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How have government housing programs affected developers' bids in Israel Land Authority land tenders?*

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איך השפיעו תוכניות ממשלתיות בתחום הדיור על הצעות היזמים במכרזי מקרקעין של רשות מקרקעי ישראל?

נטליה פרסמן, טניה סוחוי

תקציר

בשנת 2015 החל שיווק נרחב של קרקעות המדינה במסגרת התוכניות הממשלתיות בתחום דיור בר-השגה. אנו משתמשות בנתוני רשות מקרקעי ישראל ובוחנות את השפעתם של שיווקים אלה על הצעות מחיר במכרזי מקרקעין רגילים לבניית דירות לשוק החופשי ומנתחות את גורמי הביקוש לקרקע לבנייה רוויה למגורים בישראל. כדי להתחשב בהטרוגניות של הקרקעות המשווקות, אנו מיישמות את רגרסיית האחוזונים של Koenker מותאמת פנל עם אפקטים קבועים למכרז, שעוצמתם מבוקרת במנגנון lasso. אי הגשת הצעות בחלק מהמכרזים מהווה מקור להטיית הסלקציה של הפרמטרים, בדומה לתופעה שמתוארת על ידי Heckman בשוק העבודה. לצורך תיקונה של הטיית סלקציה זו, אנו מיישמות את האלגוריתם של Arrelano & Bonhomme (2017), שמבוסס copula.

לאחר התיקון של הטיית הסלקציה שמנטרל את ירידת האטרקטיביות של מכרזים רגילים בסביבה של פרויקטים מתוכננים בסבסוד ממשלתי, אנו מוצאות כי הצעות המחיר במכרזים רגילים מוצלחים עלו ככל ששיווק הקרקעות במסגרת המכרזים הרגילים התמעט. בנוסף אנו מוצאות כי עצם השְכֵנוּת עם היישובים שבהם משווקת קרקע לפרויקטים בסבסוד ממשלתי מעלה את גובה ההצעות שהוגשו במכרזים הרגילים ביישובים שבהם לא נערכו שיווקים כאלה. עוצמת השפעות אלה חזקה יותר בפריפריה.

<u>מילות מפתח</u>: מכרזי מקרקעין, דיור בסבסוד ממשלתי, פריפריה, רגרסיית אחוזונים, הטיית סלקציה.

How have government housing programs affected developers' bids in Israel Land Authority land tenders?*

Natalya Presman, Tanya Suhoy

Abstract

In 2015, extensive marketing of state lands began as part of government programs for affordable housing. We use data from the Israel Land Authority to examine the impact of these marketing efforts on bid prices in regular land tenders for building apartments for the open market and analyze the demand factors for land for high-density residential construction in Israel. To account for the heterogeneity of the marketed lands, we apply Koenker's quantile regression adapted to a panel with fixed effects for the tender, controlled by the lasso mechanism. The lack of bids in some tenders constitutes a source of selection bias in the parameters, similar to the phenomenon described by Heckman in the labor market. To correct this selection bias, we apply the algorithm of Arrelano & Bonhomme (2017), which is based on a copula. After correcting for the selection that neutralizes the decline in the attractiveness of regular tenders in the environment of planned large government-subsidized projects, we find that bid prices in successful regular tenders increased as the marketing of lands in regular tenders decreased. Additionally, we find that proximity to localities where land is marketed for government-subsidized projects raises the bid amounts submitted in regular tenders in localities where no land was marketed within the government programs. The intensity of these effects is stronger in the periphery.

JEL Codes: C13, C14, C21, C23, D44, R30, R31, R38, R52.

Key words: residential land auctions, affordable housing, periphery, quantile regression, selection bias.

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1. Introduction

Unlike other countries in the Western world, where most lands are privately owned[1], over 90% of the land in Israel is publicly owned and held by the state, the Development Authority, and the Jewish National Fund. This includes a significant portion of the inhabited land in the country, as well as land designated for future construction. The marketing of this land to private developers, usually through public tenders, is exclusively managed by a governmental body, the Israel Land Authority (ILA), in a process in which developers acquire lease rights for a limited period[2] rather than ownership rights. The planning system in Israel is also centralized, and the planning process (preceding land marketing) is bureaucratic and sluggish (see for example Eckstein et al., 2012; Eckstein and Kogot, 2017; State Comptroller, 1995, 2005, 2015; and Bank of Israel, 2014, 2019). These characteristics contribute to the rigidity of the land supply for residential construction and indirectly to the rigidity of supply in the housing market. On the other hand, state ownership of the land has enabled the government, since 2015, to implement affordable housing programs aimed at providing first-time homebuyers[3] with apartments at below-market prices.

Our research uses ILA data on the results of land tenders for high-density construction[4] held between 2000 and 2023, with results published until April 2024 (inclusive), and focuses on the impact of diverting a significant portion of the marketed land to affordable housing programs on developers' bids in regular land tenders (i.e., for building homes for the open market). The research period includes tenders held between 2022 and 2023, in a changing economic environment due to rising interest rates and a cooling housing market.

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1. Except for lands with clear public uses such as natural resources, national infrastructure, and security uses. The rate of public land ownership is also influenced by the percentage of inhabited areas in the country. For example, in the US, about 28% of the total land area is federally owned, with significant variation between states, from only 0.3% in Connecticut and Iowa to 80.1% in Nevada (according to Federal Land Ownership: Overview and Data, Congressional Research Service, updated February 21, 2020).
2. Currently, lease contracts are for 98 years with an option for an additional 98 years under conditions that will be in effect at the time of contract renewal.
3. Individuals without home ownership according to the criteria of the Ministry of Construction and Housing, who have obtained an eligibility certificate. For the exact definition, see, for example, the Israel Land Council's decisions file.
4. According to the Ministry of Construction and Housing, high-density construction is defined as construction with a minimum density of 4 housing units per dunam. According to the ILA, high-density construction is defined as residential buildings with at least 4 apartments in at least 2 floors, with at least one apartment on each floor, and the building is eligible to be registered as a condominium under the Land Law, 1969. For this study, we define plots for high-density construction as those intended for the construction of at least 6 housing units.

The estimation results are similar to those of a shorter sample ending in 2021, serving as a robustness check for the estimation. To estimate the impact of land marketing for affordable housing, we define an index for the intensity of land allocation to the "Buyer's Price," "Reduced Price Housing," and "Target Price" programs in each locality. The index measures the number of housing units planned to be built on the land marketed through these tenders as a share of the total housing units planned on land marketed by ILA.

To isolate the impact of government programs on bid prices in regular tenders, we construct an empirical model of the demand for residential construction land that includes factors defined at various levels of aggregation: 1) specific characteristics of land tenders; 2) data on developments in local housing markets at the locality level (transactions and changes in home prices, marketing of land for low-density construction, and marketing of land exempt from tender, as an indicator of competing future construction); and 3) a macroeconomic factor: forecasters' projections for the Bank of Israel interest rate close to the tender closing dates.

State ownership of a large portion of residential construction land, the existence of a governmental body responsible for marketing land to private developers, and the marketing method through public tenders make the ILA's database unique.[5] Only a few studies in the international literature have dealt with land tenders. Hüttel et al. (2013), Croonenbroeck et al. (2020), and Lehn and Bahrs (2018) used data on agricultural land prices closed in public tenders in Germany. Despite the availability of ILA land tender data, their use in Israel has been limited so far. Rubin and Felsenstein (2017) examined the impact of state land ownership on housing supply and found that this impact is weak because the marketed land is in areas with relatively low demand for housing, while in high-demand areas, there is an alternative of private land. Weintraub Gaffney (2021) used tender data to estimate land value under buildings for national accounting purposes. Other studies have dealt with the development of land prices (Bank of Israel, 2013) and the impact of national land ownership on the sluggishness of the housing market (Alterman et al., 2020). These studies used land prices determined as the winning bid in the tender. For the first time, our research offers a comprehensive analysis of the distribution of developers' bids.

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[5] A similar method exists in China, land is owned by the state, and there is a separation between ownership and land use rights. Since 2002, land use rights are mainly granted through tenders and public auctions, but the results of the tenders are not widely published.

Unlike studies that dealt with deriving the hedonic price of land (Glaesener and Caruso, 2015, and Glumac et al., 2019 in the urban sector; Maddison, 2000; Bastian et al., 2002, and Kostov, 2009 in the agricultural sector), our study looks at the distribution of bids in tenders in order to exploit the large variance between the offered prices for the same land. This variation reflects differences in developers' private valuations of the land, which are partly due to differences in expectations for future home prices, differences in construction and credit costs, and different understandings of the implications of government programs on the housing market.[6]

We apply a quantile regression following Gimenes and Guerre (2022), Gimenes (2017), De Silva et al. (2009), Sun et al. (2016), Kim et al. (2015), Zhang and Leonard (2014), and Amédée-Manesme et al. (2020). Unlike regular regressions, this semiparametric method does not assume symmetry in the error distribution, and allows for varying exogenous effects across the quantiles of the dependent variable's distribution. Regarding agricultural land prices, using a quantile regression, Lehn and Bahrs (2018) found that the impact of physical characteristics of the land and the farm is stronger in the lower quantiles of the price distribution, while the impact of other factors such as population change and residential construction in nearby areas is more noticeable in the higher quantiles of the distribution. Kostov (2009) obtained a similar result in a quantile regression analysis of transaction prices for agricultural land in Northern Ireland.[7]

Our methodological contribution lies in the combination of two econometric developments within the quantile regression framework and their application to the analysis of bid prices in land tenders. The first is Koenker's (2004) development of a quantile regression for panel data using the lasso mechanism while controlling for fixed tender effects. The second is a selection correction (in the sense of Heckman, 1979, due to the closure of some tenders without any bids) based on the works of Koenker (2017) and Arrelano and Bonhomme (2017).

[6] Another advantage of looking at the entire range of bids has become more pronounced recently due to the ILA's decision at the end of 2021 to prevent developers from winning multiple plots in the same tender to avoid monopolistic power in large projects. Developers are still allowed to submit bids for all plots in the tender to increase their chances of winning, but they cannot win more than one plot. As a result, the "winning price" recorded for many plots is not the highest bid offered for them.

[7] Lehn and Bahrs (2018) used average land price data without information on bid amounts in tenders; Kostov (2009) used transaction price data from a buyers' survey.

According to our results, extensive marketing of land for construction under government programs reduces the attractiveness of regular tenders in the same locality, as shown by the increased likelihood of tenders closing without any bids. After selection correction, we find that the bid prices in regular tenders increase as the relative intensity of marketing under government programs increases (and regular marketing decreases relatively). This effect strengthens as we move from lower to higher bid quantiles in the center and periphery of the country, but not in the Jerusalem area. Additionally, we find that mere "proximity" to localities where land for affordable housing projects is marketed raises the bid prices in regular tenders in localities where no land was marketed under government programs. These effects are much stronger in the periphery than in high-demand areas. It is likely that the development of privately-owned land and the expansion of construction under urban renewal in high-demand areas mitigated the impact of the reduction in regular ILA land tenders on the prices of land marketed in such tenders. These results align with the conclusions of Rubin and Felsenstein (2017) regarding the substitution between private and state-owned land in high-demand areas.

Additionally, we find that the rise in home prices in the year before the tender, which may reflect developers' expectations regarding the prices of homes to be built on the purchased land, increases the bid prices. This effect is stronger in the center of the country, and increases across the bid distribution in the periphery. Interest rate expectations have a significant negative impact on bid prices, which strengthens across the quantiles in the center of the country and in the Jerusalem area and remains stable in the periphery.

The remainder of the paper is organized as follows: Section 2 describes the method of marketing state-owned land in Israel; Section 3 discusses the possible implications of government programs for land prices; Section 4 describes the data; Section 5 presents the econometric model; Section 6 presents the results; and Section 7 concludes.

2. Marketing of State-Owned Land in Israel

Historically, most construction in Israel was public, and only during the 1980s did government involvement in the construction sector decrease. However, it resumed in 1989 with the wave of immigration from the former Soviet Union. Following overbuilding in the early 1990s, especially in the periphery, the government, the Ministry of Finance, and the Ministry of Construction and Housing decided in late 1991 and during 1992 to reduce public-initiated construction and to market land to developers directly through the Israel Lands Administration (ILA), focusing on high-demand areas in central Israel (State Comptroller, 1995). The ILA was tasked with marketing the land through public tenders according to the Mandatory Tenders Law, 1992, and in certain cases, it was given the right to allocate urban land without a tender, according to the Mandatory Tenders Regulations, 1993.

Today, state lands designated for residential construction are managed by the Israel Land Authority (ILA), which replaced the Israel Lands Administration in March 2013. The distribution of land ownership is not uniform across different regions. In the periphery, the vast majority of land is owned by the state, the Development Authority, and the Jewish National Fund, and is managed by the ILA. In contrast, a significant portion of land in urban areas in high-demand regions is privately owned, sometimes jointly with the state. Private lands are found in the centers of major cities, in old settlements, and around major cities.[8] The State Comptroller's Report (1995) estimated that private land constitutes between 30% and 60% of all land in high-demand areas.

State land is generally marketed through public tenders, in the form of sealed bid auctions, where the highest bid wins. This tender method achieves two goals: (1) fairness, as any developer can anonymously participate in any tender; and (2) maximizing state revenues, as land is a national resource. Given the state's ability to regulate land marketing as the sole owner of a large portion of the land, the highest bid tender method can increase land prices. This method, along with under-marketing (compared to the demand for homes), has often been cited as a major reason for rising home prices, as land is one of the main production factors in "producing" homes.[9]

A special State Comptroller audit report on the housing crisis (2015) addressed not only the reasons for the surge in housing prices since 2008 but also the lack of a government policy on affordable housing. Among other things, the report stated: "For more than a

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8 Such localities include, for example, Tel Aviv, Petah Tikva, Herzliya, Holon, Hod Hasharon, Hadera, Gedera, Givat Shmuel, Ganei Tikva, Bnei Brak, Ramat Gan, and Givatayim.

9 Several State Comptroller reports criticized the activities of the bodies involved in the development and marketing of land designated for residential construction. Among other things, these reports found continuous noncompliance with government land marketing targets. See State Comptroller Reports (1995, 2002, 2005, 2015).

dozen years, the government did not set targets for marketing apartments under the 'Mechir Le-Mishtaken' ("Buyer's Price") program". But even when the state set such targets, it did not meet them.[10] Marketing land under the "Buyer's Price" program is not a regular tender. Developers do not compete on the land price, but on the final price per square meter of the dwelling. The developer that offers the lowest bid wins the tender and purchases the land at a discount.

In 2014, the government decided on the "Target Price" program, where the state set the apartment price for eligible buyers (80% of the apartments marketed in the project), and developers competed on the land price.[11] Under this program, plots were marketed for construction in only two localities – Rosh HaAyin and Modi'in. In 2015, the new "Buyer's Price" program began, aiming to provide apartments at reduced prices compared to open market prices for households without home ownership. The program gradually expanded to many localities and became the first large-scale affordable housing program, both in terms of the number of housing units marketed and the geographical coverage. At the end of 2019, it was replaced by the "Reduced Price Housing" program with some changes in its terms (while "Buyer's Price" tenders continued to be held in 2020). Additionally, land marketing under the "Target Price" program resumed. It gradually replaced the "Reduced Price Housing" program and continues to this day. From the beginning of the affordable housing programs until the end of April 2024, land for the construction of approximately 171,000 housing units has been successfully marketed with government subsidies across the country.

These lands are regular lands that are part of the planned and available land inventory for marketing[12], and therefore did not constitute an addition to the lands that would have been

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[10] From the special audit report on the housing crisis (2015): "Only in September 2011, following the recommendations of the Trajtenberg Committee, it was determined that the ILA and the Ministry of Construction should complete the marketing of 5,000 housing units under this program by the end of 2012. In practice, only about 2,600 housing units were marketed that year. ... Given the poor outputs of this program, the government decided, after the audit was completed, to stop its operation."

[11] Although the competition in these tenders is on the land price, unlike the regular ILA tenders, the offered price does not reflect the market price of the land because developers are required to sell the dwellings at below-market price.

[12] In many localities, plots were marketed for open market construction and affordable housing in the same neighborhood. In places such as Kiryat Bialik, Ofakim, Kiryat Shmona, Kiryat Gat, Hatzor HaGlilit, Arad, Dimona, Yokneam Illit, Kiryat Ono, Ashkelon, Lod, and others, the marketing was sometimes even close in time.

marketed through regular tenders, but were marketed instead.[13] This shift created a crowding-out effect, as the number of regular tenders significantly declined with the start of the "Buyer's Price" program (Table 1). The year 2021 is remembered as one when winning bids in ILA tenders sharply increased and were much higher than the government appraiser's estimates for those lands, despite the peak in marketing that took place that year. Particularly high winning bids for lands in high-demand areas (mainly in tenders in Tel Aviv, Ramat Hasharon, and Netanya) also attracted significant public attention. The rise in interest rates in the economy starting in April 2022 cooled the housing market in general and the demand for land in particular. The success rate of tenders declined, and land prices fell during 2022–2023. With the outbreak of the Swords of Iron War on October 7, 2023, the closure of all tenders that were supposed to close by the end of 2023 was postponed to 2024.

3. The Impact of Government Programs on Land Prices in Regular Tenders

Like any other government intervention, one that is aimed at providing affordable housing creates an equilibrium different than that of the market. The intervention may lead to higher land prices, as well as an increase in the relative price of land designated for restricted uses (Whitehead and Monk, 2006; Whitehead, 2007). Gibb (2013) also argues that planning system policies may result in higher land and home prices and less affordable housing.

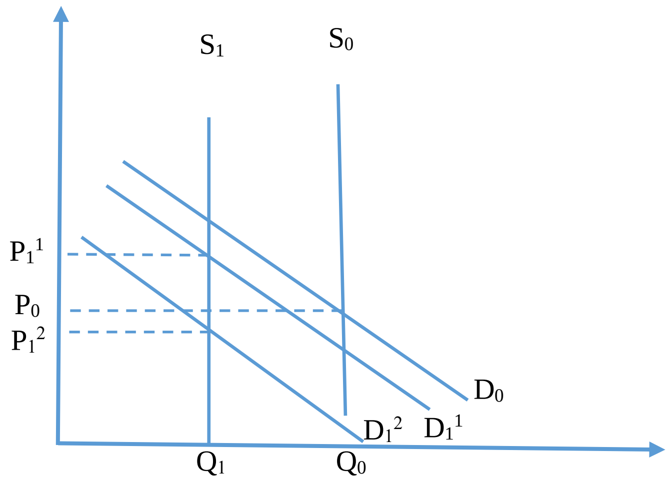
In Israel, the extensive marketing of land designated for eligible buyers under government programs has effectively created a division into two separate markets: the land market for building affordable housing and the land market for building homes for the open market. As noted in Section 2 and as shown by the data in Tables 1 and 2, the supply of land in regular tenders, both in terms of the number of plots and the number of housing units, has significantly and sharply decreased since the implementation of the affordable housing programs. This can be illustrated by a leftward shift of the supply curve (a reduction in supply from S_0 to S_1) in Figure 1.

[13] This claim does not contradict the fact that in 2021–2022, the total amount of land marketed in all programs increased.

The impact on land prices in the open market depends on the elasticity of demand for these lands and the degree of substitutability between the lands, derived from the substitutability between the homes built for eligible buyers and those built for sale in the open market. In this context, two possible scenarios can be considered. In the first scenario, the substitutability between the homes, and therefore also between the lands for the open market and the affordable housing market, is low (i.e., the shift in demand for homes to the affordable housing market is limited). In the second scenario, the substitutability is high, resulting from the shift of potential homebuyers to the affordable housing market and consequently a decrease in developers' demand for land for construction in the open market.

These two scenarios are illustrated in Figure 1 by a shift of the demand curve – D_1^1 in the first scenario and D_1^2 in the second scenario – which will lead to an increase in land prices for construction in the open market in the first scenario (P_1^1) or a decrease in land prices for construction in the open market in the second scenario (P_1^2).

Figure 1: The Impact of the "Buyer's Price" Program on the Land Market for Regular Housing



The decision between the two scenarios is an empirical question. However, there are several arguments in favor of the first scenario. First, in the early years of the "Buyer's Price" program, the quality of construction of homes designated for eligible buyers was perceived as poor due to developers needing to cut construction costs to offer low prices, as the competition in tenders was based on the final price per square meter of the apartment.[14] Subsequently, to improve construction quality, the government decided to integrate open-market apartments into "Buyer's Price" projects and set a minimum standard for the equipment of the affordable housing apartments. Second, the implementation of the government program increased demand from the population that met the criteria. The prices of the lottery apartments reflected significant discounts from market prices (see analysis in Box 8.1 of the Bank of Israel *Annual Report* for 2022), and many households obtained eligibility certificates and participated in the lotteries for the affordable housing apartments.[15] Households that could not afford to buy an apartment at market prices tried their luck and even took advantage of eased mortgage lending rules that allowed buyers under the program to take larger mortgages.[16] In the two years before the start of the "Buyer's Price" program, first-time homebuyers constituted about 43% of all homebuyers (new and second-hand apartments combined), but during the program's operation (up to and including 2020), their share rose to over half. The increase in demand for apartments following the entry of potential buyers who did not plan to purchase an apartment without the program increased total demand (it is likely that the demand from housing upgraders and investors did not decline due to the program). Despite the extensive scope of the government programs, they did not manage to meet the growing demand from eligible buyers. Transactions under the government programs constituted only about a fifth of the total purchases by first-time homebuyers from 2016 to 2022. The increase in total demand for homes was supposed to also lead to an increase in total demand for land for residential construction.

The above analysis refers to the housing market as a whole, but regional differences may exist. First, in areas where the demand for homes is relatively low, flooding the housing market with affordable housing may deter developers from building homes for the open market, which could be reflected in a decrease in the attractiveness of regular tenders – either no bids or relatively low bids, resulting in a decrease in land prices. Second, differences in the intensity of the impact may also exist. Limiting the amount of land

[14] For further details, see, for example, Bank of Israel (2017).

[15] From the start of the "Buyer's Price" program until the end of 2022, about 358,000 households obtained eligibility certificates allowing participation in the lotteries.

[16] In 2016, the Banking Supervision Department directive limiting housing loans (Proper Conduct of Banking Business Directive 329) was amended to allow a banking corporation to base the value of the purchased property in an affordable housing project on an appraiser's assessment (reflecting the market price) instead of the actual purchase price for properties worth up to NIS 1.8 million. The amendment also set the minimum equity requirement for the buyer at only NIS 100,000.

marketed through regular tenders, and the resulting increase in land prices, may lead to increased utilization of private land reserves in localities where they exist. In recent years, with the expansion of urban renewal programs, even built-up land in city centers can serve as an alternative to land marketed by the ILA. Using alternative land may mitigate the impact of the affordable housing programs on land prices in regular ILA tenders.

The uniqueness of the "Buyer's Price" program leaves us without a benchmark for estimation results. Intervention in the housing market to provide affordable housing is indeed common in many countries, but it mainly involves long-term rentals rather than selling apartments at reduced prices. It also does not involve creating separate markets. Affordable housing is usually provided by requiring a certain share of dwellings designated for disadvantaged populations to be included at the project planning stage. These apartments are rented or sold at prices lower than the market price. Although in most countries land is privately owned, planning institutions at the national and local levels regulate the construction process, and construction cannot proceed without a permit. Known regulatory intervention is called zoning, which defines the land use in new construction, such as residential, industrial, commercial, etc., and determines the construction density, and shape and size of the buildings, etc. It also sets out requirements for including affordable housing[17] (a phenomenon called "inclusionary zoning"), but this policy sometimes achieves the opposite result and harms the same population groups it is intended to help (Powell and Stringham, 2005).

In the UK, affordable housing policy is considered relatively successful due to the land use planning mechanism (Whitehead, 2007). The land is privately owned, but all development rights belong to the government, which uses this fact to require the inclusion of affordable housing as a condition for approving construction plans. The scope of affordable housing is adjusted to the project, and sometimes instead of building affordable housing apartments, developers are required to pay a direct tax, with the funds used for infrastructure, transportation, or education development (Barlow et al., 1994; Campbell et

[17] For example, in New Zealand, a requirement was set for any developer building 15 housing units or more to sell 10% of the units at a price lower than 75% of the median regional price or alternatively to sell 5% of the units at a price that translates to a monthly mortgage repayment lower than 30% of the median gross household income (Housing Accords and Special Housing Areas (Auckland) Order, 2013). In Australia, requirements for including affordable housing in new construction were set at 15% in some areas in the second half of the first decade of the 2000s, mostly with local government subsidies. Gurran and Whitehead (2011) note that these were local initiatives that were not sufficiently supported by the central government.

al., 2000). Requirements for including affordable housing in new construction range around 15%–20%, but reach about 50% in London. Over time, owner-occupied housing as a share of total affordable housing has increased (Gurran and Whitehead, 2011). In China and Hong Kong, the state owns the land, similar to Israel, and the planning system is similar to the Israeli one. In China, the local government identifies suitable places for selling subsidized housing and invites developers to submit bids. Profit rates are negotiated. The government sets the standard, sells the land at a below-market price, and allows increased construction density in commercial areas as compensation for lower profit margins in residential construction (Chiu, 2007). In Hong Kong, subsidized construction targets are set at early planning stages, and are taken into account in development and land sale plans. The government directly builds and provides subsidized rental housing, and a large portion of subsidized housing for sale is for low-income households. In 2004, about 18% of Hong Kong's population lived in owner-occupied apartments purchased from the state at a subsidized price (Hong Kong Housing Authority, 2004). Since revenue from land sales to private entities is one of the main sources of government income, land designated for public construction is cheaper land located in less attractive areas (Chiu, 2007). To the best of our knowledge, the question of the impact of affordable housing policy on land prices has not been studied in these countries.

4. Data and Variables

The primary data used in our research are from the Israel Land Authority, covering all public land tenders for plots with 6 or more housing units conducted from 2000 to 2023, with results published until April 2024, excluding tenders for special housing (sheltered housing or dormitories), rental construction tenders, and tenders in Arab localities.[18] These are detailed data about each tender, sometimes including multiple plots under the same tender number. Plots are usually divided when the total number of housing units is relatively large to allow more than one developer to win the tender. Each plot receives a different file number. If the ILA fails to market a plot, it usually appears in subsequent tenders (sometimes more than once) under the same file number but a different tender number, allowing us to track the same plot in repeated tenders. Each tender includes three

[18] We did not include Arab localities in the research because high-density construction is less common there. Also, public tenders in the Arab sector are rare, with land sales usually done through registration and lottery for self-construction.

dates: publication date, closing date (last day for submitting bids), and committee date (day the winner is chosen).

The data we use include the name/code of the locality where the land is marketed, the number of housing units in the plot, the development costs the developer must pay in addition to the land price, whether there is a minimum price in the tender and its amount, and whether it involves mixed-use construction with commercial space. For tenders that have been discussed (committee date has passed), the status of the winner is recorded (whether there is a winner or not). For each tender with a winner, information on the winning bid and the winner's name is available, and for tenders without a winner, the reason why there was no winner was provided until 2017 (inclusive).[19] Based on the tender publication date, we calculate the time elapsed since the previous tender in the same locality as one of the land supply measures. For each plot, we count the number of times it appeared in tenders (including unsuccessful ones). Additionally, we define "large plots" as those with a planned number of housing units in the top 5% of the distribution in each of the defined regions (see below). The observations of our dependent variable come from a separate file containing data on all anonymous bids submitted for each plot in all tenders. Plot data is matched with bid data based on a unique combination of file number and tender number.

After filtering out irrelevant tenders (in terms of purpose and list of localities, as well as canceled tenders), we obtained 4,258 plots in regular public tenders[20] in Jewish and mixed localities for the years 2000–2023, of which 2,996 plots were successfully marketed (an average success rate of about 70% in terms of plots).[21] A summary of the distribution of tenders by years is presented in Table 1.

The data in Table 1 indicate that the volume of land marketed in terms of the number of housing units was low from 2000 to 2008, and the success rate of tenders (tenders closed with a winner) was also relatively low. The housing crisis erupted in 2008-2009 with a

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[19] The most common reason for no winner is "no bids submitted," but there are other situations, such as "low bids," "invalid bids," "bidder won another plot" (when the bidder won several plots but chose not to realize his win in some), and more. Sometimes the ILA may decide not to declare a winner for its own reasons.

[20] We also include in regular tenders unspecified plot tenders and initiated tenders (for lands without an urban building plan) conducted in recent years.

[21] In fact, because the marketing is not always successful (i.e., there is not always a winner), out of 4,258 plots, many were offered for marketing more than once.

double-digit price increase, and from 2009, the ILA significantly increased marketing, as reflected in both the number of plots and housing units. Success rates in marketing also rose, except for 2011, which was marked by social protests and a housing market standstill. Land marketing peaked in 2014, but from 2015 to 2019, the number of regular tenders sharply declined because most land was marketed under the "Buyer’s Price" program. The programs implemented in recent years were more limited, so the volume of land marketed in regular tenders increased in 2020 and 2021, despite disruptions in the ILA activities due to the COVID-19 pandemic in 2020. The renewed decline in the number of regular tenders in the last two years is due to the cooling housing market in 2022 and the outbreak of war in October 2023. Additionally, the data show that developers' interest in the ILA's regular tenders, as measured by the share of plots with submitted bids, varies over time. For example, interest in tenders peaked in 2021, while in the last two years, the share of plots with bids has decreased. This selectivity is influenced by various factors, including the spatial composition of the lands offered in tenders. The average number of bids per plot varies over the years, but it is difficult to identify a stable relationship between it and other variables in Table 1, except for a relatively weak positive correlation between the average number of bids and the average success rate in marketing plots, with a correlation coefficient of 0.46.

Table 1. Characteristics of Regular Land Tenders for High-Density Construction of 6+ Housing Units in Jewish and Mixed Localities, 2000–2023, Excluding Canceled Tenders

Year	No. of localities where land tenders were conducted	No. of plots in tenders that were conducted	Share of plots for which bids were submitted	No. of plots successfully marketed	Share of plots successfully marketed	No. of housing units in successfully marketed plots	Average no. of bids for a successfully marketed plot
2000	35	188	72%	129	68.6%	7,854	9.7
2001	30	135	61%	77	57.0%	3,716	5.4
2002	43	172	76%	121	70.3%	5,109	6.3
2003	49	246	69%	166	67.5%	7,692	5.2
2004	45	233	55%	125	53.6%	4,725	9.0
2005	44	196	70%	129	65.8%	8,002	9.1
2006	24	118	64%	74	62.7%	3,616	9.9
2007	35	135	74%	87	64.4%	4,788	6.1
2008	36	171	67%	82	48.0%	4,436	5.0
2009	45	218	89%	186	85.3%	10,638	8.1
2010	48	252	93%	218	86.5%	14,450	8.8
2011	40	295	68%	162	54.9%	10,766	4.5
2012	42	262	83%	189	72.1%	13,171	5.5
2013	62	306	81%	223	72.9%	14,243	6.7
2014	57	437	91%	372	85.1%	24,560	8.9
2015	34	99	91%	85	85.9%	3,118	9.8
2016	26	83	76%	54	65.1%	1,986	6.3
2017	22	40	70%	27	67.5%	1,490	6.2
2018	24	50	74%	31	62.0%	1,252	3.5
2019	37	106	67%	64	60.4%	3,408	6.3
2020	39	145	72%	97	66.9%	11,178	11.2
2021	47	190	94%	171	90.0%	17,380	13.8
2022	35	81	88%	64	79.0%	9,003	11.4
2023	21	100	79%	63	63.0%	4,885	14.0

We will present the data grouped into five periods based on insights from Table 1: (1) the period before the housing crisis; (2) the period following the housing crisis and before the "Buyer's Price" program; (3) the "Buyer's Price" program period; (4) first two years after its end, during which other affordable housing programs were implemented; and (5) the last two years, during which housing market activity slowed. Additionally, we will divide the country into three regions based on housing market demand, which determines land demand: Jerusalem area (Jerusalem district), Center (Central and Tel Aviv districts), and Periphery (Haifa, Northern and Southern districts, and Judea and Samaria area). Table 2 presents the results of successful marketing for regular tenders and those under affordable housing programs by this division.

Table 2. Characteristics of Successful Tenders by Regions and Periods

Period	No. of housing units in the successful regular tenders	Rate of success in regular tenders	No. of housing units in the successful subsidized tenders	Rate of success in subsidized tenders	No. of localities where land tenders were conducted, by type		
					Both	Regular only	Subsidized only
Jerusalem area							
2000-2008	7,655	88.8%			0	5	0
2009-2014	10,750	76.2%			0	4	0
2015-2019	628	94.6%	13,608	55.2%	2	2	2
2020-2021	1,750	93.6%	1,753	95.5%	1	1	0
2022-2023	377	84.9%	231	32.4%	2	1	0
Center							
2000-2008	21,642	76.0%			0	38	0
2009-2014	23,940	96.8%	2,282	83.1%	2	34	0
2015-2019	2,862	86.1%	36,258	77.9%	15	8	10
2020-2021	10,414	92.6%	10,820	83.6%	5	19	4
2022-2023	6,365	75.6%	9,330	90.1%	5	13	7
Periphery							
2000-2008	20,641	54.2%			0	43	0
2009-2014	53,138	72.1%			0	56	0
2015-2019	7,459	50.4%	52,383	55.2%	31	12	14
2020-2021	15,944	84.8%	25,608	96.5%	18	19	11
2022-2023	7,146	58.8%	18,555	51.5%	10	7	10

Data from Table 2 show that: (1) success rates in regular land tenders in the Periphery are lower than those in the Center and Jerusalem areas; (2) in the second period, after the housing crisis, the success rate in tenders significantly increased in the Center and the Periphery but not in the Jerusalem area; (3) during the "Buyer’s Price" program period, success rates in regular tenders declined in the Center and the Periphery, likely due to extensive land marketing under the program, while in the Jerusalem area, success rates in regular tenders increased, especially against the backdrop of low success rates in "Buyer’s Price" tenders, due to the scarcity of affordable housing projects in the city of Jerusalem itself and the focus on such projects in Beit Shemesh; and (4) high success rates in regular tenders are notable in all regions in 2020–2021, with a decline in 2022–2023, especially in the Periphery.

From the data on land tenders conducted under all affordable housing programs since 2014 ("Buyer's Price," "Reduced Price Housing" and "Target Price"), we calculate an index for the intensity of these programs in each locality as the number of affordable housing units marketed as a share of the total number of housing units in ILA land marketing through tenders. The index is defined as follows: The numerator is the sum of all the housing units planned to be built under the affordable housing programs that appeared in successful land marketing (tenders that have been closed and have a winner) and in still open tenders in the same locality, from the start of these marketing efforts until the closing date of the regular tender.[22] The denominator is the sum of all the aforementioned housing units and all the housing units in previous regular tenders in the same locality, counted similarly to the affordable housing units. This index ranges from 0 to 1 and can increase or decrease over time.

According to the theoretical analysis presented in Section 3, if affordable housing units "compete" with market-price housing units, a high intensity of the program in a locality may reduce developers' willingness to participate in regular land tenders in that locality and exert downward pressure on land prices for open market residential construction. However, since only some households are eligible to purchase affordable housing program dwellings, the demand from the rest of the public will meet a limited supply of newly built apartments. This may increase developers' demand for land to build homes for the open market and lead to higher land prices.

Due to the short distances between localities in a small country like Israel, localities where land for affordable housing has not been marketed may be indirectly affected by such marketing in neighboring localities. Massive land marketing for affordable housing in certain localities may increase the attractiveness of regular land tenders in neighboring localities where land for affordable housing is not marketed. For example, land marketing for affordable housing in Kiryat Bialik may affect regular land marketing in other localities in Krayot region where land for affordable housing has not been marketed. To address this effect, we defined 53 groups of neighboring localities based on two criteria that influence their substitutability: 1) geographical proximity and 2) similarity in

[22] The addition of open tenders the results of which are unknown at the time the index is calculated is important because developers participating in regular tenders should consider the scope of **planned** affordable housing programs for the coming years.

socioeconomic level of the population.[23] For localities where land for affordable housing has not been marketed, we use a dummy variable that takes the value 1 if land for affordable housing has been marketed in another locality in the neighboring group and 0 if no land has been marketed for this purpose in any locality in the neighboring group. Appendix A presents a list of 127 Jewish and mixed localities where regular tenders for high-density construction were conducted between 2000 and 2023, with standard classification by districts/subdistricts and the defined neighboring groups for the purpose of this research. It also shows data on the first tender dates for "Buyer's Price" or "Target Price" programs since 2014. Appendix B shows the development of the index for the intensity of affordable housing programs, as defined above, in selected years.

To calculate additional explanatory variables, we used the number of land transactions for industrial and commercial purposes in the 18 months preceding a regular tender for high-density construction as a measure of investment in employment development in the locality,[24] the number of housing units in transactions for land sales for less than 6 housing units per plot, and transactions for tender-exempt high-density construction land sales in the 18 months preceding a regular tender for high-density construction, as two measures of alternative residential construction in the same locality. These data were calculated from ILA transaction files.

Our research does not address the mutual influence between land prices and housing prices, but we must consider that developers participating in land tenders have information on home prices in the project area and expectations regarding their future development. According to the Ricardian approach, land price is derived from asset market prices. Based on this approach, Alonso (1964) and Muth (1969) defined land value as the value of developed land minus development costs and desired profit margins. This method, known as the residual approach, is commonly used in real estate appraisal to derive land value, defined as the amount remaining after subtracting all construction costs and developer profit from the value of the built asset. This method is also used by developers in deciding the price they are willing to pay for land (Somerville, 1996; Adams et al., 2009; Leishman et al., 2000; Monk et al., 1996). Developers' expectations regarding future home sale

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23 Of the 53 groups, some include only one locality because no suitable neighbor was found according to both criteria.

24 The choice of the number of transactions is imposed on us because plot area data is missing in many transactions.

prices will influence their bids for land. Expectations of higher home prices will lead to higher bids (Oxley, 2004; Monk et al., 1996). Antwi and Henneberry (1995) provide evidence from the commercial real estate market, where developers assume that historical trends will continue and derive expectations from recent trends. In a rising housing market, a developer may think that home prices in a year or two, when he starts marketing them, will be higher than those prevailing at the time of the land purchase. Rising home prices can also reflect regional development (such as infrastructure, transportation, and employment development) that we do not observe at the individual locality level but may affect land value. Since the development of housing demand and prices varies between regions, developers examine price developments at the locality level where the land is marketed.

We use real estate transaction data from the Real Estate Price Register (CARMAN) to calculate the change in home prices and the number of transactions in the housing market in the 12 months preceding the tender publication, normalized to population size, at the locality level. These data reflect the activity in local housing markets. Annual rates of change in home prices in localities where land tenders were conducted are calculated using hedonic regression according to the Central Bureau of Statistics (CBS) methodology based on real estate transaction data. In addition to the sale price, this methodology includes information on the main quality variables of the asset (such as type of dwelling – regular, garden, or rooftop apartment or cottage, number of rooms, dwelling area, building age, new or second-hand dwelling, etc.) and the dwelling's statistical area, allowing the addition of the CBS socioeconomic index of that area to the analysis. Additionally, we incorporate the identifier of transactions under the "Buyer’s Price" program from the Tax Authority transaction files since 2018 (start of reporting). The estimation method and calculation of indices are detailed in Appendix C.

Developers who purchase land usually finance the purchase with short-term bank loans (two to three years) with interest rates linked to the prime rate. Therefore, another data point we use is the analysts' average projections for the Bank of Israel interest rate for the next 12 months, as it was a month before the tender closing date.

Additionally, in estimating the likelihood of bid submissions in a tender (selection equation), we use data on local authorities' extra-budgetary development expenditures per capita in the year before a land tender in the locality as a measure of local investment and infrastructure development. These data are calculated from CBS local authority data files.[25]

Tables 3.1 and 3.2 provide descriptive statistics of the data divided into three regions. The high bid values for land per housing unit at the upper end of the bid distribution are noteworthy, especially in the Center. In places where land supply is limited and housing demand is strong, the fiercest competition among developers is mainly for land access (Adams and Watkins, 2008; Barker, 2004). When land supply is limited due to planning constraints or other reasons, the developer is less concerned about competition with other developers. Therefore, in places where land release is limited and slow, the developer can be more optimistic about the prices he can achieve in the housing market. Stronger competition for land causes developers to think that to win, they need to offer a price higher than that derived from the residual method, and they calculate a higher bid by reducing construction costs and squeezing profit margins (Monk et al., 1996). In such cases, bids are likely to be high relative to the appraisal of the same land conducted by the government appraiser.[26] Figure 2 illustrates this phenomenon. The figure shows the ratio of the winning bid to the government appraiser's appraisal. In 2020-2021, the distribution of this ratio shifted significantly to the right in the Tel Aviv district and more moderately in the Central district. In contrast, in 2022–2023, a leftward shift in the distribution is evident in all high-demand areas.

Since in the first-price sealed bid auction the winning bid equals the purchase price, the bid that ensures maximum profit is necessarily lower than the participant's private valuation. The developer's dilemma in a land tender is between submitting a bid lower than his private valuation, which would increase future profits but risk losing the tender, or submitting a bid that reflects or even exceeds his private valuation, which would reduce profits but increase the probability of winning the tender. The expectation of rising home prices in the locality in the coming years will certainly encourage the developer to choose the second option. The choice between the two options also depends on the developer's

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[25] We tried using several additional variables characterizing the localities, including the growth rate of the young population (ages 25–44), socioeconomic index, peripherality index, and topography index, as well as the entry into operation of new train stations, but their impact was not statistically significant in the estimation.

[26] The appraisal amount is not disclosed to developers, but it appears in most tenders in the ILA data files we use. However, the minimum price published in most tenders is usually derived from the appraisal, so experienced developers can infer the appraisal amount from it.

risk aversion and business situation at the time of the tender. For example, whether the developer has a pipeline of additional projects ensuring a revenue stream, given the lack of information on the timing and location of future land marketing; whether he has the ability to secure funding for land purchase or cheaper-than-average financing as a public company; whether he is efficient enough in construction costs to make the project profitable; whether the marketed plot contains enough housing units to create economies of scale; whether he anticipates being able to request and receive planning easements from the local planning committee to increase the number of housing units in the project according to the Sheves amendment, thus increasing profits; and whether he is interested in establishing a "foothold" in a particular locality where he is already building and specializing, or alternatively, seeking an opportunity to enter a new market, especially in high-demand areas.[27] All these factors can explain the differences in developers' bids for the same land. We do not examine the impact of these considerations on bid amounts in this study.

The list of all variables is summarized in Table 4.

[27] The phenomenon of establishing a "foothold" deserves special attention because it reflects the developer's private value, where he derives special benefits from participating in and/or winning the tender due to the synergy between the marketed land and the projects he is executing in the same locality. Winning a tender in the same area where the developer has projects for sale will strengthen his position in that area, reduce competition from other developers, and allow him to maintain higher housing prices. Unfortunately, we cannot expand the research in this direction at this stage because we do not have details on the identities of the tender participants, except for the winners.

Figure 2: Distribution of the Ratio Between the Winning Bid and Land Appraisal in the Jerusalem, Central, and Tel Aviv Districts, and the Periphery (Northern, Haifa, and Southern districts and Judea and Samaria area)

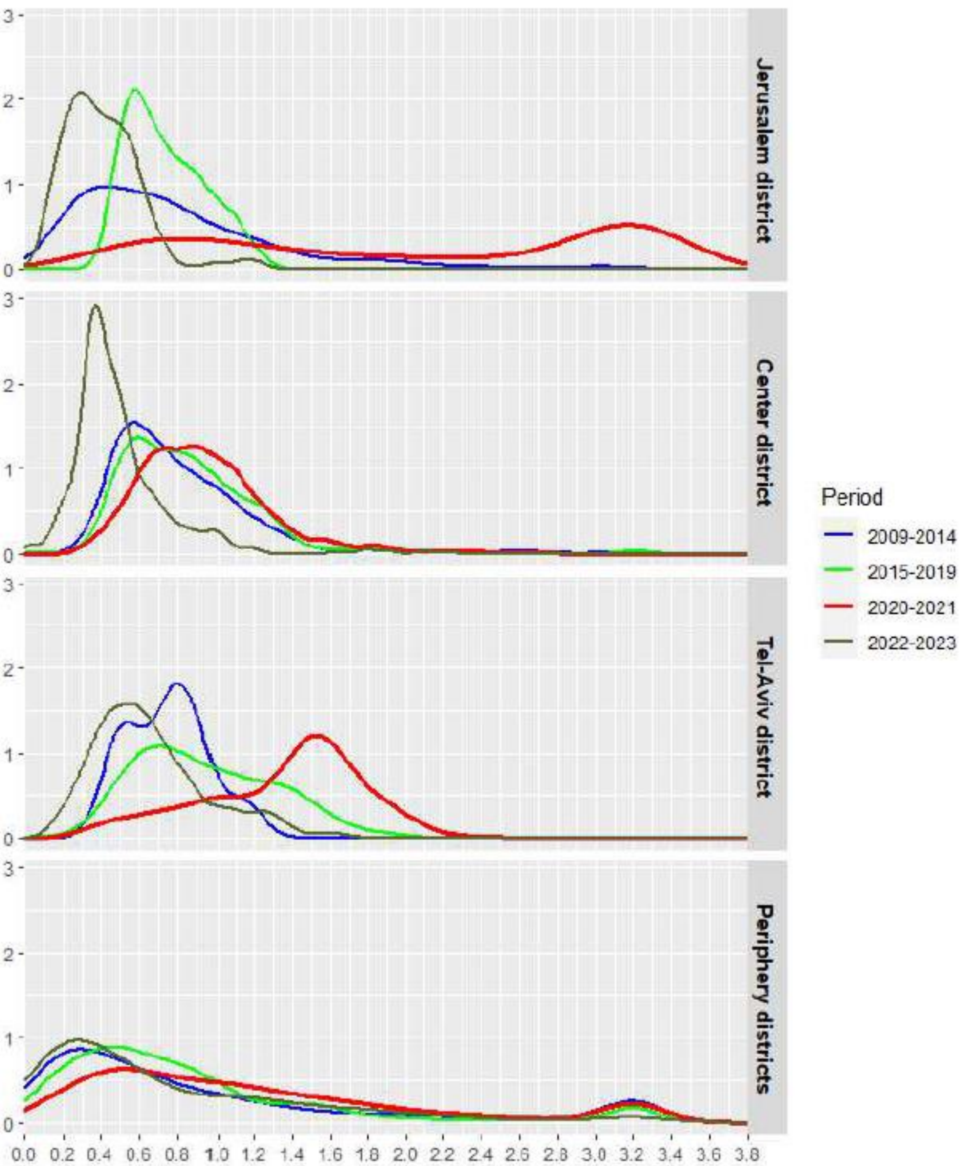

Table 3.1. Descriptive Statistics of Raw Data

Variable	Measurement units	Area	Min	25%	Average	50%	75%	Max
Panel A. Characteristics of the distribution of continuous data								
No. of housing units per plot	units	Jerusalem	6	24	58.1	46	75	434
		Center	6	16	70.8	51	104	1,072
		Periphery	6	22	58.1	38	72	632
Minimum price per plot	NIS thousand	Jerusalem	0	430	5,250	1,400	3,226	285,767
		Center	0	1,337	11,825	4,186	11,294	569,679
		Periphery	0	0	1,520	196	1,123	73,400
Developmemt costs per plot	NIS thousand	Jerusalem	0	1,758	8,093	5,373	10,732	55,458
		Center	0	180	8,109	3,365	12,130	206,015
		Periphery	0	1,462	6,521	3,247	7,110	144,329
Bid amount per plot	NIS thousand	Jerusalem	27	2,340	14,753	4,571	10,158	512,777
		Center	63	3,937	36,373	10,267	28,800	1,457,778
		Periphery	10	906	6,251	2,415	6,300	222,222
Winning bid per plot	NIS thousand	Jerusalem	291	4,067	21,937	7,191	15,587	512,777
		Center	194	5,760	50,441	16,200	37,670	1,457,778
		Periphery	45	1,660	10,368	4,125	11,556	222,222
No. of transactions in the housing market in the locality in 18 months before tender	units	Jerusalem	0	214	416	500	581	1,210
		Center	0	35	165	90	213	1,040
		Periphery	0	27	112	55	124	636
Cumulative quantity of marketed housing units in the regular tenders since the first subsidized tender in the locality	units	Jerusalem	506	5,477	7,192	8,891	8,891	8,931
		Center	42	210	1,443	867	2,135	6,473
		Periphery	20	405	2,415	1,347	3,518	11,111
Cumulative quantity of marketed housing units in the subsidized tenders in the locality until publishing regular tender	units	Jerusalem	44	703	783	703	791	1,455
		Center	0	52	645	664	898	2,179
		Periphery	0	143	719	469	773	4,901
Panel B. Frequency characteristics of categorical data								
Projects combined with commerce		Jerusalem			18.7%			
		Center			5.4%			
		Periphery			9.4%			
Rate of localities without affordable housing projects but in proximity to localities with such projects		Center			10.8%			
		Periphery			27.8%			

Table 3.2. Descriptive Statistics of Variables Calculated for the Model

Variable	Measurement unit	Area	Min	25%	Average	50%	75%	Max
Bid amount per housing unit	NIS thousand	Jerusalem	0.018	58	248	113	311	2,864
		Center	0.007	139	436	311	601	3,272
		Periphery	0.000	26	125	67	165	1,968
Change in housing prices in the locality	log difference	Jerusalem	-0.630	-0.016	-0.006	0.035	0.072	0.187
		Center	-0.354	0.016	0.057	0.058	0.083	0.329
		Periphery	-0.254	0.019	0.065	0.062	0.091	0.386
No. of transactions in the housing market per thousand inhabitants in the 18 months before the tender	units	Jerusalem	0	0.6	0.9	0.7	0.9	5.2
		Center	0	0.9	1.2	1.2	1.5	7.0
		Periphery	0	1.1	2.9	1.5	2.2	7.0
No. of marketed housing units in low-density construction	units	Jerusalem	0	0	17.6	7	28	112
		Center	0	0	13.6	4	16	258
		Periphery	0	0	33.1	4	31	1091
No. of marketed housing units in tender-exempt high-density construction	units	Jerusalem	0	0	150.7	128	271	1630
		Center	0	0	156.2	15	202	1278
		Periphery	0	0	52.5	0	82	834
No. of land transactions for industrial and commercial purposes	units	Jerusalem	0	3	8.5	7	9	37
		Center	0	0	3.8	2	5	44
		Periphery	0	0	5.7	2	6	59
No. of repeated attempts to market a plot	units	Jerusalem	1	1	1.1	1	1	6
		Center	1	1	1.1	1	1	6
		Periphery	1	1	1.2	1	1	9
Minimum price per housing unit	NIS thousand	Jerusalem	0	12	94	29	109	1,191
		Center	0	42	160	116	259	2,364
		Periphery	0	0	27	6	28	641
Development costs per housing unit	NIS thousand	Jerusalem	0	55	134	119	192	775
		Center	0	11	96	91	145	590
		Periphery	0	43	117	88	159	475
No. of bids per plot in tender with submitted bids	units	Jerusalem	1	7	14.3	12	19	46
		Center	1	10	18.3	16	24	60
		Periphery	1	6	11.2	10	15	41
Index for the intensity of government-run affordable housing programs, 2015-2023 (0 before 2015)	ratio	Jerusalem	0	0.81	0.80	0.92	0.93	0.99
		Center	0	0.00	0.34	0.04	0.77	1.00
		Periphery	0	0.22	0.54	0.66	0.85	1.00
Index for the intensity of government-run affordable housing programs, 2000-2023	ratio	Jerusalem	0	0.00	0.12	0.00	0.00	0.99
		Center	0	0.00	0.11	0.00	0.00	1.00
		Periphery	0	0.00	0.16	0.00	0.00	1.00
Extra-budgetary development expenditures per capita in the year before a land tender in the locality	NIS	Jerusalem	167	767	1,052	874	1,109	4,179
		Center	201	852	1,467	1,319	2,041	6,506
		Periphery	59	736	1,440	1,060	1,920	8,728

Table 4. List of Variables

Variable type or transformation	Expected sign in quantile reg	Quantile Regression	Selection equation	Source	Variable description
log	dependent var	✓		ILA tender files	Bid amount per housing unit
dummy (1,0)			✓	ILA tender files	Dummy for tender with submitted bids
log	-	✓	✓	ILA tender files	Development costs per housing unit
dummy (1,0)			✓	ILA tender files	Dummy for minimum price in tender
log	+	✓		ILA tender files	No. of bids[a]
log	+	✓		ILA tender files	Minimum price per housing unit
log			✓	ILA tender files	No. of housing units planned on a plot
dummy (1,0)	+	✓		ILA tender files	Large project[b]
log	-	✓	✓	ILA tender files	No. of repeated attempts to market a plot [c]
dummy (1,0)	+	✓	✓	ILA tender files	Dummy for projects combined with commerce
log			✓	ILA tender files	No. of days since previous regular tender in the locality
log			✓	CBS	Budget development expenditures per capita in the locality
log	+	✓	✓	ILA transaction files	No. of land transactions for industrial and commercial purposes[d]
log	?	✓	✓	ILA transaction files	No. of marketed housing units in low-density construction[d]
log	-	✓	✓	ILA transaction files	No. of marketed housing units in tender-exempt high-density construction[d]
HIS [h]	+	✓	✓	Tax Authority, CBS	No. of transactions in the housing market per 1,000 inhabitants in the 18 month before tender[d]
	-	✓		Bank of Israel	Expectations for BOI interest rate
log difference	+	✓		CBS	Change in housing prices in the locality[e]
HIS [h]	?	✓	✓	ILA tender files	Relative intensity of government-run affordable housing programs, ratio of total marketing[f]
dummy (1,0)	?	✓		ad hoc definition	Proximity to locality with government-run affordable housing programs[g]

Notes for Table 4:

a) Calculated by counting bids from ILA records.
b) Arbitrarily set to 1 for tenders where the number of housing units is in the top 5% of the distribution.
c) For plots for which marketing failed in the past.
d) During the 18 months preceding the month of the tender publication.
e) In the year preceding the tender year. The methodology for calculating home price indices at the locality level is described in Appendix C.
f) This ratio is calculated for each tender date. The accumulation of housing units in both types of tenders (regular and government-subsidized land) is done from the first government-subsidized land tender date in the locality.
g) Calculated based on neighboring groups created for this study and presented in Appendix A.
h) IHS Transformation is defined as: $IHS(x) = \log(\, x + \sqrt{x^2 + 1}\,)$.

5. Empirical Model

Our research is based on an unbalanced panel dataset of land tender results from the Israel Land Authority (ILA) from 2000 to 2023, conducted in 127 Jewish and mixed localities. The data allow us to utilize repetitive observations on the same object (tender), as in half of the tenders, more than one plot was marketed. This approach helps to account for the heterogeneity of plots in terms of unobserved land characteristics (location, topography, special tender conditions such as various stipulations). It is crucial to note that the ILA markets land at different levels of preparedness, and the timing of the start of construction depends on the progress/completion of infrastructure work, such as road construction, or the availability of a sewage treatment plant without which a sewer system cannot be established. Land is often handed over to developers only 1.5–2 years after the tender is won (after the completion of basic infrastructure work). During this period, the winner incurs significant financing costs. Additionally, the fixed effect of the tender also reflects the impact of the year in which the tender was published. Our data cover a long period during which real estate prices rose significantly, while bids are in current prices and not inflation-adjusted.

Utilization of the data panel structure to control for unobserved heterogeneity within quantile regression has been examined in various studies (see, for example, Lamarche, 2010, 2021; Bryan et al., 2015; Koenker, 2004, 2017; Geraci and Bottai, 2007; and Geraci, 2014). Abrevaya and Dahl (2008) show that failing to account for unobserved heterogeneity in panel data can lead to overestimation of the estimated parameters. Canay (2011) proposes a two-step procedure to handle unobserved heterogeneity, assuming this effect does not vary across quantiles. In the first step, a fixed effect for each object is estimated using ordinary regression, and in the second step, quantile regression is applied to the residuals adjusted for this effect. Ando and Bai (2020) propose a common factor approach derived from a large number of correlated explanatory variables, with weights that vary across quantiles according to the estimated degree of heterogeneity from the panel.

We apply Koenker's (2004) procedure, which estimates the impact of exogenous variables and fixed effects of the tenders simultaneously, as follows:

$$Q_{y_{ijl}}\left(\tau_k \middle| x_{ij}\right) = x'_{ij}\beta(\tau_k) + \alpha_i \quad \tau_k \in (0,1) \quad (1),$$

where

– $Q_{y_{ijl}}(\tau_k)$ is a k-th quantile in the distribution of all bids y_{ijl}, and $(i = 1, \dots n)$ denotes the tender number, $(j = 1, \dots m_i)$ denotes the plot number published under the same tender i, and $\left(l = 1, \dots s_j\right)$ denotes the bid number submitted for plot j in tender i;

– x_{ij} is a matrix of observations on explanatory variables, including observed tender and plot characteristics (data from ILA files) as well as additional local and macroeconomic explanatory variables, as described in Section 4, which can be matched to the tender based on its publication date and the locality where it takes place;

– $\beta(\tau_k)$ is a vector of parameters for the exogenous factors that vary across quantiles, including the intercept parameter, which is typically created by adding a unit vector to the matrix of explanatory variables x_{ij};

– α_i is a fixed effect of tender *i* that does not vary across quantiles and is interpreted as a location shift factor in the distribution of bids.

The estimation of parameters in Equation (1) relies on the optimization of Equation (2), as follows:

$$\min_{(\alpha,\beta)} \sum_{k=1}^{q} \sum_{i=1}^{n} \sum_{j=1}^{m_i} \sum_{l=1}^{s_j} w_k\, f_{\tau_k}(\, y_{ijl} - \alpha_i - x'_{ij}\beta(\tau_k)) \quad (2),$$

where $f_u(\mathrm{u}) = \mathrm{u}(\tau - \mathrm{I}(\mathrm{u} < 0))$ is defined as a partial linear loss function and weights w_k are set ad-hoc to control for the importance of each quantile *k* in the optimization. Koenker (2004) suggests using weights (0.25, 0.5, 0.25) for three quantiles (0.25, 0.5, 0.75). We apply the method of Lamarche (2021), which proposes equal weights $w_k = \frac{1}{q}$, $(1 \leq k \leq q)$ in the case of *q* quantiles.

In a panel with a large number of objects (tenders), *n*, and small numbers of plots, m_i, (i.e., repeated observations of the same tender), Procedure (2) yields parameters with large variances. Therefore, an additional step in this development was to reduce the magnitudes of the fixed effects, α_i, by adding a penalty component in the optimization (shrinkage), as follows:

$$\min_{(\alpha,\beta)} \sum_{k=1}^{q} \sum_{i=1}^{n} \sum_{j=1}^{m_i} \sum_{l=1}^{s_j} w_k\, f_{\tau_k}(\, y_{ijl} - \alpha_i - x'_{ij}\beta(\tau_k)) + \lambda \sum_{i=1}^{n} |\alpha_i| \quad (3),$$

where λ is a positive parameter that determines the size of the penalty relative to the aggregate magnitude of the fixed effects, defined in the lasso style, i.e., in terms of the absolute value of the coefficient α_i, including the possibility of setting it to zero (l1-shrinkage). Lamarche (2010) shows that for any $\lambda > 0$, the obtained estimators $\hat{\beta}$ are unbiased. We adopt λ =1 ad-hoc, based on recommendations in the literature.

Another issue that requires attention in the context of our model is the phenomenon of nonrandom selection in the panel, arising from the fact that only some of the developers' bids are available for observation. We do not have access to (either the amount or the quantity of) the valuations of developers who did not participate in the tender. The success rates presented in Tables 1 and 2 indicate that many tenders for plots close without a winner, often because no developer submitted a bid. In a small number of cases, a few bids are documented in tenders that failed due to bids being lower than the minimum price or invalid. This phenomenon is similar to that described in Heckman's (1979) pioneering work in the labor market: nonrandom selection into employment causes parameter bias in wage equations. It can be assumed that our research also exhibits positive selection in the data, meaning tenders with higher bids are more likely to appear in the panel, while lower bids in some tenders are not available. Therefore, in the case of quantile regression, positive selection is likely to cause greater bias in the parameters of the lower quantiles.

Following Heckman (1979), who proposed a selection correction method for the mean of the distribution, several recent studies have addressed selection correction in quantile regression. Among these works are the studies by Abadie et al. (2002), Angrist et al. (2006), Firpo (2007), and Frolich and Melly (2008), which mainly focus on labor market and income inequality issues. In the case of quantile regression, selection correction is based on calculating the "amount of selection" for each observation or a propensity score that predicts the probability of each observation appearing in the panel.

Unlike ordinary regression, where selection correction is possible through controlling for the selection factor (inverse Mills ratio) as an additional explanatory variable, in quantile regression, selection-corrected parameters are obtained by shifting the quantiles of the distribution according to the level of selection impact (rotated quantiles). This is essentially the idea behind the method of Arellano and Bonhomme (2017), which is based on a copula function of the cumulative distribution that depends on the residuals of the quantile regression (3) and predicted values from the selection equation. We combine this method with the panel estimation described in Equation (3) according to Koenker's (2004, 2017) procedure.[28]

As mentioned, similar to the situation in ordinary regression, selection correction in quantile regression requires an initial step of predicting the probabilities of appearing in the panel (propensity scores). Unlike labor market analyses where these probabilities can be estimated at the individual level based on personal characteristics, we encounter the problem of different levels of detail between the quantile regression (3) (at the level of a single bid) and the selection equation of the tenders (aggregating bids submitted for a specific plot). As empirical results show later, aggregating bids by plots weakens the correction.

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[28] See also further developments by Koenker (2017) and Muñoz and Siravegna (2021), documented for use in Stata and R.

It can be assumed that each plot marketed in a tender has several characteristics that affect its attractiveness to developers, and consequently, the likelihood of the tender closing with a winning bid, so that all bids would be recorded in the ILA records. Such factors include location, socioeconomic characteristics of the locality where the tender is conducted, and the tender's characteristics, such as the number of housing units, development costs, minimum price, etc. We define the selection equation to express the likelihood of bid submission for a plot as a probit function of a set of factors, z, some of which may overlap with the explanatory variables, *x*, in Equation (3).

Formally, the idea of shifting the quantiles of the distribution, τ_k, as a function of the selection effect in the panel can be expressed as follows:[29]

$$\widehat{\tau_k} = pr\left(y^*_{ijl} \leq Q\left(\tau_k, x_{ij}, \alpha_i\right) \middle| D_{ij} = 1, z_{ij}\right) = \grave{}pr(u_{ijl} \leq \tau_k | \eta_{ij} \leq p\left(z_{ij}\right), z_{ij}) \quad (4),$$

where

– $\widehat{\tau_k}$ is the selection-corrected quantile of distribution;

– y^*_{ijl} are the observed bids from developers (available from ILA data), as opposed to all bids, y_{ijl}, defined in Equation (1) without considering selection, i.e., including bids that were not submitted;

– D_{ij} is the selection indicator, taking the value 1 when bids are submitted for plot *j* in tender *i* and 0 otherwise;

– z_{ij} are the characteristics of plot *j* in tender *i* that affect the likelihood of bid submission;

– u_{ijl} are the residuals from the quantile regression;

– η_{ij} are the residuals from the selection equation describing the likelihood of bid submission for plot *j* in tender *i*.

According to Arellano and Bonhomme (2017), the serial correlation between the residuals from the quantile regression, u_{ijl}, and the residuals from the selection equation, η_{ij}, is the source of bias in the parameters β in Equation (3). Once the selection probabilities (i.e., propensity scores) are estimated, the quantiles of the unobserved distribution of y_{ijl}, τ, can be mapped into the selection-corrected quantiles of the observed bids y^*_{ijl}, $\hat{\tau}$, as follows:

$$\hat{\tau}_{ijl} = C_{x,a}(\tau_k, v_{ij}; \rho)/v_{ij} \quad (5),$$

[29] Keeping the notations and indices defined for Equation (1).

where

– $\hat{\tau}_{ijl}$ are the selection-corrected quantiles (at the bid level) for the selection effect, as opposed to the quantiles τ_k calculated from the observed bids alone;

– $C_{x,a}(\tau_k, v_{ij}; \rho)$ is the copula function expressing the degree of dependence between the residuals of the quantile regression and the residuals of the selection equation;

– v_{ij} are the predicted probabilities for the plot *j* in tender *i* to receive bids according to the selection equation;

– ρ is an arbitrary parameter of the copula function, for which it is difficult to find a clear economic interpretation, and it can be optimized locally using the method of moments, as described below.

As mentioned earlier, our data structure does not allow for the calculation of propensity scores at the level of individual bids but rather at the level of groups of bids submitted for the same plot. To obtain the propensity scores, v_{ij}, we estimate a probit regression in panel data as described by Croissant and Millo (2018), Arulampalam (1999), and Lechner (2012), controlling for random effects based on repeated observations of the tenders or, alternatively, of the localities, as follows:

$$v_{ij} = \Phi\left(\frac{-\left(z_{ij}'\theta + \epsilon_i\right)}{\sigma_\eta}\right) \quad (6),$$

where:

– $\Phi(.)$ is the normal cumulative distribution function predicting the probabilities $pr(D_{ij} = 1 \big| z_{ij}, \epsilon_i\ )$;

– ϵ_i is the random effect of tender *i* or, alternatively, the locality where tender *i* is conducted;

– θ is the vector of estimated parameters;

– σ_η is the standard deviation of the residuals of the selection equation, distributed according to $\eta_{ij} \sim \mathrm{N}(0, \sigma_\eta^2\ )$.

For the optimization of the copula parameter, ρ, we use the method of moments as documented by Arellano and Bonhomme (2017) and Koenker (2017). (The latter also suggests the optimal likelihood method as an alternative.) According to the method of moments, the optimal value of ρ is obtained by minimizing an objective function defined as the Euclidean distance based on selection-corrected regression residuals, standardized and translated into sign terms, for each quantile.

Finally, we sum up the model estimation steps:

1) Estimation of the quantile regression (3) without accounting for selection bias;
2) Estimation of the propensity scores, v_{ij}, for each plot j in tender i, i.e. the probabilities to receive bids, according to the selection equation (6);
3) Estimation of the quantile regression corrected for selection bias using different values for the ρ parameter of the copula function. This step involves calculating the objective function value for each ρ. The range of the ρ parameter values for simulation is arbitrarily set along with the grid (the space between two adjacent values of ρ);
4) Selection of the optimal ρ for which the objective function reaches its (local) minimum based on the simulations performed;
5) Estimation of the quantile regression corrected for selection bias using the optimal ρ parameter.

6. Results

6.1 Selection Equation

We present the estimation results of the selection equation (6) in two versions: one controlling for the random effect of the tender and the other for the locality. The results of both versions are shown in Table 5 and indicate several factors that significantly affect the likelihood of a tender closing with or without bids. Both versions have a similar estimation fit, and there is evidence of high heterogeneity (statistically significant at 1%) at both the tender and locality levels, as can be inferred from the standard deviations of the defined random effects. However, for the purpose of calculating propensity scores, we prefer the version controlling for the random effect of the locality, according to the AIC test.

The probability that a developer will bid on a tender decreases as the development costs added to the land price increase, as the intensity of marketing within affordable housing programs in the same locality increases, and as the number of previous unsuccessful marketing attempts of the same plot increases. Conversely, the probability that a developer will bid on a tender increases as the time since the last regular tender in the same locality lengthens. These are the variables with the most significant impact on the developer's decision to bid on a tender (at a statistical significance level of 1%). Additionally, we find that factors increasing the probability that a developer will bid on a tender include investment per capita in the local authority's development budget, the number of housing units planned to be built on the plot (which allows for economies of scale in the construction process), and the extent of land sales for low-density construction in the same locality (which likely signifies the attractiveness of the locality to a more affluent population). Publishing a minimum price in the tender reduces the probability that a developer will bid on it by about 5%. In the version with random effects of the localities, the fixed effects of most years since 2009 are positive and statistically significant (the base year is 2000), and in the version with random effects of the tenders, the fixed effects of the districts are mostly statistically significant, with the highest probability that a developer will bid on a tender being for lands located in the Jerusalem and Central (base category) districts. Table 6 presents the distribution characteristics of the bid amount per housing unit (in natural logarithm), conditional on the likelihood of the tender closing with bids, with propensity scores calculated based on the results of the selection equation. The data in Table 6 confirm that selection correction in the bid distribution is required for estimating our model.

Table 5. Estimated Parameters of the Selection Equation (6), According to the Random Effects Version

	Random Effects for tenders			Random Effects for localities		
Explanatory variables	**Parameter**	**Std.Err**	**t-stat**	**Parameter**	**Std.Err**	**t-stat**
Intercept	0.46	0.14	3.30 ***	0.40	0.12	3.44 ***
year 2001	-0.07	0.08	-0.88	-0.02	0.05	-0.48
year 2002	-0.04	0.08	-0.54	0.08	0.05	1.50
year 2003	-0.11	0.08	-1.47	0.01	0.05	0.13
year 2004	-0.21	0.08	-2.80 **	-0.11	0.05	-2.39 *
year 2005	-0.02	0.08	-0.31	0.07	0.05	1.33
year 2006	-0.10	0.08	-1.19	-0.02	0.06	-0.34
year 2007	0.01	0.08	0.17	0.10	0.06	1.76 .
year 2008	-0.11	0.08	-1.40	-0.03	0.05	-0.58
year 2009	0.10	0.08	1.27	0.21	0.05	4.07 ***
year 2010	0.13	0.08	1.70 .	0.24	0.05	4.75 ***
year 2011	-0.03	0.08	-0.43	0.04	0.05	0.79
year 2012	0.05	0.08	0.66	0.13	0.05	2.68 **
year 2013	0.06	0.08	0.77	0.18	0.05	3.62 ***
year 2014	0.11	0.08	1.50	0.22	0.05	4.59 ***
year 2015	0.15	0.09	1.64	0.28	0.06	4.77 ***
year 2016	0.07	0.10	0.72	0.19	0.07	2.83 **
year 2017	-0.08	0.10	-0.79	0.13	0.08	1.69 .
year 2018	-0.15	0.11	-1.38	0.17	0.08	2.18 *
year 2019	-0.14	0.10	-1.43	0.17	0.07	2.52 *
year 2020	-0.08	0.10	-0.79	0.19	0.06	2.89 **
year 2021	0.08	0.09	0.87	0.39	0.06	5.99 ***
year 2022	0.05	0.10	0.47	0.23	0.07	3.12 **
year 2023	-0.11	0.11	-1.01	0.13	0.07	1.92 *
Jerusalem district	0.07	0.04	1.83 .			
Northern district	-0.16	0.03	-4.91 ***			
Haifa district	-0.15	0.04	-3.77 ***			
Tel Aviv district	-0.12	0.04	-3.27 **			
Southern district	-0.09	0.03	-3.16 **			
Judea and Samaria area	-0.03	0.05	-0.62			
log(development expenditure per capita)	0.07	0.02	4.06 ***	0.04	0.01	2.73 **
log(development costs per unit)	-0.01	0.00	-5.07 ***	-0.01	0.00	-6.04 ***
minimum price dummy	-0.08	0.03	-2.59 **	-0.05	0.02	-2.24 *
log(housing units)				0.02	0.01	2.19 *
log(repeated marketing)	-0.11	0.02	-6.57 ***	-0.11	0.02	-7.34 ***
log(nonresidential sales)	0.00	0.01	-0.01	-0.01	0.01	-1.61
log(low-density units)	0.00	0.01	0.58	0.01	0.00	2.30 *
log(high-density_no tender)	0.01	0.00	2.10 *	0.00	0.00	0.50
mixed-use	-0.07	0.03	-2.26 *	-0.02	0.02	-0.86
ihs(transactions_housing market)	0.04	0.02	2.04 *	0.03	0.02	1.84 .
log(days since previous tender)	0.02	0.01	2.56 *	0.02	0.00	3.93 ***
his(affordable housing programs intensity	-0.16	0.04	-4.19 ***	-0.22	0.05	-4.64 ***
sd.id	0.32	0.01	41.89 ***	0.16	0.02	10.19 ***
sd.idios	0.23	0.00	72.09 ***	0.37	0.00	87.21 ***
Log-Likelihood:	**-1263.9**			**-1712.0**		
AIC	**2613.8**			**3500.1**		
N of free parameters	43			38		

Notes for Table 5:
a) sd.id denotes standard deviations of individual effects (individual Intercepts); sd.idios denotes standard deviations of idiosyncratic effects (errors);
b) A large number of locality characteristics (peripherality index, topographic index, socioeconomic index, growth rates of the young population, etc.) were examined for the regression and were excluded from its final version because they were not significant.

As noted in Section 5, the data structure limits us in this correction of selection bias due to different levels of detail between the bid analysis using quantile regression and the estimation of the likelihood of bid submission to the tender (at the plot level, i.e., a group of bids). Table 7 presents the Spearman serial correlation coefficients between the residuals of the quantile regression (3) and the residuals of the selection equation (6), estimated by areas.[30] The correlation coefficients are calculated according to the percentiles of the explained variable measured as the log bid amount per housing unit, while the residuals of the selection equation estimated at the plot level are uniformly distributed over the number of bids per plot and paired with the residuals of the quantile regression specific to the bid. Table 7 provides evidence of significant positive selection in the lower percentiles of the distribution, meaning the lower bids are those not observed in the ILA data. Apparently, grouping selection probabilities by plots results in relatively weak correlation coefficients compared to the strong correlation coefficients obtained in wage equations (in the order of –0.24 and –0.79 for married and single males, respectively, in Arellano and Bonhomme, 2017), which ultimately results in a much more minor selection correction. According to the results in Table 7, bids for tenders in the Periphery area were most affected by the selection phenomenon.

Table 6. Distribution of Log Bids per Housing Unit and the Likelihood of Tenders to Close with Bids Predicted by the Selection Equation, by Area, Based on Data from 2000–2023

	mean	min	max	q10	q50	q90
	Jerusalem area					
log(bid per housing unit)	12.4	9.6	14.9	10.4	11.6	13.3
propensity scores	0.9	0.5	1.0	0.7	0.9	1.0
	Center					
log(bid per housing unit)	13.0	10.0	15.0	11.2	12.6	13.8
propensity scores	0.9	0.2	1.0	0.7	1.0	1.0
	Periphery					
log(bid per housing unit)	11.7	4.6	14.5	9.1	11.1	12.6
propensity scores	0.7	0.3	1.0	0.6	0.9	1.0

30 The parameters estimated in the quantile regression before selection correction are reported in Subsection 6.3 alongside the parameters estimated with selection correction.

Table 7. Serial Spearman Correlation Coefficients between the Residuals of Quantile Regression (3) and the Residuals of the Selection Equation (6), According to Distribution Percentiles and Areas

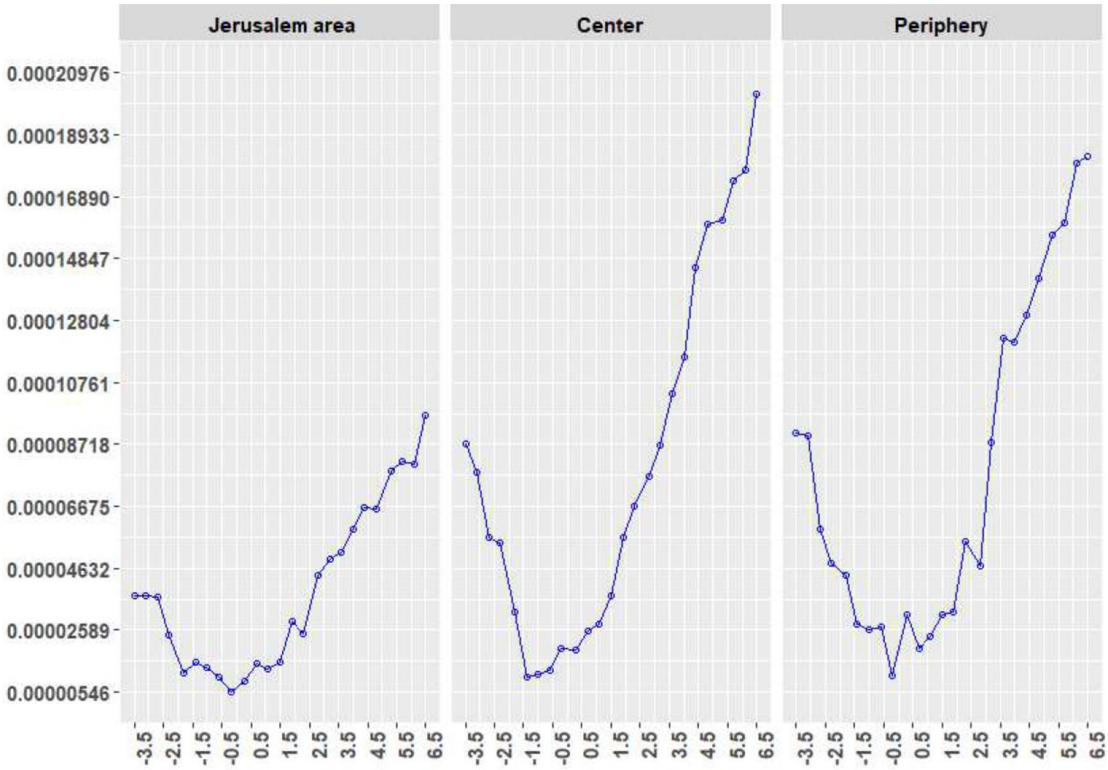
Quantile	Jerusalem area		Center		Periphery	
	parameter	p-val	parameter	p-val	parameter	p-val
0.1	-0.032	0.077	-0.039	0.005	-0.064	0.000
0.2	-0.027	0.128	-0.024	0.026	-0.036	0.001
0.3	-0.027	0.132	-0.021	0.053	-0.027	0.092
0.4	-0.026	0.137	-0.014	0.195	-0.013	0.185
0.5	-0.016	0.356	-0.010	0.368	-0.010	0.287
0.6	-0.016	0.377	-0.006	0.553	-0.010	0.314
0.7	-0.003	0.862	-0.006	0.596	-0.010	0.303
0.8	0.041	0.021	0.003	0.746	-0.010	0.307
0.9	0.014	0.429	-0.003	0.758	-0.009	0.352
0.95	0.005	0.779	-0.001	0.920	-0.002	0.859
No. of obs.	3,153		8,777		10,363	

6.2 Selection of the Optimal ρ for the Copula

We apply the Frank copula function following an in-depth empirical study by Arellano and Bonhomme (2017), who did not find significant differences in selection correction when using the Frank copula or the Gaussian copula; the first type is also the default in Koenker's (2017) procedure, which presents optimization results for ρ obtained from the method of moments against the optimal likelihood method.

It should be noted that the function $M(\rho, \hat{\theta}, v, \hat{\tau})$, which is the subject of optimization, is not continuous as it includes an indicator operator (for the sign of the residuals), and its minimal value calculated according to the set of different values for the parameter ρ is affected by the range and the grid size chosen for ρ. We adopt a strategy of starting with a very wide range and then narrowing it down, along with reducing the grid around the likelihood area of the minimum. Figure 3 presents values of $M(\rho, \hat{\theta}, v, \hat{\tau})$ obtained from repeated estimations of the quantile regression with copula correction based on a series of 25 values of ρ for each area. After attempts to adjust the initial range for each area, we end up with a uniform range between the areas of [-3.5, 6.5] with a grid of 0.4. The optimal values of ρ corresponding to the minimum point of $M(\rho, \hat{\theta}, v, \hat{\tau})$ in each area are: Jerusalem (–0.583), Center (–1.417), and Periphery (–0.167).

Figure 3: Values of the function $M(\rho,\hat{\theta},v,\hat{\tau})$ (Y-axis) of the method of moments over the range of ρ values of copula function (X-axis), in each area*



* Optimal values of ρ corresponding to the minimum point of $M(\rho,\hat{\theta},v,\hat{\tau})$ in each area: Jerusalem area (-0.583), Center (-1.417), Periphery (-0.167).

6.3 Results of the Model Estimation Before and After Selection Bias Correction

We estimate the quantile regression divided into three defined demand areas (Jerusalem, Center, and Periphery). The parameters of the explanatory variables, as estimated in the quantile regression (3) before considering the selection effect and after the correction, are presented in Figure 4 to allow a graphical presentation of the development of the estimated parameters across the quantiles of the bid distribution and comparison of the impact strength before and after selection correction and between the areas. Standard deviations are calculated using bootstrapping. All explanatory variables in Figure 4 are divided into four groups: 1) variables intended to isolate the impact of affordable housing programs; 2) macroeconomic and locality-level variables; 3) characteristics of the local real estate markets (competing land transactions and local development); and 4) plot-specific characteristics.

The estimation results are consistent with regional differences in land prices favoring the Center area and with lower success rates in marketing in the Periphery, especially in the early years. We find that, in general, selection correction affects the parameters more in the lower quantiles of the bid distribution and sometimes more in the Periphery than in the Center. In the selection-corrected model, lower intercept estimates are obtained in the lower decile of the bid distribution (compared to the base model). As expected, the intercept estimates characterizing the quantiles of the bid price distribution for land per housing unit (in log terms), controlling for the impact of explanatory factors, are systematically lower in the Periphery than in the Jerusalem and Center areas, and higher in the upper deciles of the bid distribution.

Land marketing within affordable housing programs increases land prices for regular high-density construction in successful tenders. This impact is economically and statistically significant, especially in the Periphery, where large quantities of land were marketed in affordable housing programs, mainly in their early years. Selection correction further strengthens this result, consistent with the estimation results of the selection equation, according to which the attractiveness of regular tenders decreases as the intensity of land marketing for affordable housing in the locality increases, meaning the number of tenders that developers bid on decreases, but in attractive tenders, they are willing to offer higher prices. Also the impact of proximity to localities where land for affordable housing was marketed is particularly strong in the Periphery, with these effects strengthening across the bid distribution in regular tenders. The impact on land prices in high-demand areas is weaker, and in the Jerusalem area, it decreases in the higher deciles of the bid distribution. In localities in the Center where land for affordable housing was not marketed, such marketing in neighboring localities raises land prices but to a lesser extent than in the Periphery. These results support our hypothesis regarding the increase in total land demand described in Section 3, as well as the claim that the impact may be stronger in areas where there is no substitution for state-owned land.

Given the importance of the question regarding the impact of land allocation for affordable housing programs on bid prices in regular tenders, we examined the sensitivity of the results to an alternative definition of neighboring groups. We replaced the variable for proximity to a locality where land was marketed at a subsidized price with a proximity ratio calculated based on a GIS system that does not consider the socioeconomic level of neighboring localities and the degree of geographical dispersion between localities in different parts of the country.[31] The results of the tests are presented in Appendix D, and they indicate that although the impact of affordable housing programs weakens somewhat in the Periphery, it still exists.

The impact of interest rate is, as expected, negative and is the strongest in the Center even after selection correction. Additionally, the impact strength increases across the bid distribution deciles in all areas except the Periphery. Developers typically finance land purchases with loans, and the higher the land price they offer, the more credit they will need, along with increased financing costs that burden the developer.

The more housing prices rose in the year before the tender, the more optimistic developers are and the more willing they are to offer a higher price for the land, but this effect is weaker in the Periphery and is only felt in the higher deciles of the bid distribution. In the Center, the impact of rising housing prices is quite stable, while in the Jerusalem area, it weakens across the bid distribution. (In the Center, selection correction causes a significant change in the impact strength.) The number of housing market transactions in the locality also has a positive impact on the bid price. In the Periphery, this impact strengthens across the bid distribution deciles, while in the Center, the result is the opposite, and in the Jerusalem area, the impact of this variable is weak. It seems that in the Periphery where the demand for housing and prices are relatively low compared to high-demand areas, localities with a vibrant housing market are more attractive, signaling to developers that they can offer a higher price for the land.

In terms of the scope of competing residential construction, the impact strength is weak. In the Periphery, selection correction further weakens it regarding land marketing for tender-exempt high-density construction, but it strengthens the positive impact of land marketing for low-density construction. This result is consistent with the hypothesis that such construction in the Periphery can attract a more affluent population and benefit the development of the locality. Land transactions designated for industry and commerce increase the bids for residential land in regular tenders in the Jerusalem area, while in other

[31] In constructing neighboring groups, we considered settlement density. The distances between neighboring localities in the Periphery are greater than those between localities in the Center.

areas, this impact is weakly negative. It is possible that in the Jerusalem area, this involves extensive construction for the high-tech industry, but we did not test this hypothesis.

Regarding the tender characteristics, the impact of development costs added to the land price is negative, as expected, but low, except in the Jerusalem area, where the strongest impact is observed in the lower deciles of the bid distribution. The minimum price has a positive impact on the bids, as expected, since it is a lower threshold for the bid. In the Center, where land is sold at much higher prices than the minimum, its impact is the weakest, while in the Jerusalem area and in the Periphery, the minimum price has a noticeable impact in the lower deciles but not in the higher part of the bid distribution. Selection correction weakens this impact in all areas. The higher the number of bidders in the tender, the higher the submitted bids, with the strongest impact in the Periphery and the lower deciles of the bid distribution. Although the number of bidders in the tender is not known to the competitors, it is likely that developers can identify attractive lands with high demand. For plots where residential construction is combined with commerce, developers are willing to pay higher prices in high-demand areas but not in the Periphery. Building a commercial floor reduces construction costs for the developer and may also increase the attractiveness of living in such a building. Previous unsuccessful marketing attempts of the plot lower the developers' bid prices, significantly in the Jerusalem area and more strongly in the lower deciles of the bid distribution, but to a lesser extent in other areas. The impact of project size is positive, with higher strength in the lower deciles of the bid distribution and stronger in the Jerusalem area. This result may reflect an underestimation, since in the past, many developers tended to "create" large projects for themselves by submitting bids and winning several plots in the same tender. Since the end of 2021, the ILA prevents developers from winning several adjacent plots to prevent them from controlling the local housing market. On the other hand, the lack of impact in the higher deciles of the bid distribution may be related to the following consideration: In large plots that include several buildings, developers start construction of the buildings gradually rather than simultaneously (which also allows them to sell the apartments in smaller "batches"). However, as the project lengthens, the levels of uncertainty and risk also increase, weakening the positive impact of exploiting economies of scale and the monopolistic power of a developer in a certain area.

7. Conclusions

In this study, we examine the differential impact of government-run affordable housing programs and macroeconomic, local, and plot-specific factors on the distribution of bid prices for land for high-density construction in regular Israel Land Authority (ILA) tenders from 2000 to 2023. We apply quantile regression in an unbalanced panel data framework, considering both unobserved land heterogeneity and the selection phenomenon in bid offers. This methodological approach to addressing these two issues is applied for the first time in this field. Controlling for fixed effects of the tenders using Koenker's method provides a powerful tool for estimating impacts and minimizing the standard errors of parameter estimates.

After controlling for numerous factors that influence the developers' bids in land tenders, we find that land marketing for affordable housing construction reduces the attractiveness of regular tenders in the same locality, leading to more tenders closing without bids. After selection correction, we document an increase in bids for lands in successful regular tenders as the supply of these lands diminishes. Similarly, we find that mere proximity to localities where land was marketed for affordable housing projects raises the bids in regular tenders in localities where no land was marketed for such housing. Due to the government's housing policy, which directed a significant portion of the land to tenders for affordable housing, regular land tenders have become rarer, and developers who, for various reasons, did not participate in the government programs or failed to win them competed for a limited number of regular tenders, thus increasing the prices of land for open-market housing. The finding that government programs had a stronger impact on land prices in the Periphery aligns with Rubin and Felsenstein's (2017) claim that during periods when the ILA reduces marketing, building starts on private land increase. It is likely that in response to government housing policy, the development of private lands in high-demand areas increased, while in the Periphery, most lands are state-owned, and only a minority are private lands. Additionally, in recent years, the use of built-up lands within urban renewal has been increasing. In 2022–2023, a quarter of all building starts were in urban renewal projects, with these projects concentrated mainly in high-demand areas in central Israel and especially Tel Aviv and its vicinity. Thus, the expansion of the use of built-up lands for new construction has mitigated the impact of the reduced marketing of undeveloped lands in regular ILA tenders in recent years.

Our results support the differential impact of factors influencing land demand both by dividing into different demand areas and across the quantiles of the bid distribution. For example, the impact of the change in home prices in the year before the tender, reflecting developers' expectations regarding the prices of the dwellings to be built on the purchased land, is stronger in central Israel localities and increases across the bid distribution. Interest rate expectations have a significant negative impact that strengthens across the quantiles in the Center and Jerusalem areas and remains stable in the Periphery.

Figure 4.1. Estimated parameters for the variables of land marketing for government-run affordable housing programs, by percentiles (X-axis) and areas. In blue – before selection correction, in red – after correction.

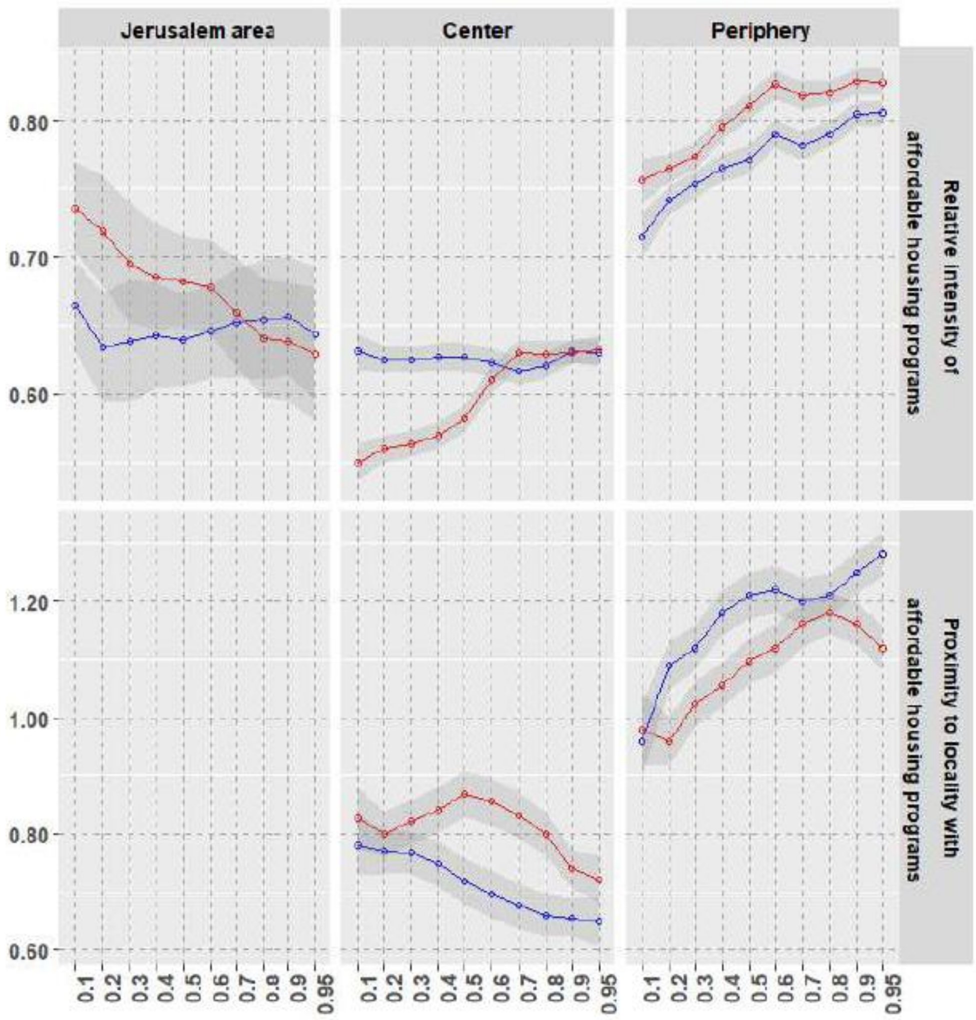


Figure 4.2. Estimated parameters for the group of macroeconomic and locality-level variables, by percentiles (X-axis) and areas. In blue – before selection correction, in red – after correction.

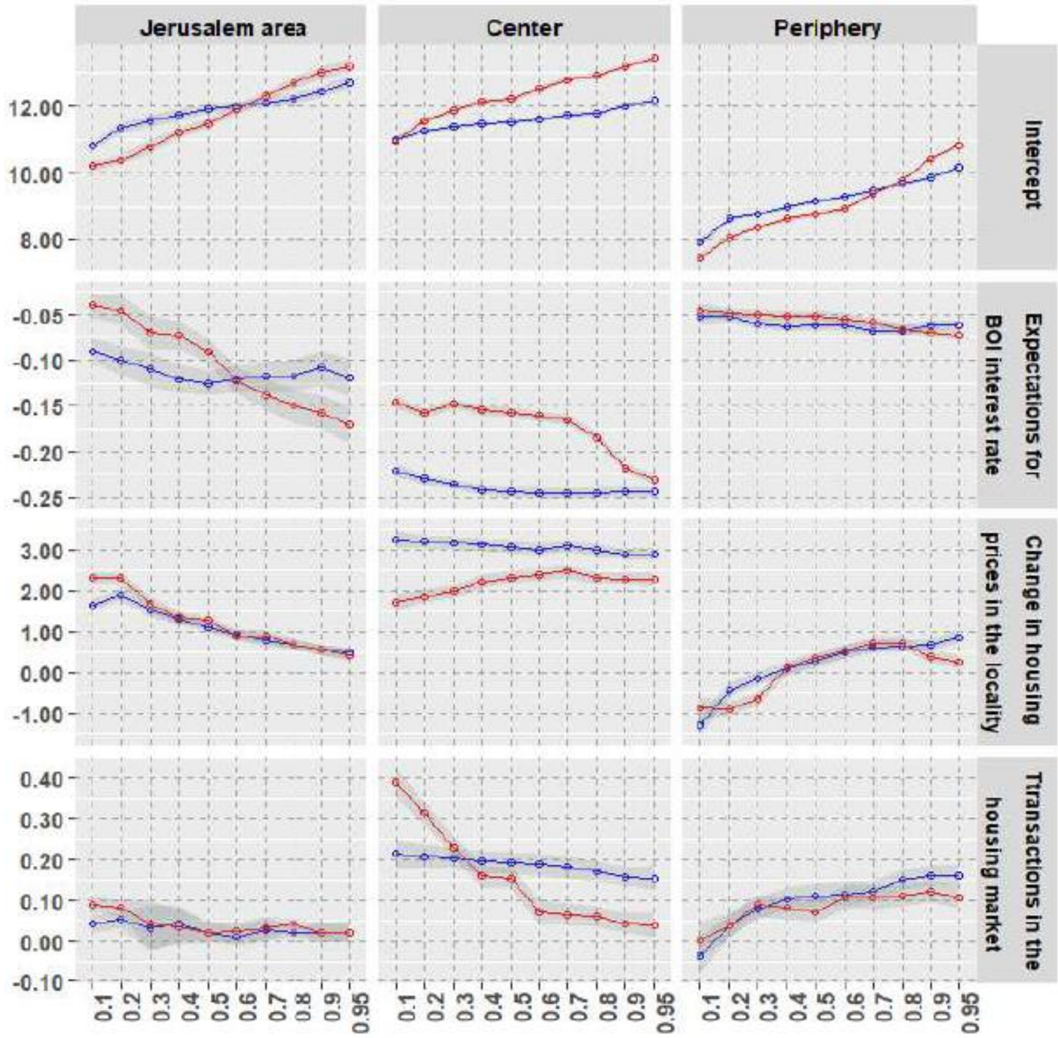


Figure 4.3. Estimated parameters for the group of local real estate market factors (land transactions for competing construction and local development) by percentiles (X-axis) and areas. In blue – before selection correction, in red – after correction.

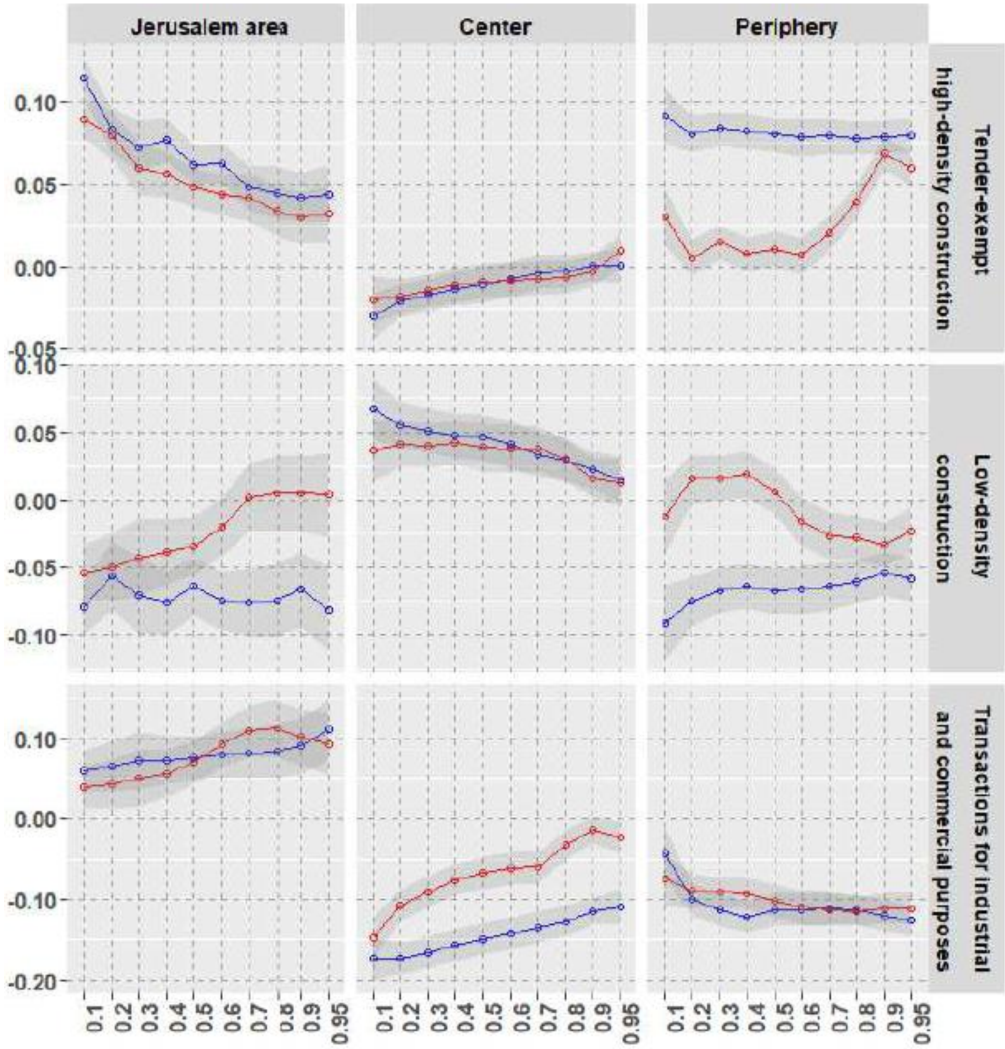
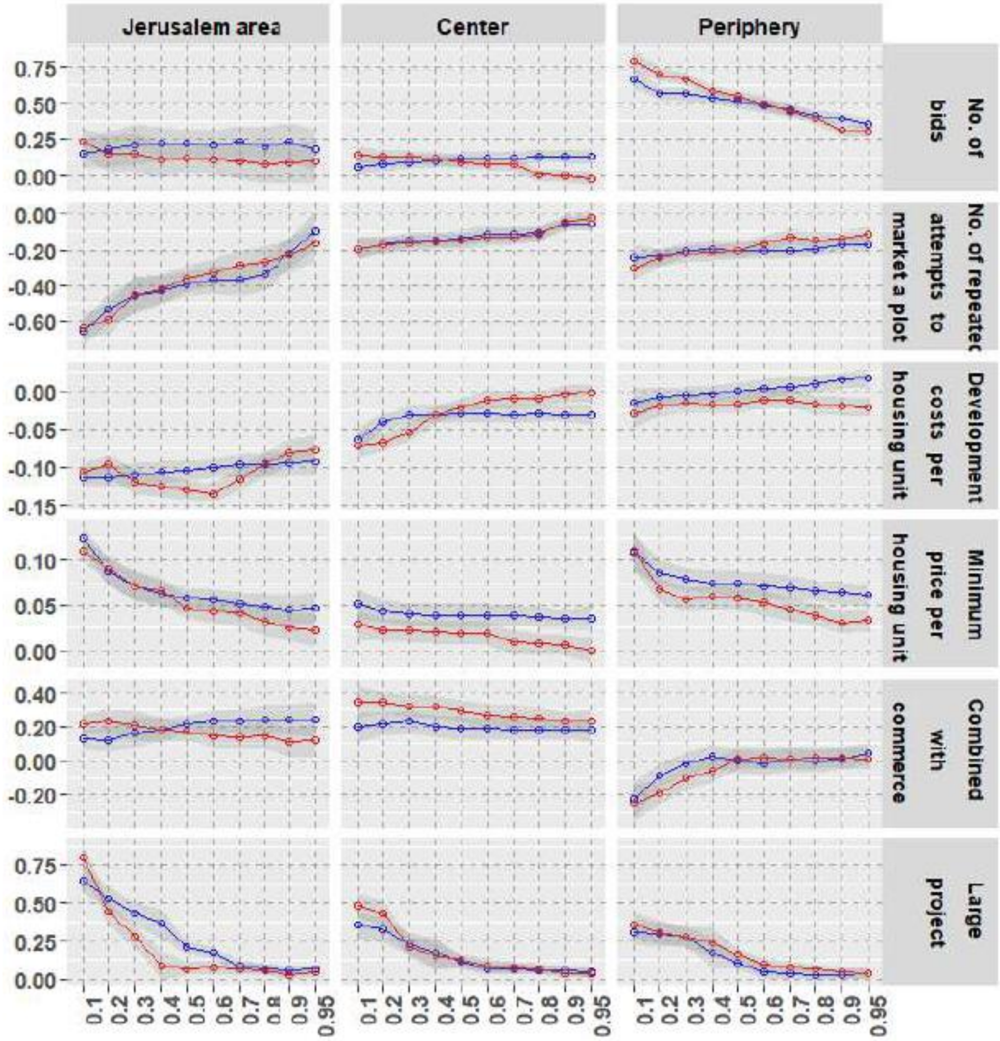


Figure 4.4. Estimated parameters for the group of variables specific to the tender/plot, by percentiles (X-axis) and areas. In blue – before selection correction, in red – after correction.



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Appendix A

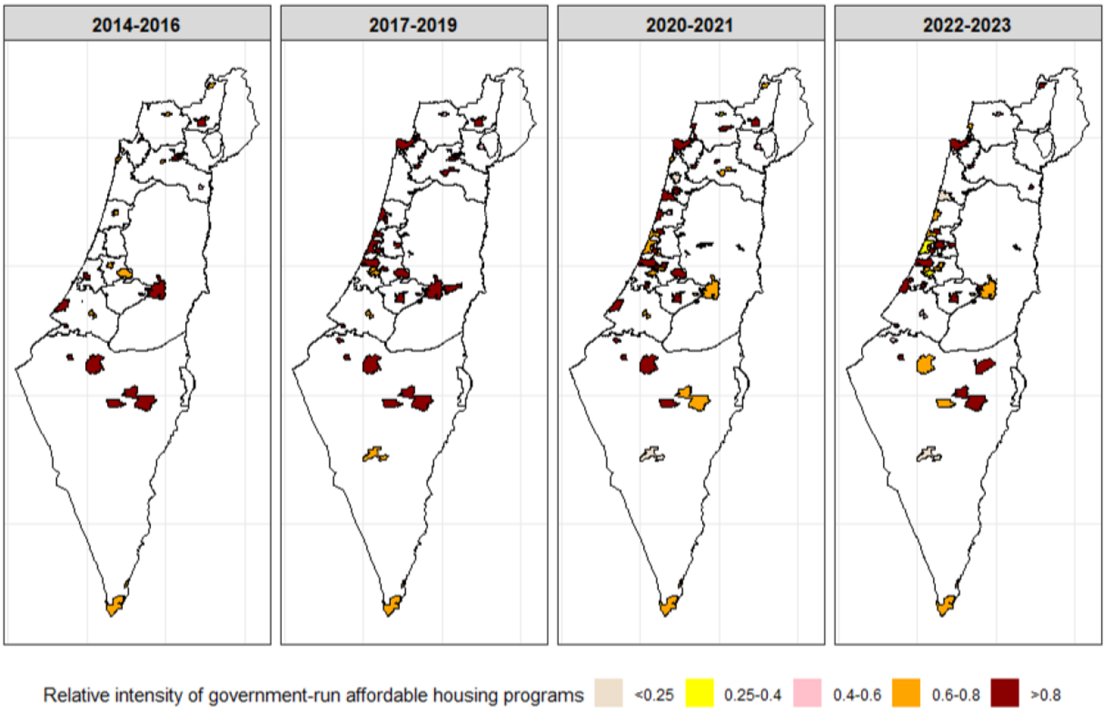
List of Jewish and mixed localities where regular land tenders for high-density construction were conducted in the years 2000–2023, by district, subdistrict and neighboring group, and first subsidized tender date in locality

Locality Name	Locality code	District Name	District code	Subdistrict code	Neighborhood group	Population (2020)	First subsidized auction
MEVASERET ZION	1015	Jerusalem district	1	11	g16	24,247	28/12/2015
NEVE MICHA'EL	1071	Jerusalem district	1	11	g16	883	
TZUR HADASSA	1113	Jerusalem district	1	11	g16	12,142	03/04/2023
KIRYAT YE'ARIM	1137	Jerusalem district	1	11	g17	6,238	31/10/2018
BEIT SHEMESH	2610	Jerusalem district	1	11	g17	132,544	31/08/2015
JERUSALEM	3000	Jerusalem district	1	11	g18	951,149	30/07/2015
ROSH PINA	26	Northern district	2	21	g19	3,217	
YAVNE'EL	46	Northern district	2	22	g21	4,332	
KFAR TAVOR	47	Northern district	2	22	g22	4,400	
MIGDAL	65	Northern district	2	22	g23	1,980	
YOKNE'AM ILLIT	240	Northern district	2	23	g24	24,091	24/09/2015
SHLOMI	812	Northern district	2	24	g27	6,754	28/07/2016
MIGDAL HAEMEK	874	Northern district	2	23	g25	25,722	17/09/2015
NAZERAT ILLIT	1061	Northern district	2	25	g25	41,937	24/09/2015
MA'ALOT-TARSHIHA	1063	Northern district	2	24	g27	22,122	30/04/2015
KARMI'EL	1139	Northern district	2	24	g28	46,122	24/09/2015
KFAR VRADIM	1263	Northern district	2	24	g29	5,492	
HATZOR HAGLILIT	2034	Northern district	2	21	g19	9,569	29/10/2015
KIRYAT SHEMONA	2800	Northern district	2	21	g20	22,363	20/08/2015
KATZRIN	4100	Northern district	2	29	g20	7,500	27/12/2021
TIBERIAS	6700	Northern district	2	22	g23	45,867	29/06/2017
AKKO	7600	Northern district	2	24	g30	49,503	28/12/2016
AFULA	7700	Northern district	2	23	g25	56,769	23/07/2015
ZEFAT	8000	Northern district	2	21	g21	36,061	31/10/2016
NAHARIYA	9100	Northern district	2	24	g28	59,156	27/12/2016
BEIT SHE'AN	9200	Northern district	2	23	g26	18,705	30/11/2016
ATLIT	53	Haifa district	3	32	g31	4,528	16/11/2015
RECHASIM	922	Haifa district	3	31	g21	13,265	30/12/2015
OR AKIVA	1020	Haifa district	3	32	g34	19,447	25/07/2018
HARISH	1247	Haifa district	3	32	g34	19,567	14/01/2015
NOFIT	1284	Haifa district	3	31	g24	2,546	11/12/2023
TIRAT CARMEL	2100	Haifa district	3	31	g31	24,296	30/07/2015
KIRYAT TIV'ON	2300	Haifa district	3	31	g24	18,312	20/12/2016
HAIFA	4000	Haifa district	3	31	g32	283,736	30/12/2015
HADERA	6500	Haifa district	3	32	g1	98,908	25/12/2016
KIRYAT ATA	6800	Haifa district	3	31	g33	59,364	
PARDES HANNA-KARKUR	7800	Haifa district	3	32	g1	43,760	29/06/2017
KIRYAT MOTZKIN	8200	Haifa district	3	31	g33	45,463	23/07/2015
ZICHRON YA'AKOV	9300	Haifa district	3	32	g35	23,437	07/12/2017
KIRYAT BIALIK	9500	Haifa district	3	31	g33	41,912	31/12/2015
KIRYAT YAM	9600	Haifa district	3	31	g33	39,459	24/08/2017
BINYAMINA-GIV'AT ADA	9800	Haifa district	3	32	g35	15,925	05/06/2018
MAZKERET BATYA	28	Central district	4	44	g12	15,093	
ELYAKHIN	41	Central district	4	41	g1	3,484	
TEL MOND	154	Central district	4	41	g2	13,492	
GAN YAVNE	166	Central district	4	44	g13	23,925	28/09/2017
KFAR YONA	168	Central district	4	41	g3	26,182	30/10/2016
KFAR YA'AVETZ	170	Central district	4	41	g2	661	
PARDESIYA	171	Central district	4	41	g2	6,641	22/12/2015
EVEN YEHUDA	182	Central district	4	41	g2	14,020	26/12/2017
KADIMA-TZORAN	195	Central district	4	41	g2	22,717	31/12/2017
GANEI TIKVA	229	Central district	4	42	g4	21,551	13/11/2017
BET DAGAN	466	Central district	4	43	g9	7,299	24/09/2015
KIRYAT EKRON	469	Central district	4	44	g14	11,077	16/08/2021
YAD BINYAMIN	577	Central district	4	44	g13	4,278	
GIVAT SHMUEL	681	Central district	4	42	g5	27,249	
KFAR CHABAD	696	Central district	4	43	g15	6,720	
MATZLIAH	757	Central district	4	43	g10	1,346	
BET HASHMONAI	1050	Central district	4	43	g9	2,172	
BNEI AYISH	1066	Central district	4	44	g14	6,925	28/02/2022
MEVO MODI'IM	1141	Central district	4	43	g36	238	
TZUR NATAN	1148	Central district	4	42	g2	290	
MODI'IN-MAKKABBIM-RE'UT	1200	Central district	4	43	g11	94,657	31/12/2014

Locality Name	Locality code	District Name	District code	Subdistrict code	Neighborhood group	Population (2020)	First subsidized auction
KOKHAV YA'IR	1224	Central district	4	42	g2	8,735	
SHOHAM	1304	Central district	4	43	g11	21,014	05/03/2017
EL'AD	1309	Central district	4	42	g15	49,167	29/12/2016
MATTAN	1315	Central district	4	42	g7	3,570	
TZUR YITZHAK	1345	Central district	4	42	g2	7,080	
BE'ER YA'AKOV	2530	Central district	4	43	g9	29,015	27/09/2017
GEDERA	2550	Central district	4	44	g13	28,896	24/12/2015
ROSH HAAYIN	2640	Central district	4	42	g8	67,624	30/12/2014
YAVNE	2660	Central district	4	44	g13	49,836	31/07/2016
KFAR SAVA	6900	Central district	4	42	g7	101,830	19/07/2023
LOD	7000	Central district	4	43	g10	80,932	23/07/2015
NES ZIONA	7200	Central district	4	44	g12	50,706	28/06/2018
NETANYA	7400	Central district	4	41	g3	222,129	24/07/2016
PETAH TIKVA	7900	Central district	4	42	g8	250,484	05/09/2021
RISHON LEZION	8300	Central district	4	44	g9	256,053	27/08/2015
REHOVOT	8400	Central district	4	44	g12	146,095	28/09/2017
RAMLA	8500	Central district	4	43	g10	76,987	30/08/2016
RA'ANANA	8700	Central district	4	42	g7	76,277	30/12/2015
YEHUD	9400	Central district	4	42	g4	30,020	09/03/2022
GLIL YAM	346	Tel-Aviv district	5	51	g37	562	
AZOR	565	Tel-Aviv district	5	53	g39	13,332	
OR YEHUDA	2400	Tel-Aviv district	5	52	g10	36,770	29/12/2016
KIRYAT ONO	2620	Tel-Aviv district	5	52	g4	40,835	06/12/2017
RAMAT HASHARON	2650	Tel-Aviv district	5	51	g38	47,512	
TEL AVIV - YAFO	5000	Tel-Aviv district	5	51	g38	463,808	28/12/2017
BAT YAM	6200	Tel-Aviv district	5	53	g39	127,803	19/07/2022
GIVATAYIM	6300	Tel-Aviv district	5	52	g5	61,061	
HERZLIYA	6400	Tel-Aviv district	5	51	g37	98,966	28/06/2016
HOLON	6600	Tel-Aviv district	5	53	g39	197,246	
RAMAT GAN	8600	Tel-Aviv district	5	52	g5	167,556	28/12/2016
BE'ER ORA	21	Southern district	6	62	g42	1,220	
OFAKIM	31	Southern district	6	62	g43	32,555	24/06/2015
ASHDOD	70	Southern district	6	61	g14	226,154	19/07/2020
MIZPE RAMON	99	Southern district	6	62	g44	5,185	31/08/2016
NETIVOT	246	Southern district	6	62	g43	39,703	29/11/2017
EVEN SHMUEL	400	Southern district	6	61	g40	2,287	
YEROHAM	831	Southern district	6	62	g45	10,773	30/07/2015
SDEROT	1031	Southern district	6	61	g41	29,074	31/08/2015
KIRYAT MALACHI	1034	Southern district	6	61	g14	24,384	25/12/2017
NEVE ZOHAR	1057	Southern district	6	62	g45	53	
MERKAZ SHAPIRA	1098	Southern district	6	61	g14	2,801	30/07/2015
ALUMA	1145	Southern district	6	61	g40	698	
SAPIR	1176	Southern district	6	62	g44	498	
MEITAR	1268	Southern district	6	62	g46	9,980	29/03/2023
DIMONA	2200	Southern district	6	62	g45	35,269	31/08/2015
ARAD	2560	Southern district	6	62	g45A	27,208	28/06/2021
EILAT	2600	Southern district	6	62	g42	52,519	30/12/2015
KIRYAT GAT	2630	Southern district	6	61	g40	58,482	10/03/2016
ASHKELON	7100	Southern district	6	61	g41	146,519	28/12/2015
BE'ER SHEVA	9000	Southern district	6	62	g47	210,595	04/11/2015
ELKANA	3560	Judea and Samaria	7	73	g48	3,911	24/10/2021
ARIEL	3570	Judea and Samaria	7	73	g49	19,582	10/01/2018
MA'ALE EFRAIM	3608	Judea and Samaria	7	75	g51	1,255	01/01/2020
KIRYAT ARBA	3611	Judea and Samaria	7	77	g53	7,338	27/04/2023
MA'ALE ADUMMIM	3616	Judea and Samaria	7	76	g52	37,846	25/01/2017
KARNE SHOMRON	3640	Judea and Samaria	7	73	g49	9,417	
EFRAT	3650	Judea and Samaria	7	76	g52	11,405	22/03/2023
BEIT ARYE	3652	Judea and Samaria	7	74	g49	5,351	14/08/2018
IMMANUEL	3660	Judea and Samaria	7	73	g50	4,129	01/01/2020
GIVAT ZE'EV	3730	Judea and Samaria	7	74	g18	19,225	
ALFEI MENASHE	3750	Judea and Samaria	7	73	g48	7,997	30/03/2017
ORANIT	3760	Judea and Samaria	7	73	g48	8,965	
GEVA BINYAMIN	3763	Judea and Samaria	7	74	g18	5,913	18/01/2021
BETAR ILLIT	3780	Judea and Samaria	7	76	g50	61,125	25/01/2017

Appendix B

Intensity of land marketing within government-run affordable housing programs in four selected periods (based on the latest regular tender date in each locality/period).



Appendix C

Explanation for Calculating the Rate of Change in Housing Prices by Locality, Based on CARMAN Data Using the CBS Housing Price Index Methodology[32]

Using detailed transaction data, we estimate regressions to calculate the annual hedonic index at the locality level according to Equation (A1):

$$\log\left(P_{ijt}^{(d)}\right) = c_0^{(d)} + \sum_k \alpha_k^{(d)} X_k + \beta^{(d)} M_i + \gamma_{jt} FE_{jt} + \varepsilon_{ijt}^{(d)} \quad (d = 1, \ldots 7) \qquad \text{(A1)},$$

where index d refers to the district and indices i, j, k and t refer to the transaction, locality, dwelling characteristics, and transaction year, respectively, and:

– P is the transaction value;

– X represents the dwelling characteristics, including the socioeconomic index of the statistical area[33], building age, apartment type (including identification of nonstandard dwellings such as garden, roof, duplex, cottage), second-hand dwelling, new dwelling not under the "Buyer's Price" program purchased "on paper", dwelling area, and number of rooms;

– M is a dummy variable identifying a transaction for a dwelling built under the "Buyer's Price" program (since 2018);

– FE represents fixed effects, which are interactions between the vector of years (1998, …, 2022) and the vector of localities belonging to the district;

– ε is a random error term;

– $c_0^{(d)}, \alpha_k^{(d)}, \beta^{(d)}, \gamma_{jt}$ are parameters for estimation using the Maximum Likelihood Method.

We estimate regressions at the locality level in separate panels for each of the seven districts, weighting the transactions according to the population size in the locality. Outlier observations are filtered according to the CBS method: We exclude transactions whose value is less than 45% and more than 220% of the average value of transactions in the

32 For more details on the methodology, refer to the CBS publication: https://www.cbs.gov.il/en/publications/Madad/Pages/2022/Average-Housing-Indices-and-Prices%20-September-2022.aspx.

33 If the socioeconomic index of the statistical area is unknown, the calculation is based on the average socioeconomic index of the surrounding statistical areas or the average in the locality.

same locality in the 18 months preceding the transaction date. (CBS uses a three-month average due to lower spatial resolution.)

The annual change (in terms of log differences) of the hedonic price in locality j derived from the Model (A1) is:

$$\gamma_{jt} - \gamma_{j(t-1)}$$

We validated the estimation results against the CBS Housing Price Index data, and the results were satisfactory. The following table shows the change in annual housing prices obtained by estimation of Model (A1) at the locality/subdistrict level and aggregated to the total economy level against the change in the CBS Index of Home Prices.

year	Aggregated from locality level	Aggregated from subdistrict level	CBS total economy
2000	-1.5	-1.1	-4.8
2001	-1.9	-2.0	-3.5
2002	5.1	5.3	5.3
2003	-4.1	-3.2	-5.7
2004	0.0	-0.1	-0.8
2005	1.1	0.7	0.2
2006	1.9	2.0	0.5
2007	-0.4	-0.4	-1.6
2008	8.7	8.5	7.6
2009	15.7	16.5	13.7
2010	17.2	16.8	17.6
2011	10.3	10.1	10.5
2012	4.2	3.9	3.2
2013	7.9	8.4	9.1
2014	6.6	6.7	6.4
2015	6.6	6.9	5.9
2016	7.0	6.9	7.5
2017	3.7	3.9	3.9
2018	-0.1	-0.4	-0.8
2019	2.8	2.4	1.9
2020	2.5	2.1	3.1
2021	6.1	6.2	8.4
2022	13.3	12.5	15.5

Appendix D

Results of Sensitivity Tests for the Definition of Neighborhood Groups

To examine the sensitivity of the results to the ad-hoc definition of neighborhood groups, we replaced our neighbor variable with a neighbor ratio calculated based on a GIS system that does not consider the socioeconomic level of the locality or the degree of spatial dispersion between localities in different parts of the country. The estimation results using both methods are presented in the following chart (percentiles of bids distribution on the X-axis, parameter estimates on the Y-axis):