Presale, Credit Constraints and Housing Supply*

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December 18, 2024

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Abstract

Home builders often rely on a combination of traditional credit and presale agreements to fund construction. In presale, buyers make advanced payments to builders, repaid by the delivery of a completed condo. I measure the premium builders pay for using presale-based finance in the Israeli housing market from 2010 to 2019. I find the presale premium is typically positive and substantial at 4%-8%, suggesting builders are credit constrainted. I then develop an equilibrium model of the housing market featuring overlapping generations of builders with time-to-build constraints and borrowing limits, as well as households with dispersed incomes and frictional mortgage access. Calibrating the model to the Israeli economy, I find that removing credit constraints causes presale to disappear endogenously and makes housing production more capital and less land intensive. Prohibiting presale causes housing production and affordability to collapse, highlighting presale's role in mitigating credit constraints.

Keywords: Presale, Credit Constraints, Housing Supply

JEL code: D20, L74, R21, R31

*I thank David Genesove, Boyan Jovanovic and Dan Waldinger for many helpful comments and discussions. I also thank Jess Benhabib, Danny Ben Shahar, Tom Cui, Morris Davis, Tomer Ifergane, Alexey Khazanov, Alessandra Peter, Stijn Van Nieuwerburgh and Jinglin Wang for helpful discussions. I also thank participants of the IO workshop at NYU Stern, at the macro lunch at NYU Economics, and at the Furman Center fellows meeting at NYU Wagner. This research was supported by the Israel Science Foundation (grant No.50/23), by Israel Scholarship Education Foundation (ISEF) and by The Alrov Institute for Real Estate Research at Coller Faculty of Management at Tel Aviv University. All mistakes are my own.

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1 Introduction

Home builders rely on a mix of traditional credit and presales—selling units before or during construction—to fund their projects. This practice introduces a novel and largely unexplored interaction between household finance and production finance with potential implications for housing supply and affordability. Presale offers buyers an affordable path to buying a new home. However, builders' reliance on presale funding signals potential credit constraints, which may restrict overall housing supply, ultimately exacerbating affordability challenges. Although this study focuses on Israel, presale is a widespread phenomenon in major economies. For example, in the United States during 2022–2023, only 36.7% of the 1.3 million new houses sold (480,000 units) were sold after construction was completed, while 17.5% (228,000 units) were sold before construction even began.[1] Despite its prevalence, little is known about how presale financing influences housing supply and housing affordability.

This study introduces and quantifies the "presale premium"—the additional cost builders incur to secure funding through presale compared to traditional credit sources. Using detailed transaction data from the Israeli housing market between 2010 and 2019, the analysis reveals that presale premiums are positive in 66% of cases with a mean of 7.7% and a median of 4.2%.[2] To explore the implications of presale premia, it then develops the first quantifiable equilibrium model of the homeownership market that incorporates presale transactions. Calibrated to Israeli data, the model rationalizes presale prices that imply substantial premia as a result of borrowing limits faced by builders. Counterfactual experiments illuminate the roles of presale and credit constraints in the housing market. Removing borrowing limits eliminates the need for presale and enables construction to be more capital-intensive and less land-intensive, increasing the number of housing units per unit of land by 26.5%. Prohibiting presale while maintaining borrowing constraints leads to a 22% decline in housing supply and a 39% increase in average house prices. These results clarify the interactions between financial constraints, presale practices, and housing market outcomes.

I calculate the presale premium by subtracting the builder's cost of traditional credit from an implied presale interest rate. This implied rate is determined similarly to the Yield-To-Maturity on a bond: it is the rate at which the net present value of the sum of all transfers resulting from the presale transaction equals zero.

[1] Source: https://www.census.gov/construction/nrs/pdf/newressales.pdf

[2] Comparable to an interest rate in yearly terms.

The primary challenge in measuring the presale premium lies in the fact that presale involves transferring ownership of a finished housing unit that does not have an observable market value at the time of transfer. This is because the unit is traded only on the presale date.[3]

To estimate the market value of the finished housing unit at the time of completion, I rely on detailed transaction-level data from Israel spanning the years 2010–2019. This dataset includes standard information for each transaction, such as the date, price, location, and unit characteristics. Crucially, it is augmented with a presale indicator that identifies transactions where a builder sells a unit before an occupancy permit is issued. This indicator, mandated by reporting requirements introduced in 2008, enhances the accuracy of presale identification. However, reporting prior to 2010 appears to have been inconsistent, making 2010 the earliest reliable starting point for analysis.

Using this data, I estimate the value-at-completion of presold condos through a three-step approach. First, I employ hedonic regressions to estimate the value of various characteristics of completed condos, excluding presale transactions to ensure that the estimated prices reflect only the intrinsic value of these characteristics. Second, I apply these hedonic estimates to infer the value of presold condos as if they had been completed at the time of sale. Finally, I adjust these inferred values to account for changes in local average housing prices between the presale date and the expected completion date, ensuring that the estimates reflect market dynamics over time.

To account for the expected timing of presale installments, I utilize regulatory limits that tie installment payments to building progress, combined with a rule of thumb for construction progress provided by an industry expert. For the builder's cost of credit, I assume a rate of prime plus 2%, based on industry reports indicating that builders' bank credit costs typically range between prime plus 1.25% and prime plus 2.5%. This approach ensures a realistic representation of both the timing and cost of financing in presale transactions.

I find that the presale premium is positive in around 70% of the transactions in my data, suggesting credit constraints are usually binding.[4] The monthly average presale

[3]The presale price should not equal the value of a completed unit because, while agreements to sell finished housing units usually settle within a few weeks, presale agreements may take months of even years to settle.

[4]Even if credit constraints were always binding, a 100% occurrence of positive premiums would not be expected. This is because prices in presale transactions are determined through bilateral bargaining, where buyers often lack information about the builder's specific financial conditions, leading to variation in the negotiated outcomes.

premium is around 10% and the monthly median is around 5%, suggesting funding through presale carries substantial costs for the builders. I also find there is no trend in the average level of the presale premium over my sample period, which is not too surprising given the relative stability of the Israeli economy and the housing market in the period 2010-2019.[5]

Next, to investigate the equilibrium implications of presale in the homeownership market, I develop a model incorporating overlapping generations of short-lived builders who fund lengthy construction projects by optimizing their mix of borrowing and presale. Builders determine both the total number of units to construct and how many to sell through presale versus after completion, where unsold units are offered at potentially higher spot market prices. Both the presale and spot markets are competitive, with builders acting as price takers. Consequently, the presale premium is determined in equilibrium by the endogenous interaction of presale and spot market prices. The overlap between successive cohorts of builders ensures competition between those selling presale units and those selling completed homes.

Housing demand arises from overlapping generations of finite-lived households that consume housing services and a numeraire good. All households begin life as renters, but may transition to homeownership if they can afford it. Households have heterogeneous, fixed incomes, and to purchase a house, they must save for a mortgage down payment, reducing their immediate consumption. Consequently, presale is inherently less attractive than buying a completed house, as it forces households to either buy earlier (with fewer savings) or delay homeownership further. This "inferiority" of presale for buyers affects its pricing and reflects factors such as construction timelines, the utility of homeownership, marginal utility of consumption (dependent on income net of rent), time preference, savings interest rates, and mortgage terms.

Homeowners nearing the end of life sell their homes (less depreciation) as second-hand spot sales and derive utility from passing proceeds to heirs outside the model. Depreciation ensures ongoing housing production, even without population growth. A market for second-hand homes is crucial to capturing the empirical structure of housing

[5]This study focuses on presale as a method of funding, as alternative motivations for presale appear to be negligible in the Israeli context. For instance, the practice of diverting presale income to other projects, identified by Chen et al. (2024) as a key driver of presale in China, is effectively ruled out in Israel due to the widespread use of externally supervised, project-specific bank accounts. Additionally, the data does not support the presence of adverse selection into presale transactions and suggests only a modest network externality, which is accounted for in the reported presale premia. Further details on these considerations are provided in Appendix B.

markets, where roughly two-thirds of transactions involve existing homes. These homes compete with both presales and new spot sales, while presales and new spots are typically priced too far apart to attract the same buyers. By integrating both household and builder considerations, the model offers rich microfoundations for the emergence of a presale market in equilibrium.

I calibrate the model to the Israeli housing market. I externally calibrate most parameters using publicly available statistics and previous research. The risk free rate is matched to the yield on a 1 year government bond; the mortgage rate and duration are matched to the average rate and duration of non-indexed newly originated mortgages (weighted average of fixed rate and variable rate). The builder's interest rate and presale installments are set based on accounts of industry experts; the builder's fixed cost and variable cost parameter are based on Ministry of Construction and Housing report (Armoni 2015); the Cobb-Douglas parameter is taken from Hoffman and Khazanov (2024); the intertemporal substitution parameter is taken from Ilek, Cohen and Chen-Zion (2024).

The other parameters, which include the builder's cost curvature parameter and borrowing limit, household preferences for house types and bequest, as well as the depreciation rate of old to new houses, are calibrated to match endogenous model variables to data moments. The data moments are calculated based on transaction data for the year 2015. Targets for the prices of the three house types are also based on my transaction data and I use hedonic pricing to net out observed systematic differences in quality between the house types. The builder's parameters are calibrated to match the data moments for average project size and average presale share, given that the builder's borrowing limit is binding in equilibrium. To calibrate the flow of services generated by the different housing types I first normalize the flow from rent to 1 and then find the vector of flows from other housing types to match the demand for the three house purchase types to data moments.

Calibration results imply a borrowing limit of 27.8 million New Israeli Shekel (NIS) per project, with another 9.9 million funded from the first installement on 17.5 presales, suggesting presale plays a non negligable role in funding construction. Also of note is the finding that households derive 8.2% more housing services from condos they bought in presale compared with condos they bought after completion. This is despite the fact that the presale service flow captures risks of delayed delivery and low quality. A potential explanation is that households value very highly the opportunity to customize the condo that presale affords. Presale's higher flow of housing services notwithstanding, the highest income households buy completed new condos while the lowest income home buyers buy presale. This reflects the inherent inferiority of presale from a consumption perspective that arises from the requirement to pay a substantial cost far in advance of receiving the benefits of that cost. Middle income home-buyers buy second hand houses, as expected. So while there is no household who is indifferent between buying presale and and buying new, there are households who are indifferent between second-hand and new other households who are indifferent between second-hand and presale.

After calibrating the model, I turn to study two counterfactual policy experiments. First, I consider the prohibition of presale. This can be thought of as an extreme case in which the various restrictions on presale make it nonviable. The absence of presale results in builders being unable to fund as much construction as in the baseline. Construction drops by 27.3% while the prices of spot sales and second hand sales jump by 36% and 38.1% respectively. This result illustrates the importance of presale in mitigating the worst effects of credit constraints.

Second, I consider the alleviation of builders' borrowing constraints. Such an outcame can plausibly be achieved by various interventions such as subsidizing banks' loans to builders. When borrowing is unconstrained, presale is no longer used. Even though households get a much higher service flow from owning a condo bought in presale relative to a completed new condo, the other disadvantages of presale evidently outweigh this benefit. Second, builder's total funding costs, which combine the explicit interest rate on bank credit with the implicit interest rate on presales, is reduced relative to the baseline. Builders now borrow as much as they need at the bank rate, avoiding the onerous presale premium, which reduces their effective marginal costs. Thus, each builder finds it optimal to build more units per project. In the new equilibrium, project size increases from 40.5 to 51.2, a 22.5% increase. Thus, housing production becomes much more capital intensive and much less land intensive.

In a future work I plan to allow the supply of both land and capital to be upward sloping. In such a model, an increase in borrowing driven by the removal of a borrowing limit should drive the borrowing interest rate to increase. At the same time, construction becoming less land intensive should drive the price of marginal land to decrease. Because the supply of land tends to be much less elastic than that of capital, it is likely that the total effect would lower building costs, which would likely lead to higher total production. In addition, the quality of the marginal land should increase and the land saved from development can accommodate other public uses, both of which should increase welfare. Thus, while the present model does not quantify the main benefits of eliminating credit constraints, it pinpoints the source of those benefits - an increase in the ratio of capital to land in housing production.

Related Literature The main contribution of this study is to show the implications of presale-as-funding for housing supply and affordability in the presence of credit constraints. The main related literatures are those on presale, on constraints to housing supply, on the housing production function and on macro housing.

The empirical presale literature has so far focused on the east Asian housing markets. Several prominent studies have explored the implications of particular institutional arrangements. For example, Gan, Hu and Wan (2022) focus on the implications of the fact that in Hong-Kong, buyers in presale do not commit to purchase the final condo but only buy an option for purchasing it. They show this leads to a large share of presale contracts being rescinded before completion. This option does not exist for presale buyers in other markets I am aware of. Similarly, Chen et al (2024) explore how builders in China use income from presale to start other projects - an option that builders in the West do not have. I follow the example of these studies in carefully considering how the institutional setting shapes presale. My contribution is to study a new institutional environemnt, and one that is similar to other major markets such as the US.

Furthermore, while the empirical presale literature has explored many determinants of presale, it has not given much consideration to the connection of presale to builder credit constraints. The main exception is Chau, Wong and Yiu (2007) who state builder credit constraints as a motive for presale and conduct a careful analysis of two concurrent developments, mainly focusing on the difference between presale and spot prices. My contribution in this respect is to calculate the premium builders pay for using presale as a source of funding, and to explore the implications for housing supply and affordability.

A small group of papers has sought to develop theoretical models of presale. Most such papers have either focused entirely on the builder's problem e.g., Shyy (1992) and Lai, et al. (2004), or on an interaction of a representative builder with a representative household in a stage game, e.g., Chau, Wong and Yiu (2007) and Chen et al (2024). The first analysis of presale as a simultaneous game between builders and buyers was developed by Edelstein, Liu and Wu (2012), where households with heterogenous beliefs choose between buying presale in the first period or a completed condo in the second period. My contribution is to develop a richer steady state equilibrium framework that allows for calibration and includes financial frictions on both sides of the market.

This study also contributes to the literature on constraints to housing production. From the seminal contributions of Gyourko, Saiz and Summers (2008), Glaeser and Ward (2009) and Saiz (2010) and as recently surveyed in Molloy (2021), this literature has focused on regulatory and geographic constraints on housing production. My contribution is to consider how credit constraints may limit housing supply, and the large but partial role presale plays in mitigating such constraints.

Another relevant literature is on the housing production function. This literature, which includes the seminal contribution of Epple, Gordon and Sieg (2010) and of which a prominent recent example is Combes, Duranton and Gobillon (2021), typically aims at identifying the physical production function of single family homes, modelling construction as an event rather than as a process. Two recent working papers, Ben-Moshe and Genesove (2022) and Genesove, Levy and Snir (2023), extend this literature to multi-family homes. My contribution is to consider how financing constraints and presale shape production decisions and equilibrium house prices.

Finally, this study is related to the literature on macro housing in which macro-style models are extended to include a housing sector and where household consume housing services in addition to consumer goods. This literature, starting with Davis and Heathcote (2005), has mostly focused on the interaction of dynamic macro forces (such as credit supply expansions, e.g. Landvoigt, Piazzesi and Schneider, 2015) with household finance considerations. The present study highlights the interaction of household finance with builder finance which emerges as a result of presale.

2 Institutional Context

Presale, as commonly practiced in Israel since 2008, involves a binding agreement between a builder and a buyer. The builder commits to delivering a completed housing unit with predetermined specifications by a specific date, while the buyer agrees to a schedule of payments tied to project milestones. In multi-unit developments, presales typically begin shortly after the land is acquired and continue until just before an occupancy permit is issued, spanning approximately five years.

Reforms introduced after the collapse of a major developer in 2007 have significantly improved the transparency and structure of Israel's presale market, facilitating this research and enhancing its international relevance. These reforms align Israeli presale practices more closely with those in other countries, broadening the applicability of this study's findings. Three key aspects of the 2008 reforms are particularly important.

First, builders are now required to report all presale transactions to a newly established regulator (Ministry of Construction and Housing, 2022). This enables precise identification of presale transactions, overcoming data limitations from earlier periods. While transaction dates are publicly available, building completion dates are not, and the prereform reliance on the "building year" variable often yielded unreliable results. This data improvement is a primary reason the study focuses on the post-reform period.

Second, the reforms introduced bank supervision of project accounts for most developers. Under this system, both credit from banks and income from presales are deposited into a dedicated account for the project. Funds can be withdrawn only for approved project expenses, with final balances released to the developer only after an occupancy permit is issued (Ministry of Construction and Housing, 2022). This prevents the diversion of presale funds to unrelated uses and closely mirrors U.S. practices, where project-specific accounts are subject to strict regulatory oversight (Chen et al., 2024).

Third, the reforms imposed limits on the proportion of the presale price that can be collected from buyers at various stages of project completion. This change prohibits upfront full payment, a practice common in China, and aligns Israel's installment-based system with standard U.S. practices (Chen et al., 2024). Further details about these payment schedules are discussed in Section 4.

3 Data

The primary data source for this study is a database of nearly all arms-length (excluding gifts) apartment sales in the 43 larges cities in Israel between January 2008 and October 2021 (inclusive). Each transaction record contains its price, date, location (parcel number), number of rooms, apartment area in square meters, year of construction and floor number. This database, maintained by the Survey of Israel, is augmented by a presale indicator and a project name that are drawn from Ministry of Construction and Housing records. These records are compiled from reports by developers to the Ministry of all sales of apartments in unfinished buildings mandated by the 2008 amendment to the Law of Sale.

I also use the Israeli deeds database, maintained by the Tax Authority, which contains (nearly) the universe of arms length transactions in real estate in Israel between 1998-2022. On each transaction I observe the price, date, location and property details such as type, area, rooms (bedrooms + living room), building year, floor(s).

Throughout the study I focus on transactions in buildings with at least 2 floors and at least 4 housing units. I do so because I expect low density construction such as single family houses to face financial considerations that are substantially different from those of high density construction. In particular, a single family house can go from land acquisition to occupancy permit much more quickly than a multi-family building, for several reasons: planning is much simpler and faces less regulation, building does not require work at an altitude, several nearby houses can be built fully in parallel, and underground parking is rare. For all these reasons, finance is for a shorter term and the usually cheaper land makes credit constraints less likely to be binding.

As noted in the introduction, all prior empirical research about presale has been from south Asia. Thus, this data, by being from a different geographic region with a different culture and legal framework, has the advantage of broadening the scope of evidence available to researchers. It also includes a presale indicator which allows me to know the precise length of presale in each project.

That said, this data has an important limitation that should be addressed. The limitation stems from the fact that the reporting requirements for presales to The Ministry of Construction are different from the reporting requirements for deeds to the Tax Authority. For this reason it is difficult to link them, which results in my data containing two copies of some transactions, where one copy is indicated correctly as presale and the other is incorrectly indicated as non-presale. I take several measures to address this problem: First, I drop from my data all transactions indicated as non-presale with a negative age at sale (transaction year minus building year). Second, I drop all transactions indicated as non-presale that occur before a presale transaction in the same building. Third, I conduct an analysis (see Appendix A.4) that shows that about 74% of age zero, about 19% of age one and about 6% of age two transactions that are indicated as non-presale are in fact presales. I thus drop an appropriate percentage of such observations from the data. To the extent that presales indicated as non-presale are still present, this should cause my estimates of value at completion to be biased downward (because presales tend to be sold at a discount). This should bias my estimates of the presale premium downward as well.

Tables 1 and 2 present transaction level summary statistics for spot sales and presales respectively (I refer to transactions in completed condos as presales). Presales and spot sales are not very dissimilar, but they are not identical either, as one would expect. One reason for the difference is that presales naturally tend to occur in newer buildings, compared with sales of finished houses, which include second-hand housing. In my data, newer builders tend to have more stories and larger condos. The average floor of a presold condo is 5.5 out of an average of 11.6 floors, while for a spot sale it is 3.93 out of an average of 7.8 floors. The presold condos are nearly 1/5 larger: spot sales have on average 4.05 rooms on an area of 97.2 square meters while presales have on average 4.35 rooms on an area of 112.6 meters. In the next section I discuss how I account for these differences when calculating the presale premium.

Table 1: Spot Sales Summary

	(1)	(2)	(3)	(4)	(5)
VARIABLES	N	mean	sd	min	max
year sold	122,075	2,015	2.790	2,010	2,019
rooms	122,075	4.056	0.874	1	10
square meters	122,075	97.19	27.68	21	800
floor	122,075	3.933	3.660	-1	47
building floors	122,075	7.795	5.269	2	42
building year	122,075	2,001	8.495	1,982	2,019
age at sale	122,075	14.30	8.634	0	37

Notes: year sold is the year that appears on the deed record as year of sale; rooms is the number of rooms in the asset, sqm is asset size in square meters, age is year of sale minus building year.

Table 2: Presale Summary

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
year sold	57,608	2,014	2.577	2,010	2,019
rooms	57,608	4.349	0.927	1	10
square meters	57,608	112.6	28.50	21	785
floor	57,608	5.467	4.128	-1	47
building floors	57,608	11.58	11.38	2	78

Notes: year sold is the year that appears on the deed record as year of sale; rooms is the number of rooms in the asset, sqm is asset size in square meters, age is year of sale minus building year.

4 Presale Premium

Definition Each presale transaction results in stream of money transfers from the buyer to the seller and ends in the transfer of a finished condo from the seller to the buyer. I define the presale interest rate in a presale transaction as the interest rate that, if used to discount each of the transfers, would cause the sum of the discounted transfers to equal zero.

To make this definition both more formal and more concrete, denote the presale price by $p > 0$, the value of the finished condo by $s > 0$, the share of the presale price due at each date $t_n \in \mathbb{N}$, $n \in \{0, 1, ..., N\}$ by $\iota_n \in (0, 1)$. Thus, the net present value of the transaction from the builder's perspective is:

$$V(r) \equiv \sum_{n=1}^{N} \frac{p\iota_n}{(1+r)^{t_n}} - \frac{s}{(1+r)^{t_N}}$$

and the presale interest rate, denoted r_p, is r such that $V(r) = 0$:

$$r_p \equiv \{r \mid V(r) = 0\}$$

There are two main challenges involved in calculating the presale interest rate r_p: the expected timing of payments and the expected value of the finished condo are both unobservable. Those challenges are addressed as follows:

Table 3: Milestones and Installments

	Milestones	Max Installment Share
0		7%
1	The frame of the ceiling of the ground floor of the building is completed	40%
2	The frame of the ceiling of the floor of the sold condo is complete	60%
3	Plastering of the entire building is complete	75%
4	Exterior finishes are complete	90%
5	The key to the condo is delivered to the buyer	100%

Timing of payments Each payment's due date is defined in the presale contract, and is subject to regulation. The regulation limits the share of the presale price the builder can receive before reaching each of several specified milestones in the project. The first milestone is reached when the frame of the ceiling of the ground floor of the building is completed. Before the first milestone is completed, the builder can receive up to 7% of the presale price. After the first milestone is reached, the builder can receive up to 40%. In presales that occur before the first milestone, the buyer pays up to 7% up front and an additional 33% when the first milestone is reached. In presales that occur after the first milestone, the buyer pays up to 40% up front. The other milestones and corresponding shares are 2) the frame of the ceiling of the ground floor of the building is completed (60%); 3) the frame of the ceiling of the floor of the sold condo is complete (75%); 4) exterior finishes are complete (90%); 5) the key to the condo is delivered (100%). The milestones and installment shares are summarized in Table 3

Because I do not observe actual presale contracts, I assume that the buyer is required to pay as much as regulation would allow. If this is not true, this would cause me to underestimate presale interest rates.

Because I do not observe each builder's estimates of when each milestone would be reached, I use a heuristic provided by an industry expert to calculate, based on the number of floors in the building and the condo's floor number, the average time until each milestone is reached. Further details about the heuristic are provided in Appendix E.1.

Value at completion To overcome the challenge of inferring the value of the completed condo I first use hedonic pricing to measure the value of various characteristics of completed condos. I exclude presales from the sample of observations used to calculate the values of characteristics because their price reflect a combination of values of characteristics and of other considerations.

I regress the natural log of transaction price on the natural logs of condo rooms and of area in square meters, as well as on the condo floor number, a third degree polynomial of building age at sale, building fixed effects and year by neighborhood fixed effects. I find that running the regressions separately in each district improves out of sample prediction while using separate years does not, so I do the former but not the latter. Second, I use the resulting hedonic values to infer the counterfactual value of the presold condo if it was completed by the time it was sold, setting the condo age at sale to zero. The third degree district specific polynomial in the hedonic regression helps make sure that I can accurately fit the price of hypothetical transactions at age zero. For more details on the hedonic estimation see Appendix A.2.

Finally, I account for changes in the local average prices of houses between the date of actual sale and the expected date of completion. I do so by calculating monthly average prices in each neighborhood and assuming builders know the price trends between sale and completion. Using forecasted neighborhood price trends results in a similar average presale premium but greatly increases the share of extremely large positive and negative expected appreciation rates, which I consider to be unlikely to occur in actual forecasts by builders. I cap the price changes by 10% per year because in some neighborhoods observed appreciation displays extreme values, which I consider to be unreasonable to foresee. Adjusting for price trends separately from the hedonic regression allows me to make the adjustment for each month and neighborhood combination, whereas the hedonic regression only controls for year by neighborhood fixed effects. I find that using neighborhood by month fixed effects in the hedonic regressuib performs poorly so I avoid doing so. For more details on adjusting for local time trends see Appendix A.3.

Presale premia Denoting by $1+r_b$ the interest rate the builder pays per year on the traditional credit it receives, either from the bank or from other lenders, I define the presale premium as:

$$\Delta r_p = r_p - r_b$$

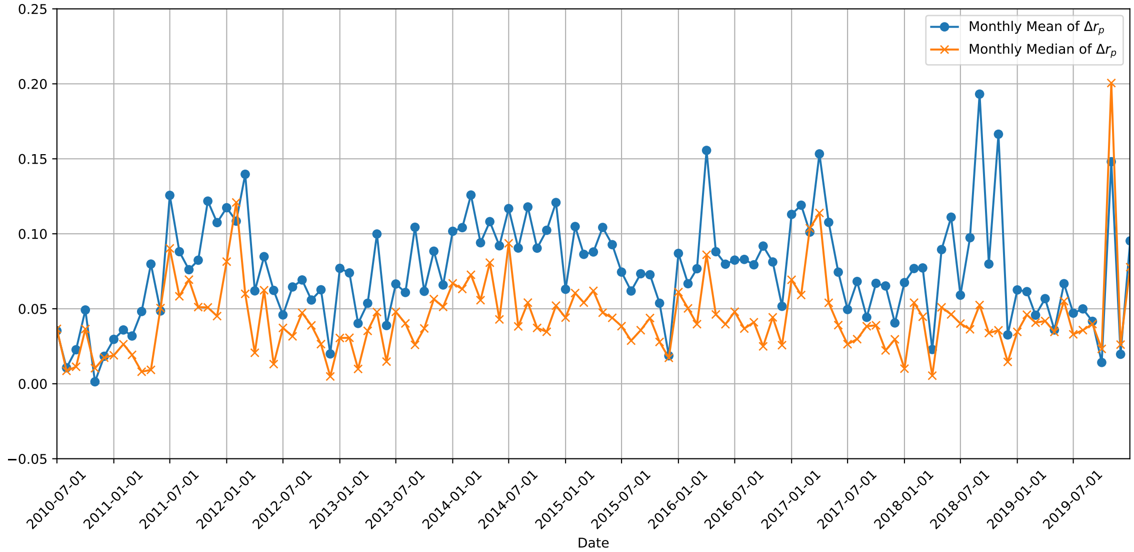
According to market experts, the interest rate on the builder's bank credit always falls within the narrow range of prime plus 1.25% and prime plus 2.5%, where prime is the interbank benchmark lending rate published by The Bank of Israel and regularly reported in the business press. Lending from other sources appears to be insignificant. Due to lack of access I am forced to ignore other sources. This may cause the presale premium Δr_p to be biased slightly upward.[6]

Results Figure 1 plots the monthly mean and median of the presale premium. Both are always positive and mostly quite economically meaningful with most monthy values falling between 5%-10%. A premium of 5% implies that a builder pays a rate that is more than double his lending rate to obtain funds through presale, while a 10% premium implies the builder pays a rate that is more than triple. This naturally raises the question of why a builder would agree to sell at prices that imply such rates. As noted above, funds obtained through presale cannot be diverted to any use outside the project until completion. In Appendix B I discuss two other potential reasons. I find that the data is not consistent with adverse selection into presale and that it is only consistent with a small network externality, by which I mean that demand for presales in a project seems to increase slightly with previous sales in that project. I account for this externality in the results presented here.

The median of the monthly presale premium is usually below the mean, which implies a right skewed distribution. This makes sense because very constrained sellers may agree to sell at very low prices, which would cause very high presale premia. On the other hand, buyers are unlikely to agree to very high prices because they always have other options, which would limit the frequency of very low presale premia. Neither the mean nor the median display a strong trend in their central tenancy. However, both become more volatile towards the later part of the data. This is probably the result of truncated projects caused by the end of the data in 2021, which causes me be more likely to underestimate time to completion in the later part of the data. This, in turn, causes the premium to reflect large differences between presale prices and expected spot

[6]While some builders issue bonds to the public, these offerings tend to raise a small share of their funding needs and to come at a cost that exceeds their cost of bank credit. For example, the biggest builder, with a 16% market share, raised with its 2015 offering only enough to fund 2.9% of market construction. The YTM at issuance was 4.9% while the rate on bank credit was at most 4.5%.

Figure 1: Monthly average and median presales premium



Notes: In each presale transaction I calculate the presale premium as detailed in the text. I then calculate, for each month, the mean and median of the premia.

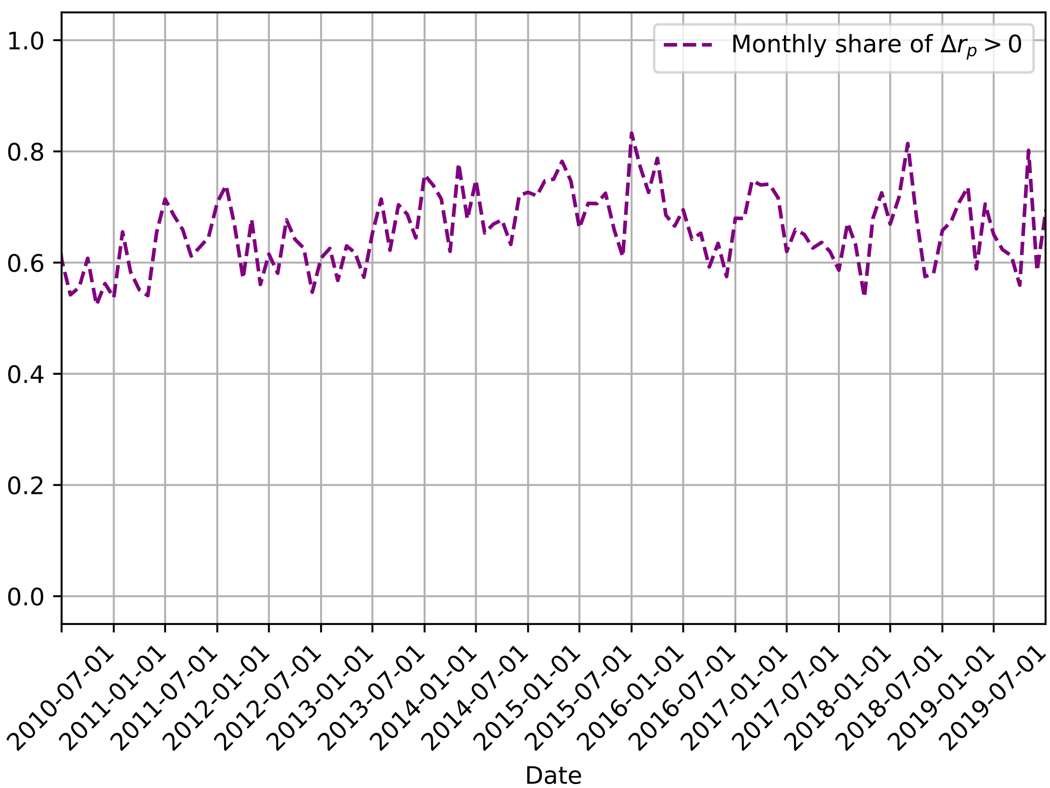
values, resulting in extreme observations, both high and low.

Figure 2 plots the share of presales with a positive premium in each month. The share fluctuates around 60% in until 2013 and then around 70% for the rest of the sample. The volatility is quite low, with the shares never coming close to either 90% or 40%. One should not expect all presales to carry a positive premium because prices are determined in bilateral bargaining where the buyer is uninformed about the builder's financial position and therefore cannot appropriate the whole surplus.

5 Quantitative Model

The previous sections presented empirical evidence indicating that presale premia are substantial, pervasive and persistent. Now I turn to examining the implications of presale as a funding method for the housing market. In particular, I focus on builder credit constraints as the reason for builders to presell at prices implying positive presale premia. I discuss other potential reasons for such behavior in Appendix B and find their contribution to explaining presale premia to be minor at most. The model I develop is designed to deliver endogenous presale quantities and prices along with prices and quantities for completed new condos and second hand condos. It is intended to answer two main questions: First, how does the possibility of a presale market change the

Figure 2: Monthly share of presales with a positive premium



Notes: In each presale transaction I calculate the presale premium as detailed in the text. I then calculate, for each month, the share of transactions with a strictly positive premium.

effect of credit constraints on the housing supply and affordabilty? Second, how does the existance of credit constraints affect the housing market when presale is possible?

Environment The economy operates in discrete time: $t = ..., -1, 0, 1, ...$ There are two types of agents: builders and households. In each period t, a mass $B_t > 0$ of builders and a mass $n_t > 0$ of households are born. Builders live for two periods, while households live for $A > 2$ periods.

There are up to three markets, indexed by $j \in \{0, 1, 2\}$: a market for incomplete condos (also referred to as 'presale' and indexed by $j = 0$), a market for complete new condos (also refered to as 'spot', indexed by $j = 1$), a market for second hand condos (also referred to as 'old', indexed by $j = 2$). Both builders and households are price takers and the law of one price holds in each market.

The model is deterministic. Participants can calculate prices as far into the future as they require. Because I restrict my analysis to steady state conditions, I omit the subscript t whenever it is not required for clarity. I use P to denote the set of all prices in the current period and in the subsequent $A - 1$ periods. To conserve on notation I write all choice variables as a function of P, even when the decision only requires some of the prices or a shorter horizon. Similarly, I use P_j to denote the set of current and future prices of j.

5.1 Households

Preferences Households derive utility from consuming housing $h \geq 0$, a numeraire consumption good $x \geq 0$, and from bequest of an estate worth $\eta \geq 0$ at the end of life. Their goal is to maximize their lifetime utility, which is given by:

$$U = \sum_{a=1}^{A} \beta^a x_a^\gamma h_a^{1-\gamma} + \beta^A \psi \eta \tag{1}$$

Households discount the future at a rate $\beta \in (0, 1)$, have a Cobb-Douglas per period utility with parameter $\gamma \in (0, 1)$ and the value of their bequest η is weighted by the parameter $\psi > 0$.

Income At the start of life, each households draws an income $w > 0$ from the positive valued random variable W with associated CDF F_w. In each subsequent period they receive the same income they drew in the first period.

Housing At the start of life, all households are renters. Being a renter yields a per period flow of housing services $h_R > 0$ and costs $R > 0$ per period. If a household obtains a completed condo, they stop paying rent and their flow of housing services increases to $h_j > h_R$, $j \in \{0, 1, 2\}$. To obtain a condo they must either purchase a completed condo, either new or old, or buy an incomplete condo and presale and then wait one period.

Denoting by y the age of purchase and by a the current age, the flow of housing services can thus be summarized by:

$$h(j, y, a) = \begin{cases} h_j & j \in \{1, 2\}, a \geq y \\ h_0 & j = 0, a \geq y + 1 \\ h_R & o.w. \end{cases}$$

The rental payment per period is:

$$R(j, y, a) = \begin{cases} 0 & j \in \{1, 2\}, a \geq y \\ 0 & j = 0, a \geq y + 1 \\ R & o.w. \end{cases}$$

Mortgage To buy a house, a household may obtain a mortgage with a minimum down-payment requirement as a share of purchase price $m_d \in (0, 1)$, a fixed term $m_y \in \{1, 2, ..., A\}$ and a fixed interest rate $1 + r_m \in (1, 2)$. They save for the down-payment and get a return on their savings that is below the mortgage rate $r_m > r_f \in (1, 2)$. I am assuming households save only for the purpose of buying a house and, while saving, they save a fixed sum in each period $s(P_j, y, a)$ such that:

$$s(P_j, y, a) = \begin{cases} P_j m_d / y & a \leq y \\ 0 & a > y \end{cases}$$

While repaying their mortgage, buyers of completed condos pay a fixed sum each period. Buyers of presale pay a two part mortgage. Thus, $m_p(P_j, y, a)$ can be summarized as:

$$m_p(P_j, y, a) = \frac{r_m}{1-(1+r_m)^{-m_y}} \cdot \begin{cases} P(1-m_d) & j=\{1,2\}, a \in [y+1, y+m_y] \\ P(1-m_d) & j=0, a \in [y+2, y+m_y] \\ P(\iota - m_d) & j=0, a=y+1 \\ P(1-\iota) & j=0, a=y+m_y \\ 0 & o.w. \end{cases}$$

Depreciation and Bequest Homeowners who reach the end of life sell their house net of depreciation (at the rate $\delta \in (0,1)$) as a second hand condo and bequeath the proceeds to progeny outside the model. The total value lost to depreciation depends on the number of years the household spend in the house, so if the purchase age of a completed house is y, whether its new or old, the proceeds from its sale are $P_2(1-\delta)^{A-y}$, which is also the value of the estate. A an incomplete house purchased at age y results in an estate of $P_2(1-\delta)^{A-y-1}$. Thus, the estate can be summarized by:

$$\eta(j, y) = \begin{cases} P_2(1-\delta)^{A-y} & j \in \{1,2\} \\ P_2(1-\delta)^{A-y-1} & j=0 \\ 0 & o.w. \end{cases}$$

Depreciation ensures that housing production remains necessary in steady state. The existence of second hand homes in the economy is necessary to represent the empirical distribution of activity in the housing market where about two thirds of transactions are in second hand homes. In addition, second hand homes can be in competition with both presales the new spot sales, while presales and new spot sale's prices tend to be too different to be considered by the same household.

Household Problem Each household chooses whether to buy a house, which type of house and when to buy it, subject to its income and prevailing prices and interest rates. This determines the household's savings, and its spending on housing. The household consumes the remainder of its income, which must be positive in each period. Thus the problem of a household with income w can be written as:

$$max_{\{j,y\}}\{U(w,P,j,y)\} = max_{\{j,y\}}\{\sum_{a=1}^{A}\beta^a x(w,P,j,y,a)^{\gamma}h(j,y,a)^{1-\gamma} + \beta^A\psi\eta(j,y)\} \tag{2}$$

$$s.t.$$

$$x(w,P,j,y,a) = w - s(P,j,y,a) - m_p(P,j,y,a) - R(j,y,a), \ \forall a$$

With $h(j,y,a), R(j,y,a), s(P,j,y,a), m_p(P,j,y,a), \eta(j,y)$ as defined above.

Household Tradeoffs A household face three main tradeoffs - buy or rent, what to buy and when to buy. Buying a house yields a higher flow of housing services relative to rent and allows for a bequest. On the other hand, most households must save to buy a home, which lowers their consumption early on (which matters more because of discounting), and later they must pay a mortgage at an interest rate that exceeds the rate on their savings. Finally, they incur losses from depreciation in their house.

The second trade off is what to buy. Regarding the two spot options, a new condo and a second hand condo, the trade off is between a higher cost of a new condo and a lower service flow from the old condo. Regarding the choice between presale or spot sale, presale is inferior because it requires a payment ahead of receiving the benefits of homeownership. On the other hand, presale may provide access to the high service flow from a new house at a lower price. Note that the household's willingness to pay for presale is affected by the utility cost of paying earlier, both in terms of fewer periods in which to save and more periods in which to pay for rent.

Thus, the trade off between presale and spot sale cannot be summarized by a single variable in the model but rather is determined by a complex interaction of several variables, both endogenous and exogenous. In this way, the household's finance problem also affects, through presale, the builder's ability to mitigate his credit constraint. This highlights why a model of this kind is useful in understand presale. It also indicates that it may be difficult to solve.

5.2 Builders

Entry Upon birth, each builder born in period t chooses whether or not to enter the market. Those that do not enter, disappear. Those that enter pay $c_F > 0$ immediately and participate in the model for two periods: $t, t+1$.

Production A builder that chooses to enter, then chooses a quantity of housing units to produce, q, subject to a convex variable cost function:

$$C(q) = \frac{c_V}{c_E} q^{c_E}$$

$c_V > 0$ is a variable cost shifter and $c_E > 1$ is a cost curvature shifter. Building costs are paid in period t, while construction will be completed in period $t+1$.

Presale A builder that enters in period t may choose to sell $q_0 \leq q$ units in presale in period t. The units are sold at an endogenous price P_0 and generate a cash flow consisting of ιP_0 in period t and $(1-\iota)P_0$ in period $t+1$. The rest of the units will be sold in period $t+1$ at an endogenous price P_1.

Borrowing The builder must borrow any funds required in period t that are not covered by the immediate income from presale. Thus, a builder's bank balance in period t is:

$$b_0(q, q_0) = \iota P_0 q_0 - c_F - C(q)$$

Borrowing carries a per period interest rate of $1 + r_b$ on a negative balance. I assume that a negative bank balance cannot exceed a borrowing constraint $b_0 > -b_{lim}$.

The Builder's Problem The builder's profit therefore can be written as second period income, from spot sales and from the second installement on presale, plus the second period bank balance, which is just the first period bank balance b_0 times the interest on a negative balance, if the balance was negative. Formally:

$$\pi(q, q_0) = P_1(q - q_0) + P_0(1-\iota)q_0 + \begin{cases} b_0(1+r_b) & b_0 < 0 \\ b_0 & b_0 \geq 0 \end{cases}$$

The builder's problem is therefore to choose total quantity and presale quantity to maximize profit subject to the borrowing constraint and subject to earning non-negative profits (otherwise he would not enter). It can be written formally as:

$$
\begin{aligned}
&max_{q,q_0}\{\pi(q,q_0)\} \\
&\qquad s.t.\pi(q,q_0) \geq 0,\ b_0(q,q_0) \geq -b_{lim}
\end{aligned}
$$

Builder Tradeoffs Note that builders have a trade off between presale and borrowing - the more they presell, the less they need to borrow. When the presale interest rate is above their cost of credit, they only use presale if they cannot borrow enough to fund their optimal construction quantity. The presale interest rate is determined by equilibrium prices of presale and new spot sale, which are affected by the builder's choice regarding quantity to build and to sell in presale.

The model allows for multiple discrete supply regimes, each of which results in a distinct set of supply functions for presale and spot sales. The regimes can be categorized by a combination of two factors: difference between presale and spot sale prices and the builder's funding needs relative to the borrowing limit, both as a function of quantity choices. A builder may choose to not sell presales at all, or to sell just enough presales to meet the borrowing limit, or just enough to avoid borrowing at all or more than than. This results in a supply function that is discontinuous, which makes finding numerical solutions difficult. The existence of overlapping generations of builders allows for a positive supply of presales and new spot sales in every period, but does not enforce it.

5.3 Discussion of Simplifying Assumptions

I make several simplifying assumptions and discuss their implications. First, the model is deterministic - neither households not builders face any shocks. Second, households are assumed to only save for a down-payment on a house, to save a fixed amount each period (which depends on income and on the intended purchase), and do not have access to other assets. Together, these assumptions imply that both households and builders make a plan at the start of their life and have no need to revise it. Builders have three choice variables: entry, total quantity and presale quantity. Households only have two choice variables: tenure (which includes rent and the three purchase types) and purchase timing, which indicates the age at which a house is purchased and thus determines (along with the type of purchase) the required savings rate. Note that because households face a fixed environment, there is no reason to sell a house before the end of life.

These assumptions make the model different from standard models of household intertemporal choice, where households save to smooth utility across time and across states of the world. In the present model, some households may have a higher utility flow at the end of life, when they finish paying off the mortgage, compared with earlier periods where are either paying rent and saving or are repaying the mortgage. Note however that they have the option of smoothing consumption to some extent by choosing to buy later, which would increase their consumption during the early part of life when they are saving and decrease it later as they would have fewer periods after paying off the mortgage. Therefore, the main constraint to consumption smoothing is not my assumption restricting saving behavior but rather the inherent lumpiness of housing as an asset.

5.4 Solution

5.4.1 Steady State Market Equilibrium

Given parameters, a steady state market equilibrium is: prices of house purchase types $0, 1, 2$, and an allocation, namely, aggregate demand for each house purchase types and an aggregate supply of each house purchase type, such that households and builders optimize, builders get zero profit, markets for all three house purchase types clear, and the prices and allocations are identical for any two subsequent periods. See Appendix C.1 for more details.

5.4.2 Solving for Equilibrium

Unfortunately, it is difficult to characterize the conditions such that demand (supply) for each house type is always weakly decreasing (increasing) with its price. Therefore, the standard argument for existence of market clearing prices cannot be used. See Appendix C.2 for further details. Instead, I show existence by constructing an example in the Calibration section.

6 Model Calibration

In this section I present a numerical calibration of the above model. The purpose of the numerical calibration is to quantify the effects of presales and credit constraints on the housing market equilibrium in Israel. The following can be divided into several parts: First, I describe the calibration of model parameters for which there exists credible information outside the present work. Second, I internally calibrate some parameters on which no external information is available. These parameters are fitted numerically by searching for the parameter values that, when prices equal their data moments, minimize the sum of the absolute values of excess demand and excess returns.[7] I do this separately for parameters affecting the supply of new condos and for those affecting demand and the supply of old condos. I calibrate the model based on the Israeli economy in the year 2015. I choose 2015 because, being in the middle of my data, it minimizes the risk of projects getting truncated by the extent of the data.

6.1 Independently Calibrated Parameters

In this subsection I explain how I arrive at values for the parameters on which external sources are available. Table 4 details the chosen parameter values.

Income I assume income is distributed log normally, following Setty and Shlomo (2018). I choose the parameters of the distribution so that its mean equals average net income and its Gini coefficient equals the empirical Gini coefficient in Israel in 2015 based on Central Bureau of Statistics (2017). I find that about 3% of households cannot afford the average rent, so I replace their incomes with the rent. I also replace the income of the top 5% with the 95th percentile of the distribution. This does not affect their choices and conserves computational resources.

Interest Rates I set the risk free rate r_f to equal the yield on a one-year Israeli government bond. The mortgage rate and duration are matched to the average rate and duration of non-indexed newly originated mortgages (weighted average of fixed rate and variable rate). The builder's interest rate and presale installments are set based on accounts of industry experts.

Installments To accommodate the up to 6 installments in a two period setting, I divide them equally between the two periods in terms of shares, so that about 50%

[7] I introduce excess returns in the calibration exercise because it is an important institutional feature of the market: a project will not receive funding unless its expected return is above a threshold that is usually set at 15%-18%. This condition is difficult to accomodate in the baseline model without introducing builder heterogeneity because a mixed entry strategy requires indifference between entry and non-entry, which cannot be reconciled with a positive return.

Table 4: Independently Calibrated Parameters

Parameter	Value	Source
Rent (R)	3.715	Average rent on a dwelling in 2015, CBS
Income mean and variance (μ_w, σ_w^2)	$15.66, 0.67$	Average net income and Gini coefficient in 2015, CBS
Minimum and maximum income (w_{min}, w_{max})	$3.715, 37.22$	Rent, 95th percentile of $log(N(\mu_w, \sigma_w^2))$
Risk free interest rate (r_f)	0.0012	The yield on a one-year Israeli government bond in 2015, BOI
Mortgage interest rate (r_m)	0.023	Weighted average rate on non-indexed newly originated mortgages in 2015, BOI
Builder's interest rate on bank credit (r_b)	0.036	Prime plus premium of 1.25%-2.5%, industry experts
Mortgage term	20	Average mortgage term at origination in 2015, BOI
Minimum mortgage down-payment share	0.25	Regulatory minimum down-payment, BOI
Household discount factor (β)	0.98	Weighted average of borrowers' and lenders' β, calibrated by Ilek, Cohen and Chen-Zion (2024)
Household consumption share (γ)	0.75	One minus expenditure share on housing, Hoffman and Khazanov (2024)
New households per period (n)	60292.5	Total households of working age divided by 40 (average pension age minus average household formation age), CBS
Installment shares ($\iota_{h,0}, \iota_{h,1}, \iota_{b,0}, \iota_{b,1}$)	$0.49, 0.51, 0.47, 0.52$	Sum of max installment shares, discounted w.r.t milestone's typical TTB, industry experts

Notes: Money flow parameters (income and rent) are in terms of thousands of New Israeli Shekel per month. Discounting parameters (interest rates, household discount) are in yearly terms. CBS is the Israeli Central Bureau of Statistics. BOI is the Bank of Israel.

Table 5: Prices and Quantities in the Data

Variables	Values
P_0, P_1, P_2	$1128.5, 1308.5, 1255$
$D_0, D_1, D_2 = Q_0, Q_1, Q_2$	$7622, 9878, 37500$

Notes: P is price, D is demand, Q is supply, 0 is presale, 1 is spot , 2 is second hand.

of the price is due immediately and about 50% at completion. To better account for the net present value of the installments in each case, I adjust the 50% by the relevant interest rates. This results in the sum of the two installments not equaling exactly 100%. Because I use different interest rates for the household and the builder, their installments are not identical. I denote the household's (builder's) installments in the first and second periods by $\iota_{h,0}, \iota_{h,1}$ ($\iota_{b,0}, \iota_{b,1}$) respectively. See Appendix D.3 for more details.

6.2 Internally Calibrated Parameters

The parameters on which I do not have direct evidence are: (1) the supply parameters (c_V, c_F, c_E, b_{lim}); (2) flows of housing services (h_0, h_1, h_2); the bequest motive parameter (ψ); and the depreciation rate of new to old houses (δ). These nine parameters are calibrated, given that prices P_0, P_1, P_2 equal their data moments and subject to the minimum returns constraint, to minimize the distance between the model and the following moments in the data: $D_0, D_1, D_2, Q_0, Q_1, Q_2, q, q_0$, where D_j is aggregate demand, with $j = \{0, 1, 2\}$ indicating presale, spot and old respectively, Q_j is aggregate supply, q is total quantity produced by a single builder and q_0 is the presale quantity sold by a single builder. The parameter values resulting from the calibration are presented in Table 6. The calibration is conducted as follows.

First, I calculate the average prices of presales, new spot sales, and second hand sales in 2015 and use them to set the model prices (further details of the calculation are provided below). I use a similar calculation for quantities of such sales in 2015 to set the targets for aggregate demand and supply. The results of these calculations are presented in Table 5.

Second, I calculate the average number of units in a new building to be 40.5, which implies builder entry of $B_1 = \frac{Q_0+Q_1}{40.5} = 432$. This should be interpreted as 432 new buildings are built each year, each with 40.5 units. Third, I use data from a report on housing construction costs (Ministry of Construction and Housing 2015) to estimate the total land cost and the non-land costs per unit in a multi-family building in 2015. I multiply land costs per units by 40.5 to get the value for the fixed cost c_F. I set the variable cost shifter c_V such that the average cost of production at $q = 40.5$ equals non-land costs per unit in the report (more details on this calculation are provided below). Fourth, I set the cost curvature shifter c_E to set the endogenous presale share choice to 43.5% of q, given the builder's variable cost shifter, fixed costs, cost of credit and prices (c_V, c_F, r_b, P), assuming the builder's borrowing constraint is binding and assuming $q = 40.5$. Fifth, I set the borrowing limit b_{lim} to equal the builder's borrowing needs given the above, which also has the result of setting the builder's total quantity to $q = 40.5$. Sixth, I normalize the service flow from rent to $h_R = 1$ and then find the vector of service flows from other housing types (h_0, h_1, h_2) to match the demand for the three house purchase types (D_0, D_1, D_2) to data moments of sales in 2015.[8] The demand calculation also yields choices of purchase timing for each household $y(w)$, which determines the distribution of times between purchase and end of life. Given the distribution of purchase choices and times, I set the depreciation rate δ to match the supply of second hand homes in the model Q_2 to the data moment of second hand sales in 2015. Finally, I set the bequest utility parameter ψ so that the average utility from bequest equals the average utility from living off the proceeds for three additional periods (which represents retirement).

6.3 Targeted Data Moments

In what follows, I provide additional details about how I arrived at the targets for each data moment.

Average Project Size The average number of condos in a building built in 2015 was 40.5, and the average in the following 5 years was similar. This is not very different from the average number of condos in a building built between 2007 and 2020, which was 42.5. I start from 2007 because up until that year, the average building height was increasing. Between 2007 and 2020 it stabilized at around 10. I focus on buildings of at least 4 condos and of no more than 200 condos. The former is intended to abstract

[8]More formally, I use an ensamble of black-box search algorithms to find the values (h_0, h_1, h_2) that minimizes the sum of abolute relative deviations of (D_0, D_1, D_2) from the data moments $(\tilde{D_0}, \tilde{D_1}, \tilde{D_2})$, where the sum of absolute relative deviations is defined as $\sum_{j\in\{0,1,2\}} \frac{D_j(h_0,h_1,h_2)-\tilde{D_j}}{\tilde{D_j}}$.

Table 6: Internally Calibrated Parameters

Parameter	Value	Moment	Data	Model
Variable cost shifter and fixed cost (c_V, c_F)	$36, 16527$	Non-land cost per unit and land cost in thousands $(\frac{C(q)-c_F}{q}, \frac{c_F}{q})$	$507.8, 408$	$507.8, 408$
Cost curvature shifter and borrowing limit (c_E, b_{lim})	$1.9, 27788$	Builder quantity choices (q, q_0)	$40.5, 17.6$	$40.8, 17.7$
Housing service flows (h_0, h_1, h_2)	$7.9, 7.3, 7.1$	Household housing choices (D_0, D_1, D_2)	$7622, 9878, 37500$	$7622, 9420, 38012$
Depreciation rate of new to old houses (δ)	0.0576	Supply of 2nd-hand houses (Q_2)	37500	37524

Notes: P is price, D is demand, Q is supply, 0 is presale, 1 is spot , 2 is second hand, q is the total supply of a single builder: presale plus spot. C(q) is the builder's variable cost function.

from low density construction while the latter is intended to avoid inflating the mean by the inclusion of unusually large buildings or of multiple buildings which are mistakenly identified as a single building.

Builder Costs I calibrate the variable cost shifter and fixed costs parameter (c_V, c_F) to equal the total non-land cost per condo and the total land cost, respectively, of residential projects with at least 3 floors built by developers in 2015. To do so, I start from the 2015 Ministry of Construction and Housing report (2015) that examines building costs of residential projects that were completed between 2010 and June 2012. I correct for the changes in land and nonland costs over time. I obtain changes in nonland costs from the builder's cost index tracked by the Israeli Central Bureau of Statistics (CBS), which does not include land costs and which increased 13.6% between Jan 2010 and Jan 2015. Regarding land costs, I use data on land auctions from the Israeli Land Administration. I estimate the increase in land prices over this time period controlling for district and year fixed effects. See Appendix D.2 for further details.

Prices Because in the present framework, condos are assumed to be identical and the market conditions are fixed, I need to net out price differences in my data that are the result of different apartment locations, characteristics and time of sale. I do so by using hedonic regressions to estimate the effects of such differences and to net them out. This results in quality adjusted prices that are internally comparable but that are not comparable to other prices in the economy such as wages and rents. Therefore, I first calculate the ratios of the adjusted prices of presales to spot sales and of spot sales to old sales, and then multiple the ratios by the median unadjusted second hand house price in my data, which I also use as P_2 in the model calibration. See Appendix D.1 for more details.

Presale Share To determine the division between presale and spot sales by the typical developer, I do the same as in determining the ratio of presale to spot sale price, but instead of calculating the ratio of prices, I calculate the share of observations that are in the early group. Namely, for each pair of ages between -4 and 8 that are 4 years apart, I count the number of early presales relative to the sum of early and late presales.[9] Then I take the average of the resulting shares, which is 43%.

[9]For ages below -4 and above 8 presales are uncommon.

Old and New Houses According to the report by the Chief Economist at the Ministry of Finance (Ministry of Finance, 2016), there were about 100,000 houses sold in 2015. However, about 30% of the sales were to investors and 15% were to households who were postponing the sale of their previous home. As there should be no overlap between the two previous groups, this implies that about 55,000 houses were purchased by households that did not previously own a house, which I set as my target moment for the sum of all house purchase types. I target the calibration to houses purchased by new owners because in the model a household buys a house at most once.

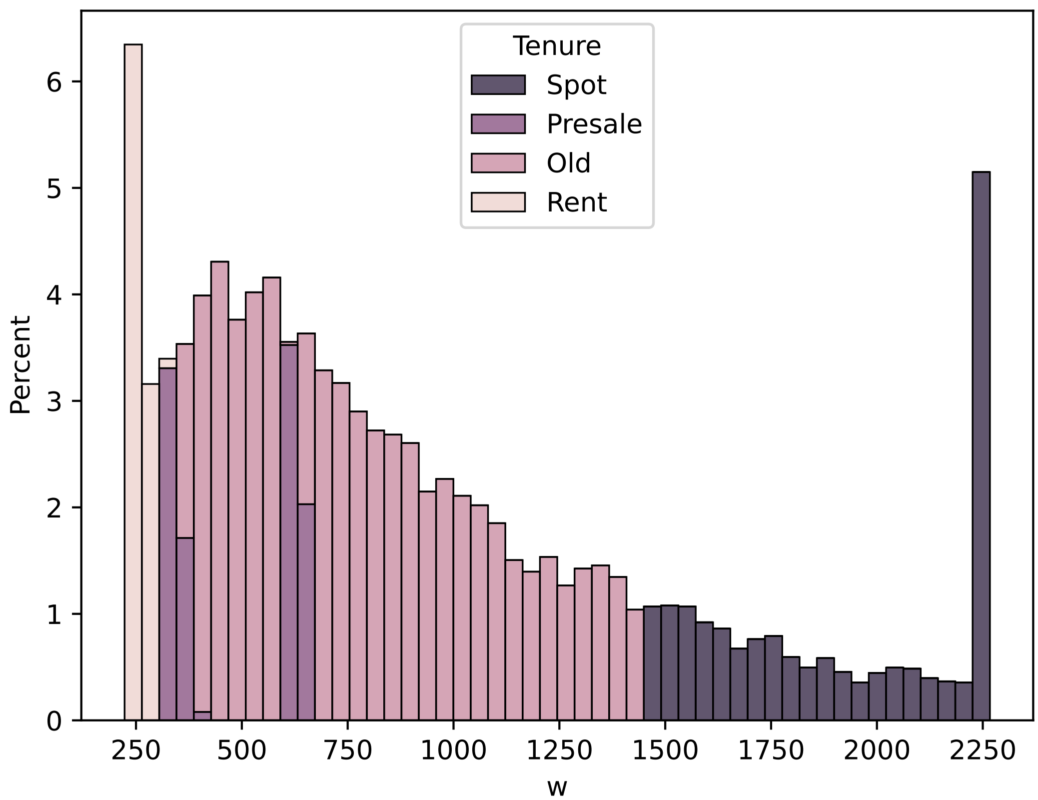
According to CBS data 31,700 new condos were sold in 2015. Assuming, that as with all condos, 55% of sales were to new households, I infer that 17,500 new condos were sold to new households while the remaining 37,500 new households who purchased houses bought old condos.

6.4 Calibration - Discussion

Housing choice by income Figure 3 presents quantized version of the income distribution, colored by the housing choice of households of that income. Income is in thousands of New Israeli Shekel per 5 years. The lowest income households with an income of around 250 are permanent renters. This is not surprising given that the flow of housing services from owning a house is so much higher than that from rent. Moving to the right on the income distribution from the renters, there is a group of presale buyers, with incomes of around 300, who buy when they are middle aged, because it takes them a long time to save for a down-payment. Recall that presale is the cheapest option so it makes sense that the most constrained households would choose it. Next there is a group of buyers of second hand condos, with incomes around 500, also middle aged, which shows the major inconvenience involved in presale - that even severely constrained households are willing to pay more for a second hand condo than for a new condo in presale. Next there is another group of presale buyers, with income around 600, who buy early in life. Next, the large group of second hand buyers who buy early in life. And finally, the highest income households who all buy new condos on the spot market early in life.

Presale versus new spot sale The calibration exercise reveals that, for prices and quantities to equal their data moments, the service flow from living in a house that was bought in presale needs to be substantially higher than from living in a new house

Figure 3: Housing choice by income



Notes: Income, w, is in thousands of New Israeli Shekel per 5 years.

bought when completed. Otherwise, demand for presale is too low, even while the presale price is substantially lower than that of a completed condo. This is even more surprising given this higher service flow captures several risks associated with presale that are not captured by the model. First, delayed delivery of condos is said to be common in the Israeli market, and although regulation requires builders to compensate the buyers, the enforcement of this often requires an intervention by the court. Second, because the buyer buys an asset that is incomplete, and often is just a design, there is a risk of lower than expected quality upon completion. These two risks should be driving the service flow from presale to be lower compared with completed condos. Nevertheless, I find the service flow from presale to be substantially higher - buyers seem to enjoy living in a condo they bought in presale more than a condo they buy when completed.[10]

I conjecture that presale buyers' higher willingness to pay for presale in reality relative to the model comes from some combination of three factors: they are underestimating the risks associated with presale, they see ownership of a new home as a status symbol (this is as opposed to the richer marginal buyer of completed new condos for whom such a purchase might have less symbolic meaning), and they place a high value on the ability to customize their condo that buying in presale sometimes affords.

7 Counterfactuals

After calibrating the model, I turn to study two counterfactual policy experiments: removal of the presale option and removal of credit constraints. Removal of the presale option can be thought of as an extreme case in which the various restrictions on presale make it nonviable. Removal of credit constraints can be achieved by various schemes such as subsidizing banks' loans to builders. In both cases, I study the medium term effects, after builders and households fully adjust to the change, but before those households reach the end of life, which starts the adjustment process of the supply of old houses. The price of old houses is free to adjust.

I am also assuming that the supply of land is constrained. Demand for land is

[10] Another factor that should make demand for presale even lower in my model is wealth inequality. By ignoring wealth inequality I am probably underestimating the inequality in the willingness to spend on housing between the marginal buyers of presale and those of completed new condos. Because wealth inequality in Israel is greater than income inequality, and because the marginal presale buyer has lower income, he likely also has much lower wealth. However, no public data seems to be available on the correlation between income and wealth so I am unable to account for this factor.

represented by the number of builders who enter, as each builder builds on a single parcel of fixed size. Thus, I assume that entry is constrained to the level I find in the baseline calibration. I will comment on how relaxing those assumptions would affect the outcomes of the experiments.

7.1 No presale

In this experiment, I constrain the presale quantity produced by each of the builders to zero. The results are presented in Table 7. The medium term result of removing presale is stark: builders are unable to fund nearly as much construction as in the baseline: new construction drops by over a quarter while prices jump by almost 40%. Note that the price increase does not help builders build more because all their income now comes after completion and their capacity is limited by their borrowing limit. This result illustrates the importance of presale in mitigating the worst effects of credit constraints.

In the long run, any reduction in construction causes an almost proportional reduction in the supply of second hand houses. Because second hand homes are more than 2/3 of the aggregate housing supply in the baseline situation, the long run effect on total supply is likely to be about three times as large as the medium term effect.

Note, however, that this effect would be partially mitigated if entry was allowed to expand. This is because builder's returns and profits increase for several reasons: the price of new units increases, more new units are sold, and because the marginal cost of construction is reduced as each building has fewer stores. This implies that if land was not constrained, entry would have increased, partially offsetting the effect of the prohibition of presale. The extent to which the effect would be offset depends on the elasticity of land prices to quantity demanded and so must be left for future research.

7.2 No credit constraints

In this experiment, I remove the credit constraint on builders, allowing them to borrow without limit at the same interest rate as in the baseline. I do so while allowing builders to choose any presale quantity, as was the case in the baseline. The results are presented in Table 8.

The effects of removing the borrowing constraint are more nuanced and less intuitive. First, I find that presale is no longer used. Even though households get a much higher

Table 7: No Presale - Counterfactual vs Baseline

Variable	Baseline	No Presale	% Change
Q_0, Q_1, Q_2	$7622, 9420, 37500$	$0, 12843, 37761$	$-100\%, +30\%, +0.6\%$
P_0, P_1, P_2	$1128.5, 1308.5, 1255$	$\emptyset, 1782, 1743$	$\emptyset, +36\%, +38.1\%$
q, q_0, q_1	$40.5, 17.6, 22.9$	$29.4, 0, 29.4$	$-27.3\%, -100\%, +28.7\%$
$B_1, \frac{\pi(q)}{C(q)}$	$432, 0.16$	$432, 0.42$	$0, +261\%$

Notes: P is price, D is demand, Q is supply, 0 is presale, 1 is spot , 2 is second hand, q is the total supply of a single builder: presale plus spot. C(q) is the builder's variable cost function. B1 is the number of builders who choose to enter.

service flow from owning a condo bought in presale relative to a completed new condo, the other disadvantages of presale evidently outweigh this benefit. The result is that there is no household willing to pay enough to persuade a builder to offer presale.

Second, builder's total funding costs, which combine the explicit interest rate on bank credit with the implicit interest rate on presales, is reduced relative to the baseline. Builders now borrow as much as they need at the bank rate, which is much lower then the baseline presale interest rate. This allows them to build more units at the same total marginal cost (which includes funding costs). In the new medium term equilibrium, project size increases from 40.5 to 51.2, a 22.5% increase, while the total housing supply is reduced by about 0.05%. Thus, housing production becomes much more capital intensive and much less land intensive.

To see why equilibrium housing supply is reduced, note first that all households above the bottom 10% were already buying houses at some point in their life and that the poorest of those homeowners were buying presale. Now that presale is eliminated, to maintain demand at a similar level would require that the price of at least one of the remaning house types decline enough to be affordable to the households who buy presale in the baseline. For builders, it is not profitable to sell new condos at much lower prices compared to the previous level, because the physical marginal cost is now much higher, nor is it profitable to sell presale.

This leaves second hand houses whose supply is vertical in the medium term so price is determined by the crossing of demand with supply and would decrease only if the demand slope shifts down. However, demand for second hand houses does not decrease (it increases slightly), so the price cannot decrease. Therefore, house prices cannot decrease. In fact, the average price increases slightly, both because presale is

Table 8: No Credit Constraints - Counterfactual vs Baseline

Variable	Baseline	No Credit Constraints	% Change
Q_0, Q_1, Q_2	$7622, 9420, 37500$	$0, 17084, 37647$	$-100\%, +72.4\%, +0.27\%$
P_0, P_1, P_2	$1128.5, 1308.5, 1255$	$\emptyset, 1408, 1372$	$\emptyset, +7.6\%, +9.4\%$
q, q_0, q_1	$40.5, 17.6, 22.9$	$51.2, 0, 51.2$	$+26.5, -100\%, +124.2\%$
$B_1, \frac{\pi(q)}{C(q)}$	$432, 0.16$	$335, 0.15$	$-22.5\%, -7.6\%$

Notes: P is price, D is demand, Q is supply, 0 is presale, 1 is spot , 2 is second hand, q is the total supply of a single builder: presale plus spot. C(q) is the builder's variable cost function. B1 is the number of builders who choose to enter.

eliminated and because the price of new and old condos increases slightly. Total housing demand ends up slightly lower than the baseline. Furthermore, the higher production per project increases marginal and average costs, such that returns drop below the baseline. This leads fewer builders to enter in a way that dominates the increase in project size. Thus, total new housing production goes down slightly.

In a richer model, where the supply of both land and capital are upward sloping, the borrowing interest rate should increase while the price of marginal land should decrease. Because the supply of land tends to be much less elastic than that of capital, it is likely that the total effect would lower building costs, which would mitigate the decline in entry and likely lead to higher total production. In addition, the quality of the marginal land should increase and the land saved from development can accommodate other public uses, both of which should increase welfare. Thus, while my model does not quantify the main benefits of eliminating credit constraints, it pinpoints the source of those benefits - an increase in the ratio of capital to land in housing production.

8 Conclusion

This paper demonstrates that builders pay a substantial premium on presale transactions in order to obtain additional funding for construction. It makes the case that builders' willingness to pay such a premium is primarily due to their inability to obtain sufficient funds through traditional financing channels. The equilibrium implications of credit constraints and presale for the homeownership market are explored through the lens of a new model. In the model, builders with time to build face a borrowing limit and choose the optimal combination of presale and debt funding. Households with heterogeneous incomes sort into four types of housing: rent, presale, new condos and second hand condos. The housing choice of households is shaped by their preference for ownership over rent, for ownership of new over second hand condos, by their need to save for a down-payment at the expense of present consumption, by the interest rate on their savings, by the length of their life and by their bequest motive.

By calibrating the model to the Israeli economy, I explore how all these forces combine to give rise to endogenous prices and quantities in the three housing markets, determining equilibrium housing affordability. Counterfactual experiments provide insights into the effects of presale and credit constraints on the housing market. In the absence of presale, the borrowing limit causes a severe reduction in supply and affordability. In the absence of a borrowing limit, presale disappears endogenously and construction becomes more capital intensive, resulting in higher buildings and conserving land. Future research should further explore the implications of presale and credit constraints by endogenizing the markets for land and credit.

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A Data Processing

A.1 Neighborhood Descriptive Statistics

Some of the analyses in this study are done at the "area" level (officially called Statistical Area and sometimes referred to informally as neighborhood). Area is a statistical category developed by the Israeli Central Bureau of Statistics to divide cities with more than ten thousand residents into small areas that are as close as possible to homogeneous in terms of demographics, land use patterns and year of initial construction. I am using the 2011 division into areas which has about two thousand five hundred statistical areas with positive residential populations.

Tables 9 and 10 present summary statistics for areas, based on the number of spots or presales in each area, respectively. Note that the number of observations is slightly smaller than in the transaction records. This occurs because I was unable to match some of the observations with a statistical area. I only use such observations when area does not play a role.

Table 9: Spot Sales Areas Summary

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
population	116,928	6,042	3,876	78	44,333
socio-economic status	116,928	6.577	2.131	1	10
distance to CBD	116,928	40.40	43.24	0.305	281.5
periphery indicator	116,928	0.258	0.438	0	1

Notes: population is the total population of an area in the year 2020; socio-economic cluster is based on demographic characteristics as described in CBS (2022); distance to CBD is the average distance in kilometers from the location of each deed in an area to the Tel Aviv HaShalom station, a central transport hub that is also located roughly at the center of Tel Aviv, which is the main business center of Israel. Periphery indicator is defined by CBS based on the distance of an area to all other areas, weighted by population and on distance to Tel Aviv, as defined in CBS (2015).

Table 10: Presale Areas Summary

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
population	55,022	6,762	4,370	565	23,691
socio-economic status	55,022	6.609	2.079	1	10
distance to CBD	55,022	43.29	44.50	0.332	281.6
periphery indicator	55,022	0.232	0.422	0	1

Notes: population is the total population of an area in the year 2020; socio-economic cluster is based on demographic characteristics as described in CBS (2022); distance to CBD is the average distance in kilometers from the location of each deed in an area to the Tel Aviv HaShalom station, a central transport hub that is also located roughly at the center of Tel Aviv, which is the main business center of Israel. Periphery indicator is defined by CBS based on the distance of an area to all other areas, weighted by population and on distance to Tel Aviv, as defined in CBS (2015).

A.2 Adjusting for Condo Quality

To facilitate comparison between condos with different characteristics and locations and sold at different times, I run a standard hedonic regression on all transactions excluding presales. I exclude presales because they may have different demand and supply characteristics than completed condos. This is useful for calculating the value of a presold condo in the counterfactual event in which it was sold after completion. I run a separate regression for each district and include year by neighborhood fixed effects, as well as building fixed effects.[11]

$$\begin{aligned} ln(Price_{nta}) = \beta_0 + \beta_1 ln(Rooms_n) + \beta_2 ln(SQM_n) + \beta_3 Floor_n \\ + \alpha_1 Age_{nt} + \alpha_2 Age^2_{nt} + \alpha_3 Age^3_{nt} + BuildingFE_n + w_{ta} + \epsilon_{nta} \end{aligned} \tag{3}$$

Spot transactions are indexed by n, $ln(Price_{nta})$ is the natural log of the sale price in spot transaction n at time t in area a, $Rooms_n$ is the number of rooms, SQM_n is

[11]Running a separate regression in each district makes sense because of the differences between districts in term of geography and patterns of development. It also improves the fit as was also found by Sayag (2012). I also try running separate regressions for different years but this seems not to make a different so I opt for the simpler option of pooling all the years and including fixed effects.

Table 11: Hedonic Regressions

VARIABLES	(1) District 1	(2) District 2	(3) District 3	(4) District 4	(5) District 5	(6) District 6
lnRooms	0.375***	0.390***	0.242***	0.269***	0.244***	0.312***
	(0.0116)	(0.0159)	(0.0118)	(0.00676)	(0.0112)	(0.00827)
lnSqm	0.413***	0.422***	0.475***	0.462***	0.641***	0.375***
	(0.0122)	(0.0162)	(0.0123)	(0.00696)	(0.0107)	(0.00866)
Floor	0.000181	0.00167*	0.00516***	0.00594***	0.00716***	0.00284***
	(0.000798)	(0.000959)	(0.000488)	(0.000230)	(0.000408)	(0.000327)
Age	0.0137***	0.00714**	-0.00197	-0.000114	0.00529	0.00216
	(0.00357)	(0.00344)	(0.00293)	(0.00147)	(0.00345)	(0.00201)
Age Squared	-0.000718***	-0.000525***	-0.000188	-0.000260***	-0.000458***	-8.14e-05
	(0.000188)	(0.000175)	(0.000127)	(6.69e-05)	(0.000148)	(0.000112)
Age Cubed	1.28e-05***	1.06e-05***	6.06e-06**	5.78e-06***	9.90e-06***	-1.22e-07
	(3.42e-06)	(3.31e-06)	(2.38e-06)	(1.23e-06)	(2.74e-06)	(2.23e-06)
Constant	11.88***	11.24***	11.50***	11.81***	11.37***	11.75***
	(0.0541)	(0.0686)	(0.0568)	(0.0301)	(0.0534)	(0.0367)
Observations	17,209	13,561	18,060	68,013	31,568	39,035
R-squared	0.851	0.827	0.867	0.848	0.822	0.854
MicroFE	Building	Building	Building	Building	Building	Building
AreaXYearFE	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Notes: I use the STATA command reghdfe to obtain OLS estimates for the coefficients of interest for each district separately (Correia 2017).

condo size in square meters, $Floor_n$ is the floor number of the condo; Age_{nt} is building age at the time of the transaction, $BuildingFE_n$ is a building fixed effect (I use parcel fixed effects which usually is a attributable to a single building), w_{ta} is a year by area fixed effect; ϵ_{nta} is a mean zero error term.

Table 12 is intended to assess the prediction quality of Equation 3 for spot sales (in sample). The variable of interest is the ratio of the absolute value of the residual to the actual price.

I construct the counterfactual spot value s_{ita} of a presale i sold in period t, in area a as

$$\begin{aligned} ln(s_{ita}) = \beta_0 + \beta_1 ln(Rooms_i) + \beta_2 ln(SQM_i) + \beta_3 Floor_i \\ + BuildingFE_i + w_{ta} \end{aligned} \tag{4}$$

Table 12: Hedonic Prediction Quality

	(1)	(2)	(3)	(4)	(5)
VARIABLES	N	mean	sd	min	max
|residual|/Price	116,775	0.0854	0.201	0	26.64

Notes: $|residual|/Price = Abs(\epsilon_{nta})/Price_{nta}$ where Abs() is the absolute value function, $\epsilon_{nta}, Price_{nta}$ are defined in Equation 3

A.3 Adjusting for Local Price Trends

To estimate the counterfactual spot price of a presold condo s, I need to adjust for the local price trends that occur between the actual time of presale and the time of completion. This is especially important because many areas in my sample experience rapid changes in average prices. To do so, whenever time to completion is greater than 6 months at sale, I apply the following correction: I multiply the predicted spot price (obtained by applying the estimates from the hedonic regression in A.2 to a presold condo) by a factor A_{taj}.

$$A_{taj} \equiv max(min(\frac{\overline{s_{Ta}}}{\overline{s_{ta}}}, 1.1^{(T-t)/12}), 0.9^{(T-t)/12}) \tag{5}$$

Where $\overline{s_{ta}}$ is the mean of quality controlled spot sales in month t and area a: $\overline{s_{ta}} = w_{ta} + N_{ta}^{-1} \sum \epsilon_{nta}$, ϵ_{nta} is defined in Equation 3; and $\overline{s_{Ta}}$ is the same in month T.[12] I restrict expected appreciation to $\pm 10\%$ because beliefs outside this range are inconsistent with the conservatism required of the assessors who are hired to value condos before they are sold. T is the date of the last presale in the building, which I take to be a conservative estimate of actual completion date.

A.4 Error in Presale Indicator

A.4.1 The error

My main dataset has two types of observations that raise concerns:

[12]Getting an appreciation rate directly from the hedonic regression that is monthly and area specific would require me to add month by area fixed effects to the hedonic regression, which would sharply reduce the number of observations available to estimate each fixed effect.

Negative aged spot sales: Such observations have a presale indicator $p = 0$ and a "building year" that is after the year of sale. I posit that this is caused by a mistake in the presale indicator due to failure to link the presale record with the deed record. Whenever a deed could not be linked with a presale, it was assigned $p = 0$, even if it had negative age.[13]

Positive aged presales: Such observations have presale indicator $p = 1$ and a building year that is before the year of sale. This implies that building year does not refer to the occupancy permit, but rather to an earlier event such as the construction permit or the start of construction. [14]

Separately, these mistakes are easy to deal with: I can just drop the negative aged spot sales because they are duplicates of presales. I can also leave the positive age presales as they are, and treat them as regular presales, because from the perspective of hedonic pricing, all presales can be seen as forward contracts to buy a new condo, i.e., a condo with age 0.

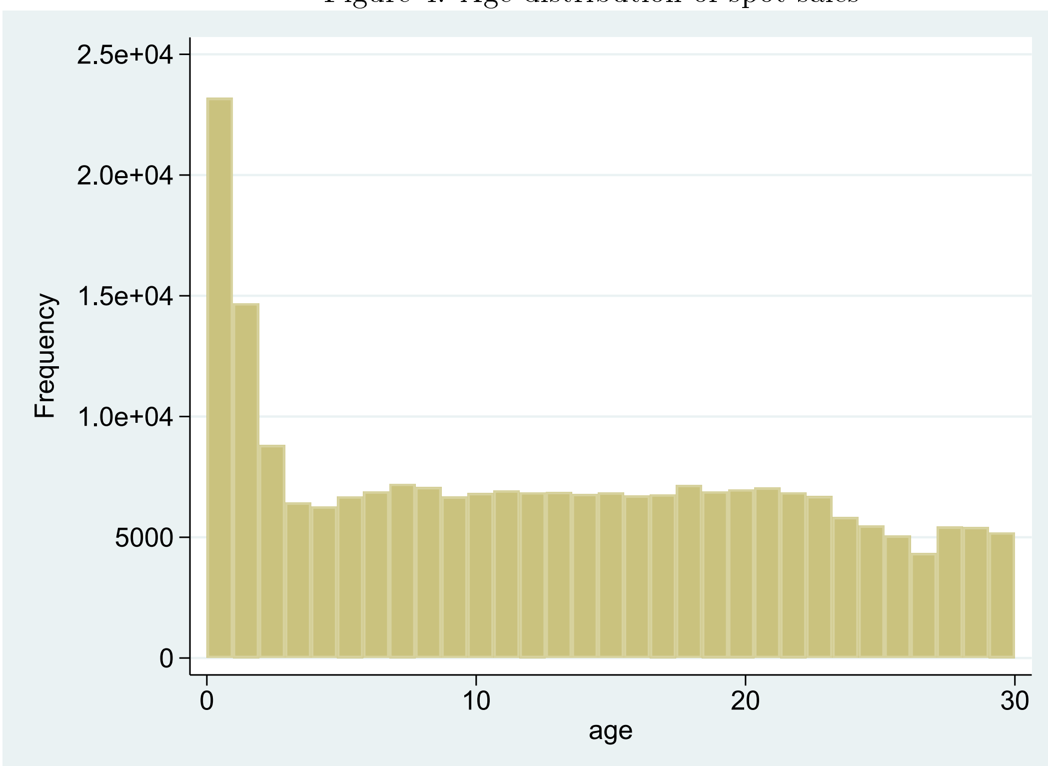
However, a difficulty arises when both errors coincide in the same observation: A building year refers to an event prior to an occupancy permit and some of the deeds are not linked to a presale record (perhaps due to a discrepancy in the exact price). This may result in observations classified as spot sales with positive ages but that are in-fact presales. Although they are impossible to identify with certainty, some observations may be more suspect of being such double-mistakes, such as those with very low ages.

Figure 4 gives a sense of the likely magnitude of this problem. For ages above 5, the frequency of spot sales in the data is roughly constant, as it should be if the quantity of new construction is constant over time and the sale probability of second-hand condos is independent of their age. But there are more than 5 times as many spot sales with age 0 as with any age above 5. This is the age distribution after removing spot sales with negative ages and those that occur in buildings with later presales.

[13] I am using the results of a linking conducted by the Survey for Israel. I cannot replicate this linking because my version of the presale dataset does not contain the variable sub-parcel which refers to apartment number in condo buildings.

[14] The alternative is a false positive in the presale indicator, which is unlikely. For a false positive to occur, the presale record would have to match the spot record in lot, parcel, sub-parcel, price, date of sale, floor and size. So, a mistaken link requires a very unlikely coincidence.

Figure 4: Age distribution of spot sales



Notes: Age distribution of spot sales after removing spot sales with negative ages and those that occur in buildings with later presales. Age is defined as year of sale minus the observed building year.

A.4.2 The correction

In this part I will try to estimate the probability that some transactions that appear to be positive aged spot sales are in fact presales. The way this is done is summarized in Figure 5.

Define p as the observed presale indicator, p^* as the true presale indicator, y_b as the observed building year, y_s as the sale year, s as numeric date of sale (number of days since 1960), b as unobserved (numeric) building date, δ as the probability that building date refers to some event prior to the occupancy permit ($b = b_-$) and $1-\delta$ that it refers to the occupancy permit ($b = b^*$), and ϕ the probability that an occupancy permit arrives in a given day conditional on it not arriving on any prior day.

Focus first on the strictly positive age case: $y_b < y_s$

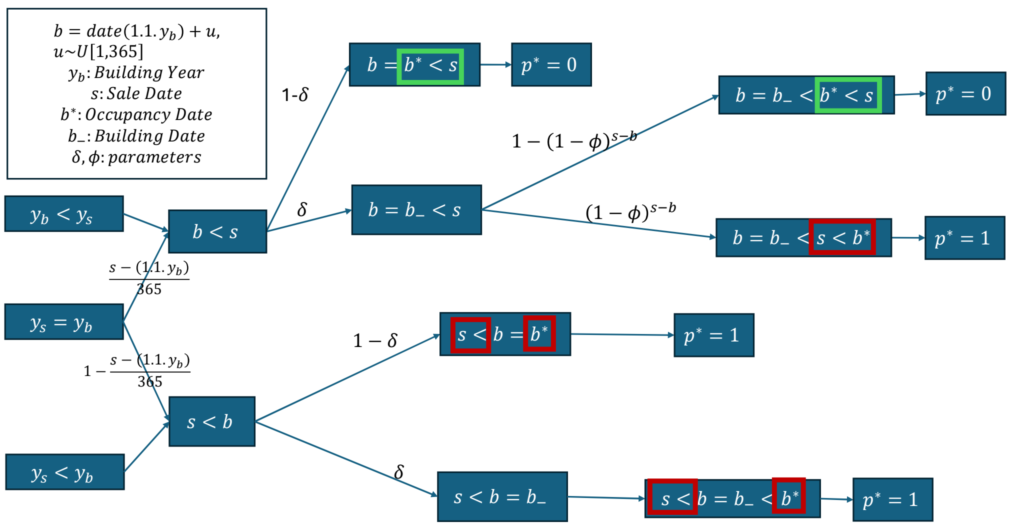
$$\begin{aligned}
&Pr(p^* = 1|p = 0, y_b < y_s) \\
&\quad =_1 (1-\delta) \cdot Pr(b^* > s|b^* = b) + \delta \cdot Pr(b^* > s|b^* > b) \\
&\quad =_2 (1-\delta) \cdot 0 + \delta \cdot Pr(b^* > b + (s-b)|b^* > b) \\
&\quad =_3 \delta \cdot Pr(b^* > s - b) \\
&\quad =_4 \delta(1-\phi)^{s-b}
\end{aligned}$$

$=_1$ is from the definition of δ as the probability that $b \neq b^* \Rightarrow b = b_- < b^*$ and the complement $1-\delta$ the probability that $b = b^*$; $=_2$ is because $y_b < y_s \Rightarrow b < s$; $=_3$ is from the memorylessness of the geometric and $=_4$ is from the definition of the CDF of the geometric.

For the zero age case, define b_{min} the first day of y_b and note that if b is as likely to occur in any day of the year, then $Pr(b < s) = \frac{s-b_{min}}{365}$, which implies:

$$\begin{aligned}
&Pr(p^* = 1|p = 0, y_b = y_s) \\
&\quad = Pr(s < b) + Pr(b < s) \cdot \delta \cdot Pr(b^* > s|b^* > b) \\
&\quad = 1 - \frac{s-b_{min}}{365} + \frac{s-b_{min}}{365}\delta(1-\phi)^{s-b}
\end{aligned}$$

Figure 5: Correcting the presale indicator



A.4.3 Estimation

Now it remains to estimate δ, ϕ. First, note that in all positive aged presales, $b = b_{-}$. Thus, the ratio of positive to negative aged presales gives a lower bound on the probability δ.[15] Then assuming this probability δ is the same for all observations, I can apply these probabilities to spot sales. I can then test the robustness of my conclusions to different values of δ between it's lower bound and 1.

To estimate ϕ is propose that:

$$\phi \equiv E_t[\frac{n_t - n_{t+1}}{n_t}]$$

Where n_t is the number of presales with age t in the main dataset for $t \geq 1$. The underlying assumptions are that the probability to get an occupancy permit (starting the second year of construction) is fixed an memory-less, and that the decline in the frequency of presales between positive ages is entirely due to projects getting completed.

A.4.4 Results

I apply a correction as follows: For each age in $0, 1, 2$, in every sale month, I drop a share of the presales equal to the average probability that spot sales in this group are presales.

[15] Because presales are included in my dataset whether they were linked or not, this ratio in my sample should be an unbiased estimate of the population ratio.

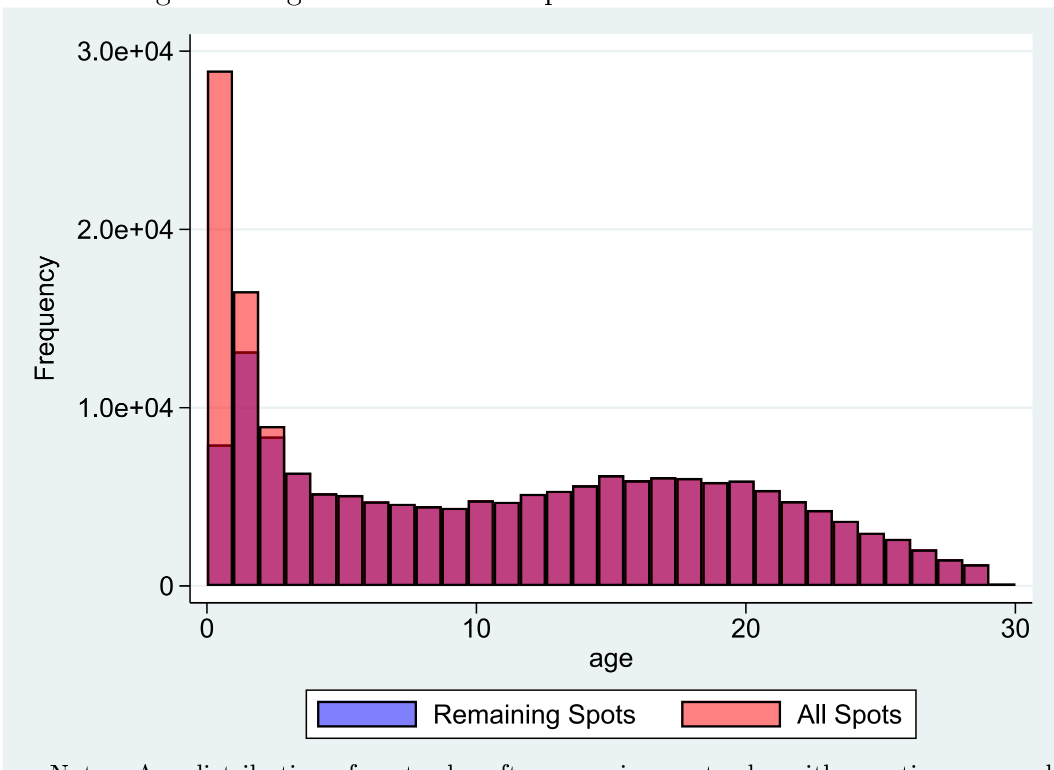
Table 13: Share of spot sales removed by age and sale month

month	age0	age1	age2
1	0.997	0.305	0.0980
2	0.983	0.278	0.0890
3	0.957	0.254	0.0810
4	0.919	0.231	0.0740
5	0.870	0.209	0.0670
6	0.813	0.191	0.0610
7	0.752	0.174	0.0560
8	0.680	0.157	0.0500
9	0.610	0.144	0.0460
10	0.526	0.130	0.0410
11	0.447	0.118	0.0380
12	0.361	0.107	0.0340

Notes: Share of spot sales removed by age and sale month.

Figure 6 describes the change in the age distribution of spot sales.

Figure 6: Age distribution of spot sales - before and after correction



Notes: Age distribution of spot sales after removing spot sales with negative ages and those that occur in buildings with later presales. Age is defined as year of sale minus the observed building year.

B Beyond credit constraints

Before measuring the presale premium, I try to account for various factors that may make it worthwhile for builders to presell at lower prices other than credit constraints. By accounting for such factors in the calculation of the presale premium I can ensure that it is indeed a premium from the builder's perspective, in the sense that it captures the economic cost to the builder of selling at a given price. For example, if all units sold in presale have lower unobserved quality compared with units sold in the spot market, and I ignored this in the calculation of the premium, I would be overestimating the true premium. Of course it is impossible to perfectly account for all possible such factors. Nevertheless, it is worthwhile to account as well as possible for the most obvious and most substantial factors.

B.1 Adverse Selection Into Presale

Table 14 presents evidence that presold condos probably tend to have higher unobserved quality compared with condos sold in the spot market. I match presale to spot transactions by condo and compare the means and medians of their hedonic residuals.[16] I find that while presales tend to sell at a discount relative to their expected price, when they are resold in the spot market, they tend to do so at a premium relative to their expected price.

The expected price is calculated only from spot sales so the discount in presale prices does not factor into it. Because I can match only very few such condos by a full address, I try more permissive match rules that use condo stats and land parcel numbers. Lower rows of Table 14 correspond to more permissive match rules. Both the mean and the median of the presale residuals is always negative except for a single case where the mean is positive but this is a case with only 9 observations. The means of the spot residuals are always positive, while the medians are positive in the three cases where the match rule is most stringent and practically zero in the fourth most stringent.

B.2 Network Externality

Suppose demand for condos in a project is increasing with the number of previous condos sold in that project. For example, this could be the case if some buyers only

[16] For more details on the hedonic calculation see Section 4 and Appendix A.2

Table 14: Repeat sales

Match	N	Median Spot	Mean	N	Median Presale	Mean
Parcel + Apt. Num	92	3894	70787	9	-66634	82249
Address + Apt. Num	301	1729	31303	43	-80168	-58186
Address + Apt. Stats	25730	1311	22588	24970	-49574	-39578
Parcel + Apt. Stats	35375	-28.81	17672	25263	-49542	-39154
Address	111829	-2408	15398	38829	-49256	-38797
Parcel	114623	-2383	15316	39113	-49175	-38598

Notes: Address includes city, street and building number. Apartment stats includes the number of rooms, area in square meters and floor number. Spot statistics are calculated based on hedonic residuals over all matched transactions that occured after the last presale within each match. Presale statistics are calculated based on the hedonic residuals over all matched presale transactions.

start arriving once some number of condos is sold because until enough units are sold, such buyers' perceived probability of project failure is too high. A seller anticipating such behavior from buyers, may find it optimal to sell the first condos for very low prices to stimulate demand. Importantly, if I ignored this, my estimates of the presale premium would be biased upwards.

I refer to this case as a network externality because demand for a seller's product is increasing in the quantity the seller has previously sold or in his previous market share. A famous example of network externalities is fax-machines. The standard approach for testing for the presence of network externalities is as follows: a hedonic regression is used to estimate willingness to pay for the product in consecutive periods, with fixed effects for each particular seller (or a group of sellers with compatible products). If a higher market share of a seller in previous periods is associated with higher willingness to pay for his product in subsequent periods, all else equal, this is evidence of a network externality.[17]

In the present setting, I test for the effect of the quantity of units sold in a project during early presale on the willingness to pay in late presale. Willingness to pay is captured by the residualized income of a project. Regressing late income on early quantity raises endogeneity concerns, for example from failing to account for project specific demand. To address this, I use an instrumental variable strategy.

Interest rate surprises are defined by The Bank of Israel as deviations of interest rate decisions from the forward guidance in place at the time (Kutai 2023). Intuitively, the

[17] For examples, see Gandal 1994, Goolsbee and Klenow 2002, Park 2004, Livingston et al 2012

decisions of potential buyers and sellers in the housing market, including developers, are affected by current interest rates and also by their expectations for future interest rates (about which they care because both can choose to transact now or later). To the extent that the current forward guidance reflects future interest rates, it should affect those decisions. Thus they are affected by an interest rate surprise, and also by the new guidance that is always issued at the same time as the new interest rate is announced. Thus, interest rate surprises that occur at the time when a project is in its early stage affects contemporaneous outcomes. However, future outcomes in that project should not be directly affected by interest rate surprises in the past.[18] Thus, surprise changes to the interest rate during early presale should have immediate effects on early quantity, but late income should only be affected through early quantity.[19]

I define early presale as the first half of presale length. For each presale project in my sample, I calculate the rate surprise variable as the sum of the surprises that occurred during the early period and use it as an instrument for early quantity.

Table 15 presents the result of three regressions. In all three, early presales are defined as presale that occur before the median date of all dates that fall between the first and last presale. The rest are defined as late. The first column presents the result of regressing early quantity, that is, the number of presales during early presale in a project, on the total residualized income from late presales in that project. It implies that each early presale increases the total residualized income by about 30,000 NIS (New Israeli Shekel), equivalent to about 2.9% of the average presale price.

The second column is the first stage regression in which I regress early quantity on the BOI rate surprise as explained above. The third column is the two stage least square regression where the rate surprise is used to IV for early quantity. It results in almost exactly the same coefficient as the OLS. A Hausman test cannot reject the hypothesis that the OLS is consistent. Thus, when calculating presale premia, I multiply the presale price by 1.029. This adjusts the presale price to account for the average benefit of selling early, thus reducing the presale premium.

[18] This is unless participants care about past surprises as those may be informative about potential future surprises but this seems unlikely in this case because both sides appear to not be sufficiently sophisticated.

[19] One may be concerned that an interest rate surprise during early presale may affect late income by affecting the time path of financial condition of buyers and sellers who had no intention of transacting in the early period but their incentive to transact in the late period is affected. However, while past interest rates affect the future time path of financial conditions of participants in this market, an interest rate **surprise** should only affect them if they are involved in sophisticated hedging operations, which seems unlikely.

Table 15: Early Quantity and Later Income

VARIABLES	(1) OLS Late Income QC	(2) 1st-stage IV Early Quantity	(3) 2nd-stage IV Late Income QC
Early Quantity	30.82***		28.13
	(6.635)		(84.98)
BOI Rate Surprise		-57.81**	
		(23.83)	
Constant	-628.8***	17.88***	-578.6
	(186.3)	(0.746)	(1,592)
Observations	963	963	963
R-squared	0.022	0.006	0.022
F-test		5.883	
Hausman chi2-stat			0.00101
Hausman pval			0.975

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Notes: OLS and first stage estimates are obtained using the Stata command "reg", second stage estimates are obtained using the Stata command "ivregress gmm".

C Model Details

C.1 Steady State Market Equilibrium

Given parameters, a steady state market equilibrium is: prices of house purchase types $0, 1, 2$, and an allocation, namely, aggregate demand for each house purchase types and an aggregate supply of each house purchase type, such that households and builders optimize, builders achieve zero profit, markets for all three house purchase types clear, and the prices and allocation are identical for any two subsequent periods.

The following conditions characterize the equilibrium.

First, given prices, each builder born in period t chooses an entry probability $Pr(Enter|t)$ such that the number of builders that enter is:

$$B_{t,1} \equiv Pr(Enter|t) \cdot B_t \tag{6}$$

Second, each builder who enters, chooses total production quantity $q_t(P)$. Together, the entry and quantity choices determine the aggregate supply of new houses:

$$Q_t \equiv B_{t,1} q_t \tag{7}$$

Third, each entering builder also chooses how many units to presell $q_{t,0}(P)$, which, together with the entry choice, determines the aggregate supply of presale in period t.

$$Q_{t,0} \equiv B_{t,1} q_{t,0} \tag{8}$$

Fourth, the choices of entry, quantity and presale together determine the supply of completed new condos in the next period.

$$Q_{t,1} \equiv B_{t-1,1}(q_{t-1} - q_{t-1,0}) \tag{9}$$

Fifth, given prices, each household decides on a plan of housing consumption, which entails choosing whether to buy a house, which type and at what age. These choices constitute the aggregate demand for the three house purchase types:

$$D_{t,j} \equiv \sum_{y=1}^{8} n_{t-y,j,y} = \sum_{y=1}^{A} \int_{w_{min}}^{w_{max}} d_{t-y,j,y}(w) dF_w, \ \forall j \tag{10}$$

Where

$$d_{t,j,y}(w) \equiv \begin{cases} 1 & j_t^*(w) = j, y_t^*(w) = y \\ 0 & o.w. \end{cases}$$

And where $j_t^*(w), y_t^*(w)$ are the optimal choices of house purchase types and purchase age given income w in households born in period t.

Sixth, the age at purchase determines the share of the house that will remain to be sold at the end of life, which, in turn, determines the supply of second hand houses:

$$Q_{t,2} \equiv \sum_{y=1}^{A} (n_{t-A,2,y} + n_{t-A,1,y} + n_{t-A,0,y}(1-\delta)^{-1})(1-\delta)^{A-y} \tag{11}$$

Seventh, the market for each housing type clears:

$$Q_{t,j} = D_{t,j} \tag{12}$$

Eighth, builders achieve zero profit:

$$\pi(q, q_0) = 0 \tag{13}$$

In addition, a steady state equilibrium also requires the following two conditions. First, that the entry probability chosen by newly born builders is the same in any two adjacent periods:

$$Pr(Enter|t) = Pr(Enter|t+1) \tag{14}$$

Second, that the function mapping income to housing choice is the same for any two adjacent periods:

$$d_{t,j,y}(w) = d_{t+1,j,y}(w) \tag{15}$$

C.2 Solving for Equilibrium

Given house prices P, conditional on entry, builders choose an optimal combination of q, q_0, subject to borrowing constraints. To do so, I first determine q_0 as a function of q. To do so, I distinguish between several possible regimes affecting the choice of q_0. First, if the presale price is weakly greater than the spot price of a new condo, then the build sells only in presale so that $q_0 = q$. Second, if the presale price is weakly below a threshold $\frac{P_1}{[1+\iota r_b]}$, then the builder sells the minimum possible number of presales. The minimum number of presales is zero, unless the borrowing limit is binding, which occurs if profit is weakly increasing at the limit. In this case, q_0 is determined by the borrowing limit condition and is denoted $q_0^{lim}(q)$. Third, if the presale price is in an intermediate range between P_1 and $\frac{P_1}{[1+\iota r_b]}$, then presale is maximal if the builder is borrowing and minimal otherwise. That is, if the builder's profit is greater when setting q_0 so that $b_0 = 0$ compared to when $q_0 = q$, then q_0 is set so that $b_0 = 0$, in which case it is denoted $q_0^{int}(q)$.

The previous discussion can be summarized by:

$$q_0 = \begin{cases} q_0^{max}(q) = q & P_0 \geq P_1 \\ q_0^{max}(q) = q & P_0 \in (\frac{P_1}{1+\iota r_b}, P_1), \pi(q_0 = \frac{C(q)}{P_0 \iota}) \leq \pi(q_0 = q) \\ q_0^{int}(q) = \frac{C(q)}{P_0 \iota} & P_0 \in (\frac{P_1}{1+\iota r_b}, P_1), \pi(q_0 = \frac{C(q)}{P_0 \iota}) > \pi(q_0 = q) \\ q_0^{lim}(q) = \frac{C(q) - b_{lim}}{P_0 \iota} & P_0 \leq \frac{P_1}{1+\iota r_b}, \pi(q_0 = \frac{C(q) - b_{lim}}{P_0 \iota}) > \pi(q_0 = 0) \\ 0 & P_0 \leq \frac{P_1}{1+\iota r_b}, \pi(q_0 = \frac{C(q) - b_{lim}}{P_0 \iota}) \leq \pi(q_0 = 0) \end{cases}$$

Next, for each of the regimes above, there is a corresponding profit function

$$\pi^s(q, q_0(q)), s \in \{max, int, lim, 0\}$$

Conditional on prices and parameters, some of the regimes are infeasible, either because their conditions do not hold or because a builder would violate the borrowing constraint by adhering to a regime. Denote by S the set of feasible regimes. For each profit function $s \in S$, I find the optimal quantity choice q^s by standard constrained optimization of π^s (recall that costs are convex in q). I define the optimal quantity overall by choosing the maximum of the feasible options.

$$q^* = \{q^s \mid s \equiv argmax_{s \in S}\{\pi^s(q, q_0(q))\}\}$$

The optimal regime also determines the final choice of presale q_0, denoted

$$q_0^* = \{q_0^s \mid s \equiv argmax_{s \in S}\{\pi^s(q, q_0(q))\}\}$$

The spot sale quantity is $q_1^* = q^* - q_1^*$.

Similarly, given house prices P, one can calculate the lifetime utility of a household from each housing choice as a function of its income. I denote by $U_{j,y}(w)$ the lifetime utility of a household with income w from buying house type j at age y. Each function $U_{j,y}(w)$ is continuous and strictly increasing in w. Feasibility constraints rule out some housing choice combinations j, y at particular ranges of w. Denote by $J(w), Y(w)$ the functions defining the feasible sets of j, y at each w. I define the optimal housing choice as the choice with the highest lifetime utility conditional on income and subject to feasibility constraints:

$$j^*(w), y^*(w) \equiv \{j, y \mid j, y = argmax_{j \in J(w), y \in Y(w)} U_{j,y}(w)\}$$

Unfortunately, it is difficult to show in general that demand for each house type is always weakly decreasing with its price and that supply of each type is weakly increasing with own price. Therefore, the standard argument for existence of equilibrium cannot be used. Instead, I show existence by constructing an example in the Calibration section.

D Calibration Details

D.1 Price Moments in the Data

Because in the present framework, condos are assumed to be identical and the market conditions are fixed, I need to net out price differences in my data that are the result of different apartment locations, characteristics and time of sale. I do so by using hedonic regressions to estimate the effects of such differences and to net them out. This results in quality adjusted prices that are internally comparable but that are not comparable to other prices in the economy such as wages and rents. Therefore, I first calculate the ratios of the adjusted prices of presales to spot sales and of spot sales to old sales, and then multiple the ratios by the median unadjusted second hand house price in my data, which I also use as the second hand price.

To calculate the price of second hand transactions, I take the median of all transaction prices in my sample for the year 2015 that are not presales, sold at market rates and have age>1. The resulting price is 1,255,000 NIS.[20]

To calculate the price of completed new condos, I first calculate the ratio of new to old spot sales in my data. I would ideally like to compare **age 0 condos sold by developers** with **age 0 condos sold by households for exogenous reasons** (and not because they discovered difficult to observe faults with the condo).[21] However, this presents three challenges - one is that sale at age 0 may imply exactly such faults or a hurry to sell, both of which introduce adverse selection and tend to push down the price; a second is that many of the observations aged 0 in my sample indicated as spot sales are in fact presales;[22] and another is that because of the bias in age of presales, age 0 presales are likely sold quite early in the presale process. To overcome those difficulties I do the following: first, I create duplicates of my dataset where presale ages are shifted back by $\Delta a \in \{1, 2, 3\}$.[23] Second, I calculate the ratio of the averages of quality adjusted prices between same aged observations between the ages of 2 and 4 (after the correction).[24]

[20]This is not far from the average price reported by CBS of 1,392.

[21]Recall that I am assuming second hand and new condos are identical except for the identity of the sell, which is why I would like to use age 0 condos for the second hand condos as well.

[22]For further discussion of this issue see Appendix A.4

[23]It is unfortunately impossible for me to determine by how much on average presale age is biased. However, based on the analysis in Appendix A.4 the range of 1-3 years seems reasonable to me.

[24]I drop age 1 for the same reasons as age 0. Quality adjusted prices are always calculated using the hedonic regressions described in Appendix A.2

This gets me 9 estimates of the ratio of spot to old prices, ranging between 0.8 to 1.11. I take the average of those estimates which is 1.043 and use this to calibrate the ratio of spot to old prices in the model. This makes the price of new completed condos $1255 \cdot 1.043 \approx 1308.5$.

To calculate the price ratio of presales to spot sales, I use the quality adjusted prices of presale transactions that differ by 5 years.[25] More precisely, for presales of each age between -3 and 5, I calculate the average quality adjusted price for that age.[26] Then, for each pair of years 5 years apart I calculate the ratio of the average for the late year to the average of the early year. The resulting ratios are between 1.08 and 1.3. I then take the average over those ratios to get 1.156.

The resulting presale price is $1308.5/1.156 \approx 1128.5$.

To summarize, the price moments in the data are:

$$\tilde{P_O} = 1255$$
$$\tilde{P_I} = 1128.5$$
$$\tilde{P_N} = 1308.5$$

D.2 Builder Costs Estimation

I calibrate c_V, c_F to match the total non-land cost per condo and the total land cost, respectively, of residential projects with at least 3 floors built by developers in 2015.

To do so, I start from the 2015 Ministry of Construction and Housing report (Armoni 2015) that examines building costs of residential projects that were completed between 2010 and June 2012. The authors surveyed builders in Israel and received answers for 110 projects, out of which 73 were carried out by developers, while the rest were carried

[25] I use presales for both numerator and denominator of this ratio because of the following reasoning. In reality, there's a spectrum that runs from very early presale to spot sale from a developer a few months after completion. And economically, it's not very important on which side of the technical divide created by the occupancy permit they fall. However, because of the limited number of periods, my model is creating a very sharp distinction between presales that occur 5 years before completion and spot sales that occur right after completion. In addition, spot sales by developers of new condos cannot be directly identified from my data. This is due to the combination of the following factors: presale indicators can never be positive for completed condos, presale indicator equaling zero does not necessarily imply that the transaction is not presale, and the age of the building tends to be downward biased (I discuss these issues in more detail in Appendix A.4).

[26] I select those ages because for other ages I have fewer than 200 observations per age. I use transactions from the years 2010-2019 rather than focusing only on the year 2015 because that would result in very few observations for different ages. Quality adjusted prices are always calculated using the hedonic regressions described in Appendix A.2

out by purchase groups. The report contains in Appendix B itemized data for each project. This includes the final cost of land per sqm of condo space in the project, and allows me to calculate the total non land cost (not including entrepreneurial profit and VAT) per sqm. To preserve respondent's privacy, the table does not include the total area of condos, nor the total number of units, but only the area of the average unit. It also does not include the precise number of floors, but only the whether the project has 1-2 floors, 3-8 floors, 9-15 floors or 16+ floors. I focus on projects that were carried out by developers and that were in buildings of at least 3 floors.

Multiplying average sqm per condo by average land and nonland costs per sqm, I get the average land and nonland costs per condo in each project. To aggregate this across projects in a way that is applicable to 2015, I weight each project's costs by the share of condos built in 2015 within floor number group and district. The results are 538,300 NIS for non land costs per unit and 259,300 for land costs per unit.

I then correct for the changes in land and nonland costs over time. I obtain changes in nonland costs over time from the builder's cost index tracked by the Israeli Central Bureau of Statistics (CBS), which does not include land costs and which increased 13.6% between Jan 2010 and Jan 2015. Regarding land costs, I take my baseline as the year 2007 because as the report notes, the land for buildings completed in 2010 - Jun 2012 was purchased in 2007 - 2008. There are no official statistics for the increase in residential land prices over that time period. Therefore, I use data on land auctions from the Israeli Land Administration. I built a panel of district by year in which at least 3 successful residential auctions occurred in each of the years 2007 and 2015. In each district year pair I calculate the average and median total land cost (winning bid plus development costs) per residential unit and per sqm residential area. Because the average price within district year tends to extremes, I use the median price. I then regress the final total land cost on district and year fixed effects. I do this separately for costs by area and costs by unit. I find that per unit costs increased by 40% while per sqm costs increased by 60%. I take the average of the two to arrive at 50%.

Finally, I correct for the fact that the average project finished in 2015 may contain more units, which affects the total land costs and thus c_F. To check if this is the case, I use my presale data to calculate the average floor number of a residential building with at least 3 floors finished in 2015 conditional on belonging to one of the above floor groups. The averages are about 4.5, 10.5 and 20.5. When each project is weighted as above by the share of its group in new condos built in 2015, I find that the average number of floors is 8, while the actual average of floors in a building built in 2015 was about 10.5. So I further multiply the resulting costs by 10.5/8 to arrive at $c_F = 16,527.5$ which is about 518.4 per unit (assuming 4 units per floor).

D.3 Installments Calibration

Regulation sets out the maximum shares of the total price that can be paid before a specific milestone in construction is reached: up to 7% before construction starts, the next 33% when the first floor roof is laid, the next 20% upon completion of the frame for the floor on which the apartment is located, the next 15% when the internal plasterwork on the walls is completed, the next 15% when external covering on the building is completed, and the last 10% when the occupancy permit is issued.[27]

Because in the model there are no distinctions between different stages of construction and only two distinct periods, I must make a judgment call about how to set installments in my model.

To faithfully recreate the economic equivalent of the above schedule in a two period setting, one must first make judgments about the average correspondence between time to completion and the stage of construction, and then to discount the payments appropriately. Note that because discount rates between builders and households differ, the installments would differ as well. Furthermore, the sum of the first and second installment will not sum to 1. I assume that when presale is 5 years before completion, 7% is paid immediately, 33% is paid 3 years before completion, the next 20% is paid 2 years before completion, 15%, a year and a half before completion, 15% a year before completion and the final 10% is paid upon completion. I further assume that the first 50% is included in the first installment (that is, the first two installments plus half of the third), and that the rest will be included in the second.

Finally, I make assumptions about the interest rates used to discount each part. For the builder it is r_b, while for the household the first 25% is discounted by r_f while the rest is discounted by r_m.[28] This yields the following formulas for the installments:

[27] One may wonder how presale can be used as an effective means of overcoming credit constraints if only 7% of already discounted prices are received before building starts. The answer is that it greatly it greatly limits the extent to which the line of credit for the project needs to expand in order to complete construction.

[28] The first 25% of the house value is discounted by risk free rate because the households needs to save up this amount, while the rest is discounted by the mortgage rate. This also implies that the effective minimum down-payment for the household who buys in presale is slightly below 25% (although due to the nearly zero risk free environment, the benefit from this is very small).

$$\iota_{b,0} = 7\% + \frac{33\%}{(1+r_b)^2} + \frac{10\%}{(1+r_b)^3}$$
$$\iota_{b,1} = 10\%(1+r_b)^2 + 15\%(1+r_b)^{1.5} + 15\%(1+r_b)^1 + 10\%$$
$$\iota_{h,0} = 7\% + \frac{18\%}{(1+r_f)^2} + \frac{15\%}{(1+r_m)^2} + \frac{10\%}{(1+r_m)^3}$$
$$\iota_{h,1} = 10\%(1+r_m)^2 + 15\%(1+r_m)^{1.5} + 15\%(1+r_m)^1 + 10\%$$

In the model, for each presale sold, the builder receives $P_0\iota_{b,0}$ immediately and $P_0\iota_{b,1}$ at completion. The buyer pays $P_0\iota_{h,0}$ immediately and $P_0\iota_{h,1}$ at completion.

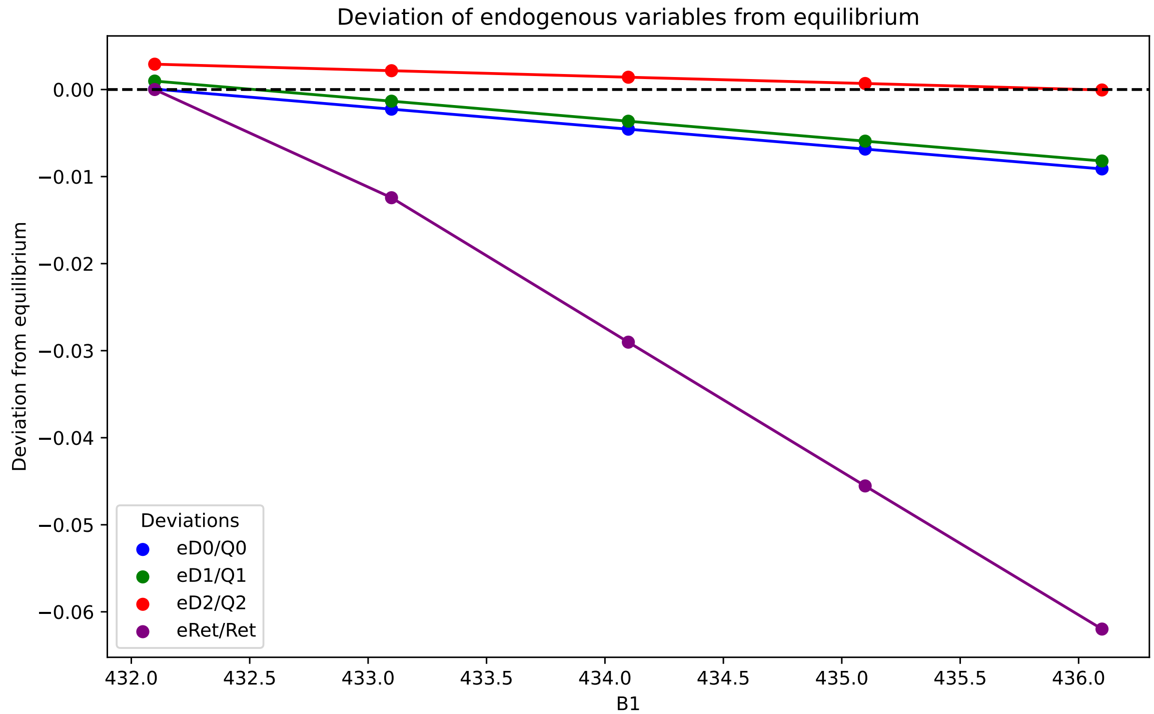
D.4 Solution

Difficulty Finding an Algorithmic Solution Several factors appear to conspire to make an algorithmic solution difficult to find. The first is the poorly behaved supply function which has multiple segments with very different behaviors, as discussed above. The second is the complicated differentiation pattern between three discrete products. Discreteness of the product space causes problems in numerical analysis because the indifference conditions used in continuous analysis become difficult to implement. This can be overcome more easily in the canonical cases of vertical or horizontal differentiation when each the ranking of products by consumers takes an intuitive form.

The present case is different. While the three types of house purchases are clearly vertically differentiated through the different levels of housing services they provide, this does not fully summarize the differentiation because of the unique features of presales. This fact is most apparent when one considers that while presale yields the most housing services, in equilibrium, it has the lowest price and is purchased by the lowest income households (of those that buy condos at all). In addition, second hand houses also play a special role because they affect the utility from buying all house types through the bequest motive. This means that higher second hand prices can also affect the location of the indifferent buyer between presale and rent.

The fact that there is no natural way to rank the three house types implies that their ranking for a consumer can depend on their prices. This causes the dynamics of demand with respect to price to be unpredictable and complicates the search for an equilibrium.

Figure 7: Existence of approximate market clearing



Notes: B1 is the number of builders who enter each period; eD0 is excess demand for presale, Q0 aggregate supply of presale, eD1 excess demand for spot sale, Q1 aggregate supply of spot sales, eD2 excess demand for second hand, Q2 aggregate supply of second hand, eRet excess returns, Ret is actual returns.

Approximate market clearing Figure 7 shows the relative deviations from equilibrium conditions as a function of builder entry B_1. The blue, green and red dots represent relative excess demand (excess demand divided by supply) of presale, new spot sales and old sales, while the purple line represents the percentage deviation of returns from their target of 16%. On the left side of the graph is the point I take as market clearing because it minimizes the sum of absolute relative deviations of the the four target quantities. As further reassurance that market clearing exists, one can also note that on the left all the dots are weakly above the zero percent line while on the right they are all below it. This suggests that for each deviation there is a point on $B_1 \in [432, 436]$ such that the deviation is precisely zero.

Table 16: Milestones

n (index)	Milestones	Time to build
4	The frame of the ceiling of the ground floor of the building is completed	$3 + \frac{1}{12} roundup(\frac{floors \cdot 4}{15}) + \frac{1}{24}$
3	The frame of the ceiling of the floor of the sold condo is complete	$3 + \frac{1}{12} roundup(\frac{floors \cdot 4}{15}) + \frac{floor}{25}$
2	Plastering of the entire building is complete	$3 + \frac{1}{12} roundup(\frac{floors \cdot 4}{15}) + \frac{4}{25} floors$
1	Exterior finishes are complete	$3 + \frac{1}{12} roundup(\frac{floors \cdot 4}{15}) + \frac{4}{25} floors + \frac{9}{25}$
0	The key to the condo is delivered to the buyer	$3 + \frac{1}{12} roundup(\frac{floors \cdot 4}{15}) + \frac{4}{25} floors + \frac{9}{25} + \frac{1}{12}$

Notes: floors is the number of floors in the building. floor is the floor number of the sold condo.

E Institutional Details

E.1 Milestones and Installments

Because I do not observe each builder's estimates of when each milestone would be reached, I use a heuristic provided by an industry expert to calculate, based on the number of floors in the building and the condo's floor number, the average time until each milestone is reached.

There are 5 milestones, which are indexed by $n = \{0, 1, 2, 3, 4\}$, and detailed in Table 16.

The heuristic is as follows: The period after the land is purchased but before the building permit is issued lasts about 3 years. Once a building permit is issued, it takes about 6 months to start the framing of the building. So I am assuming that the expected time from the start of presale to the start of framing is 3 years, assuming about six months to start presale once land is purchased.

Each underground floor takes about 1 month. The number of underground floors equals the number of condos divided by 15 parking spaces per underground floor, rounded up. Thus, from the start of framing to the completion of the underground floors is $ug = \frac{1}{12} roundup(\frac{floors \cdot 4}{15})$ years, where $floors$ is the number of floors in the building of the presale and assuming an average of 4 housing units per floor.

Each floor above ground takes about two weeks, so $\frac{1}{25}$ of a year. This determines three key stages: First, the first milestone, frame of the ceiling of the ground floor of the building, can be expected to be completed $3 + ug + \frac{1}{25}$ years from the start of presale. Second, the second milestone, the frame of the ceiling of the floor of the sold condo is complete, can be expected to be reached $3 + ug + \frac{floor}{25}$ years from the start of presale, where $floor$ is the floor number of the presale. Third, frame of the building is completed $3 + ug + \frac{floors}{25}$ from the start of presale. This is important because plastering usually doesn't start before the frame is completed.

All the plastering and finishing takes about 6 weeks per above-ground floor, which is $\frac{3}{25}$ of a year. They are done concurrently with fininshing lagging by 1-2 floors at each time. So plastering and finishing are completed $3 + ug + \frac{4}{25}floors$ and $3 + ug + \frac{4}{25}floors + \frac{9}{25}$ years after presale starts, respectively. It takes about 1 month after finishing for the occupancy permit to be issued, so the expected length of presale is $3 + ug + \frac{4}{25}floors + \frac{9}{25} + \frac{1}{12}$. For the average new project in my data, which has about 10 floors and about 4 units per floor, this comes out to about 5.29 years from land purchase to occupancy permit.