study includes information on properties for which garden owners submitted their documentation to the municipality and for which a final ruling was issued regarding the property's status as a garden or not.

A subset of these rulings were negative, meaning that property owners submitted their application for construction under the more permissive garden-area regulations (due to their facilitative nature compared to standard regulations) but ultimately failed to obtain a permit under these specific provisions. As a result, this group of owners was compelled to undertake construction under the standard, more restrictive regulations. This subset of data is treated as the experimental group for the purpose of a placebo test, as it can serve as a control group to evaluate the impact of garden removal and its replacement with construction. Therefore, this group represents a suitable candidate for implementing a placebo test.

To examine the treatment effect in this context, indices similar to the primary analysis were employed, with a key modification: instead of using the area of garden land demolished and built upon, the built-up area (footprint) of the constructed property was used in the numerator, while the area of the 5-digit postal route (consistent with the main specification) was retained in the denominator.

Table 14 presents the results of the regression analysis conducted on this dataset. These results detail the impact of both short-term and long-term indices on the dependent variable (the logarithm of price per square meter). Furthermore, the analysis was conducted using two specifications: first, without accounting for temporal trends specific to each postal route, and second, by incorporating time-trend fixed effects. This approach allows for a more precise investigation of the actual effects of construction activity on property values.

Table 14: Results of the Regression Analysis for the Placebo Test Group

	regression results (baseline)		regression results (Main)	
Dep. Var. $\log(P_{pt})$	(1)	(2)	(3)	(4)
Cumulative PC-Destruction Rate (based on Area in 3 Year)	0.287	0.157		
	(0.384)	(0.371)		
Cumulative PC-Destruction Rate (up to End of Study Period)			0.162	-0.332
			(0.322)	(0.232)
Vector of Local Characteristics (N_{pt})	N	N	Y	Y
Trend FE	N	N	Y	Y
Observations	16,514	16,514	16,171	16,171
R-squared	0.910	0.917	0.926	0.933

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Across all model specifications, the coefficients associated with garden demolition and new construction—encompassing both the short-term and long-term indices—are statistically insignificant.

As previously noted, applications for construction permits under garden-area regulations that received a negative ruling serve as a suitable control group for a placebo test. Given that the results for this group are also statistically insignificant, it can be argued that the effect observed in the primary treatment group is genuine and not attributable to random factors or unobserved spatial trends. This finding strengthens the causal interpretation that the positive price effect is a consequence of the garden conversion activity itself.

5.The Long-Difference Estimation Approach

he long-difference estimator is an econometric strategy that has gained increasing prominence in applied microeconomics and urban economics in recent years. It operates by computing the difference in outcomes between two temporally distant observations — typically the baseline year and the terminal year of the study period — to estimate the long-run effect of a treatment or policy intervention.

One of the most salient advantages of this approach is its capacity to mitigate concerns related to reverse causality. In many empirical settings — particularly in housing and land-use economics — bidirectional relationships between key variables (e.g., between garden demolition and adjacent property prices, where rising prices may incentivize demolition, and demolition may in turn affect prices) can introduce endogeneity bias into conventional regression estimates. By exploiting a relatively long temporal interval between observations, the long-difference method attenuates the influence of short-term feedback loops and contemporaneous correlations, thereby reducing the likelihood of misattributing causal direction.

A second critical challenge addressed by this method arises in contexts where treatment and control groups are not fixed over time. In the present study, as previously noted, the classification of neighborhoods into treatment and control groups evolves in a staggered manner across years — reflecting the phased implementation of demolition permits. Under such conditions, traditional difference-in-differences (DiD) estimators may yield biased estimates, as they typically rely on the assumption of stable group assignment throughout the observation window. The long-difference approach, by focusing only on the endpoints of the panel, circumvents this violation and provides a more robust identification strategy in the presence of time-varying group membership.

Moreover, the long-difference estimator is particularly well-suited for settings in which treatment timing is heterogeneous across units — a common feature in urban policy evaluations. As demonstrated by Callaway and Sant'Anna (2021), even in the presence of non-parallel pretrends driven by observed covariates, the long-difference framework — when combined with appropriate conditioning — can identify a set of causal parameters that reflect heterogeneous treatment effects over time. This property is especially valuable in staggered adoption designs, where treatment effects may vary depending on the calendar year of exposure.

The results obtained from applying the long-difference estimator — comparing outcomes in the initial year of the study period with those in the final year — are presented in Table 15.

Table 15: Results of the Regression Analysis for the Long-Difference Estimation Approach

	Diff between 1389-1396	Diff between 1389-1397	Diff between 1389-1398
Dep. Var. $\log(P_{pt})$	(1)	(2)	(3)
Cumulative PC-destruction rate (up to end of study period)	0.0108*	0.00525	0.00318
	(0.00647)	(0.00798)	(0.00931)
Vector of Local Characteristics (N_{pt})	Y	Y	Y
Trend FE	Y	Y	Y
Observations	31,122	30,394	28,425
R-squared	0.774	0.698	0.702

Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

Our long-difference estimates — comparing outcomes in the baseline year (1389) with those in the terminal year (1396) — indicate that a one-percentage-point increase in the garden demolition intensity index (measured as the share of postal walk area converted from gardens to built form over the seven-year period) is associated with an approximately 1% increase in residential property prices.

This estimated effect is statistically significant at the 10% level, providing suggestive evidence that garden demolition and subsequent redevelopment exert a positive externality on adjacent housing values over the medium to long run. The direction and magnitude of this effect are consistent with mechanisms such as improved neighborhood infrastructure, enhanced perceived safety, or market expectations of localized upgrading — particularly in contexts where demolished gardens were previously underutilized or poorly maintained.

Notably, while the point estimates remain relatively stable in magnitude across alternative terminal years (e.g., extending the observation window to 1397 or 1398), the statistical significance diminishes when the end year is shifted beyond 1396. Specifically, coefficients lose conventional significance ($p > 0.10$) when the terminal year is set to 1397 or 1398. This attenuation may reflect increased noise in longer panels, compositional changes in the housing stock, or the emergence of countervailing negative externalities (e.g., congestion, loss of mature greenery) that offset initial price gains in later years.

These findings underscore the time-sensitive nature of redevelopment externalities and suggest that the net impact of garden conversion on property values may follow a hump-shaped trajectory — positive in the medium term but potentially eroding over extended horizons.

6. Conclusion and Policy Implications

In recent years, the land-use conversion of private gardens into residential developments in Tehran has emerged as a critical urban policy issue. This phenomenon, colloquially termed "garden destruction and tower construction" (Baghdari va Sakht-e Borj), carries significant economic, environmental, and social consequences. On the one hand, construction on garden plots is highly attractive to landowners and even municipal authorities due to the substantial potential for value addition; it functions as a sustainable revenue stream for the municipality through the levying of development fees. On the other hand, these activities are associated with a reduction in green spaces, increased population density, a degradation of environmental quality, and the alteration of neighborhood social fabric.

This structural duality places municipal and related regulatory bodies in a complex position. Given the private ownership of these properties, municipalities lack direct oversight authority over garden maintenance. Simultaneously, they bear the responsibility for upholding the quality of the urban landscape. In response, the Tehran City Council has ratified various resolutions, such as the "Tower-Garden" (Borj-Bagh) and "House-Garden" (Khane-Bagh) policies, aimed at curbing garden degradation. However, the efficacy of these regulations in preventing land-use change has been limited. Paradoxically, the "Tower-Garden" resolution, by permitting higher floor area ratios (FAR) and building density on garden lands compared to adjacent residential zones, has provided a legal incentive for the conversion of gardens into built units. The empirical consequences of this policy, however, have not been rigorously examined.

This study employs econometric methods to investigate the impact of garden conversion on residential property prices in Tehran. The findings, derived from multiple empirical strategies—including a Difference-in-Differences (DiD) design integrated into a Hedonic Regression model and a Long Differences approach—provide a comprehensive picture of the relationship between garden destruction and property values.

The primary research question was: Does the demolition of gardens and their subsequent conversion into new constructions affect the economic value of adjacent properties? To address this, we utilized observational data at the 5-digit postal route level, controlling for various structural characteristics of properties and localized factors (e.g., number of metro stations, area of parks and green spaces) within our models.

Our analysis involved estimating multiple regression specifications with differing sets of controls, including time and location fixed effects, interactive fixed effects, and the incremental addition of environmental variables. Furthermore, garden destruction indicators were categorized into short-term (3-year), long-term (cumulative to the end of the period), as well as percentage and area-based measures to adequately account for temporal, spatial, and scale-related heterogeneity.

The core findings indicate that garden conversion and new construction exert a positive and statistically significant effect on the prices of neighboring properties. For instance, a one-hectare increase in the area of garden destruction over a three-year window was associated with an approximately 2.9% increase in property prices. This effect escalated to 4.7% in the long-term (cumulative) measure. Similarly, percentage-based destruction indices showed analogous effects: a 1% increase in the destruction rate led to a 2.5% price increase in the three-year window and a 3.47% increase in the long term.

Upon incorporating localized control variables (e.g., metro station count, park area), the magnitude of the garden destruction coefficient attenuated but remained positive and statistically significant. For example, the coefficient for the three-year destruction area fell to 1.2% and to 1.6% for the long-term measure. This attenuation suggests that a portion of the positive price effect is attributable to improved access to urban amenities that often accompany new development.

The analysis was further refined by controlling for spatiotemporal trends (via interactive time-location fixed effects). The results indicated that reverse causality—whereby rising housing prices themselves drive garden destruction—cannot fully explain the observed outcomes. The coefficients for destruction remained positive and significant, albeit further reduced in magnitude.

A heterogeneity analysis examined differential effects across high-income and low-income neighborhoods. In high-income areas (e.g., Districts 1, 2, and 3), the effect of garden conversion was positive but smaller in magnitude (approximately 1.7%), potentially reflecting a stronger resident preference for the preservation of green space. Conversely, in low-income areas, the effect was larger (approximately 2.4%), likely due to perceived improvements in security and quality of life following the removal of derelict, unkempt gardens. Statistical tests indicated that the difference between these coefficients was not statistically significant.

Another significant finding pertained to the differential impact based on the size of the destroyed garden. The conversion of small gardens (500–2,000 m^2) had a positive effect on housing prices, whereas the destruction of larger gardens (exceeding 5,000 m^2) exhibited a negative effect. This indicates that large gardens function as neighborhood "green lungs," and their loss can detrimentally impact quality of life.

The validity of the results was assessed through a placebo test and a Long Differences approach (see Appendix). Utilizing a sample of garden demolition applications that were submitted but subsequently rejected, the placebo test confirmed that the observed effect in the primary treatment group is genuine and not driven by random factors. The Long Differences estimation, while directionally consistent, suffered from reduced statistical power due to a smaller sample size, rendering the results insignificant.

Several mechanisms underlie the identified positive price effects: urban facility development, market expectations regarding neighborhood upgrading, and improvements in perceived security. These mechanisms were more pronounced in low-income areas, whereas the value of green space preservation held greater relative importance in high-income areas.

In conclusion, this study demonstrates that the conversion of gardens into new constructions generally exerts a positive externality on adjacent property prices in Tehran. This effect is contingent upon factors such as geographical location, resident income levels, and prevailing urban policies. However, it is critical to note that these findings do not necessarily justify the wholesale destruction of gardens, as the loss of large, ecologically valuable gardens may impose significant negative externalities on the environment and long-term quality of life.

Policy Implications

Based on these findings, several policy recommendations can be advanced:

1. **Revision of Existing Regulations:** A critical reassessment of the "Tower-Garden" resolution and related land-use conversion bylaws is warranted. This revision should be grounded in an evidence-based, comprehensive framework aimed at establishing a sustainable system for urban garden management, moving beyond ad-hoc case-by-case approvals.
2. **Implementation of a Transferable Development Rights (TDR) System:** A key strategy involves developing a TDR framework, enabling garden owners to sell their development rights to other zones within the city. In exchange, their gardens would be preserved as private or public green spaces. This mechanism would curtail excessive destruction while granting the municipality greater control over urban development patterns.
3. **Enhanced Monitoring and Database Creation:** Establishing a centralized registry for private gardens—documenting their physical status, ownership, and use—is essential. This would facilitate the identification of gardens at risk of conversion, enable better assessment of environmental and social impacts, and support more informed policy decisions.
4. **Differentiated Regulations Based on Garden Size:** Given the differential impact of destroying small versus large gardens, regulations should be tiered based on plot size. Stricter preservation policies should be enacted for large gardens (>5,000 m²), while controlled conversion of smaller plots could be permitted under specific guidelines.
5. **Promotion of Public Participation:** Fostering civic engagement and supporting the formation of NGOs focused on green space management can enhance monitoring of construction activities, propose sustainable development solutions, and raise public awareness.
6. **Balancing Private and Public Interests:** Policy design must strike a balance between landowners' economic incentives and the public good. This can be achieved through fiscal instruments such as tax exemptions for preservation or levying heavier taxes on excessive, speculative development.
7. **Mitigating Socio-Spatial Segregation:** The indirect effect of rising property prices triggering socio-spatial stratification and displacement must be acknowledged. Affordable housing policies and urban regeneration programs should be designed to prevent the sudden gentrification of neighborhoods and protect existing low-income residents.

Ultimately, this study underscores that the management of private gardens in Tehran necessitates a multidimensional approach that simultaneously incorporates economic, environmental, social, and legal considerations.

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