Horizon Risk in Renting: Evidence From a PropTech Rental Platform*

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Abstract

Rental contracts are often short-term, creating uncertainty for renters regarding the duration of their occupancy. Using contract-level data from a PropTech rental platform, we find that landlords in neighborhoods experiencing higher housing price growth and rent growth offer contracts of shorter durations and are less likely to renew expiring contracts. This effect is more pronounced among younger landlords and those with multiple or highly marketable properties. Our findings suggest that extrapolative housing market expectations shape the horizon of rental supply. We establish causality using an exogenous policy change that differentially affects the prices of different housing units.

Keywords: Rental housing, housing price, contract duration, horizon risk, PropTech

JEL classification: G11, G41, L85, R31, R38

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1 Introduction

The flexibility of short-term contracts comes at the cost of uncertainty. Previous research has extensively studied the rollover risk associated with short-term debt contracts (e.g., Acharya, Gale, and Yorulmazer, 2011; Cheng and Milbradt, 2012; He and Xiong, 2012; Valenzuela, 2016; Eisenbach, 2017; Bianchi, Hatchondo, and Martinez, 2018). In this study, we examine a similar "horizon risk" in the rental housing market. We define horizon risk as the uncertainty under which renters may be unable to stay in their rented homes for their desired duration due to reasons on the landlords' part.[1] For example, if a household needs to rent an apartment for five years but the landlord offers only one-year contracts, then the household faces horizon risk because of the uncertainty regarding contract renewal every year.

Horizon risk is likely to be economically consequential because it can deter households from making otherwise optimal long-term investments (e.g., purchasing durable goods and accumulating social capital). Issues related to horizon risk have drawn considerable attention in recent academic and policy discussions. A survey conducted by Malmendier and Wellsjo (2024) reveals that "peace of mind" ranks as the top reason for households' home purchasing decisions, surpassing other popular reasons such as rent increase, remodeling flexibility, and inflation protection. A response to a consultation conducted by the U.K. government states that longer tenancy is crucial for greater security for tenants.[2] Although long-term rental

[1] Note that horizon risk may arise from other factors that effectively shorten the contract duration, such as the early termination of a long-term contract. However, we focus on explicitly short-term rental contracts because they provide a relatively clean setting that rules out potential learning and interaction processes during tenancy.

[2] Overcoming the barriers to longer tenancies in the private rented sector: Summary of responses and government response (https://www.gov.uk/government/consultations/overcoming-the-barriers-to-longer-tenancies-in-the-private-rented-sector).

housing has the potential to offer a stable housing option that resembles homeownership, it remains rare in many parts of the world.[3] What determines the supply of long-term rental housing?

In this paper, we conduct the first systematic empirical investigation on the horizon of rental housing supplied by individual landlords. Our analysis is guided by the notion that alternative investment options influence individuals' portfolio allocation. In our context, landlords can sell their rental properties and invest the proceeds elsewhere, such as a bond. If they anticipate a higher payoff from an asset reallocation away from real estate assets in the future, then they may opt to offer only short-term rental contracts because it is more difficult to sell properties occupied by long-term tenants, as potential owner-occupants are excluded from the buyer pool.[4] We then draw from the literature on housing price momentum and extrapolative expectations (e.g., Glaeser and Nathanson, 2017; Armona, Fuster, and Zafar, 2019; Kuchler, Piazzesi, and Stroebel, 2023) to identify landlords who may anticipate a home sale. This literature suggests that agents generally expect (perhaps rationally so) housing prices to continue to rise after periods of price growth and vice versa. Thus, landlords who have experienced recent rapid housing price growth may find it optimal to prepare for a sale in subsequent periods and, therefore, may not want to be locked in by long-term contracts.

Disentangling the supply- and demand-side effects on contract duration is difficult in a conventional rental market setting because the duration of a rental contract is determined

[3] For example, in many countries, including the U.S., U.K., Canada, and China, most rental contracts have a duration of just one year. However, rental contracts commonly have a much longer duration in countries such as Germany, Italy, and Denmark (e.g., five or ten years).

[4] The difficulty of selling a tenant-occupied property compared with a vacant unit also results from the fact that scheduling showings for potential buyers becomes less convenient, which increases search and matching frictions.

through negotiations between renters and landlords. To address this empirical challenge, we use a unique contract-level dataset from a large PropTech rental platform in China, which negotiates contracts with the supply (landlords) and demand (renters) sides of rental housing *separately*. Specifically, this platform sources rental properties from individual landlords, renovates them using standardized template styles, and then leases them to renters at a premium while providing add-on services. Throughout this process, landlords and renters do not meet or negotiate. Notably, the platform consistently favors long-term contracts with landlords, as these contracts yield a larger profit margin net of fixed renovation costs. This feature allows us to measure the rental supply horizon using the contract duration between landlords and the platform and to focus on the supply-side determinants (i.e., landlords' considerations) for this contract duration.

Our primary finding is that local housing price growth negatively predicts the duration of the contracts offered by landlords, even after controlling for rent growth and other housing and landlord characteristics. This effect is statistically significant and economically sizable: a one-standard-deviation increase in local housing price growth reduces the duration of newly signed landlord-platform contracts by nearly one month. Put another way, one in every twelve landlords reduces the rental contract duration by one year following a one-standard-deviation excess (relative to the cross-sectional mean) housing price growth in the past twelve months. Furthermore, landlords experiencing local housing booms are significantly less likely to renew expiring contracts with the platform: a one-standard-deviation increase in local housing price growth reduces landlords' renewal probability by approximately five percentage points. These findings suggest that individual landlords become less willing to enter long-term rental contracts when home sale market conditions become more favorable. Additionally, we find that higher local rent growth independently predicts a shorter contract duration, consistent with the hypothesis that landlords extrapolate past rent growth and want to reset the rent more frequently when they expect a future rent increase.

We establish causality by exploiting an exogenous policy change, the home purchase restriction (HPR), which disproportionately impacts the marketability of certain types of properties. Our use of the HPR policy shock is inspired by prior research such as Deng, Liao, Yu, and Zhang (2022), who use the spillover effects of HPR policy to nearby unregulated cities to identify the impact of out-of-town housing demand on housing prices and consumer spending. Specifically, in March 2017, the Beijing municipal government substantially raised the down payment ratio for units classified as "nonordinary" for non-first-time homebuyers while raising this ratio by a much lesser amount for ordinary units.[5] As a result, the price of nonordinary units has unexpectedly dropped relative to that of ordinary units since the HPR policy took effect. Based on this context, we conduct a difference-in-differences (DID) analysis, with nonordinary units being the treatment group and ordinary units being the control group. Additionally, we employ a regression discontinuity (RD) design by focusing on the rental units around the size threshold that defines ordinary versus nonordinary units. The results from both analyses support our hypothesis: landlords with nonordinary units, potentially perceiving a lower payoff from rebalancing away from real estate assets in the future, have become relatively more willing to supply long-term contracts after the HPR policy. Collectively, our results suggest that housing market conditions causally affect the

[5]The classification of ordinary and nonordinary units is based primarily on property size, with ordinary units referring to smaller properties (below 140 square meters) and nonordinary units denoting larger properties (above 140 square meters).

horizon of rental housing supply in an economically meaningful way.

We exploit the heterogeneity in housing and landlord characteristics to examine additional predictions from our framework. First, we find that the effect of local housing price growth on the rental supply horizon is more pronounced for landlords with multiple rental units than for those with only one rental unit supplied to the PropTech platform. A possible explanation is that multi-homeowners are more likely to hold real estate assets for investment or speculative purposes (rather than for personal use), and therefore, are more responsive to housing market changes. Second, the effect is more pronounced among younger landlords, consistent with existing evidence that older generations are less inclined to speculate and more likely to live off rental incomes Gargano and Giacoletti (2022). Third, the effect is more pronounced for rental units with better liquidity in the housing market, such as those with two or fewer bedrooms and those rented as single-family homes (instead of shared apartments). This result is consistent with the proposition that liquidity facilitates trading and speculation (e.g., Amihud, 2002; Acharya and Pedersen, 2005). We also find that recent and extreme price growth disproportionately influences rental contract duration. This result is in line with prior findings in other markets that agents more strongly extrapolate on recent and extreme trends (e.g., Glaeser and Nathanson, 2017; Bordalo, Gennaioli, Porta, and Shleifer, 2019; Armona, Fuster, and Zafar, 2019).

Our framework also holds a prediction on the term structure of rents. Our main findings indicate that long-term rental supply decreases following high local housing price growth; thus, all else being equal, this drop in supply should raise the equilibrium rents of long-term rental units. Consistent with this prediction, we find that long-term rents increase relative to short-term rents following high local housing price growth.

Does the shift in the rental supply horizon impact renters' welfare? We document two pieces of evidence suggesting that it does. First, we show a "horizon matching" behavior in the rental market in which the ex-ante available horizon of a rental unit is positively associated with the renter's ex-post length of stay in the unit. Second, we find that renters' demand for long-term rental contracts, proxied by renters' contract renewal likelihood, *increases* with local housing price growth; thus, long-term rental supply falls precisely when renters' long-term demand rises. This finding is consistent with the intuition that long-term rental is a substitute for homeownership: As housing becomes less affordable, individuals' demand for long-term rental increases. This finding also helps rule out a demand-side alternative explanation that the shortening of the rental supply horizon following high local housing price growth may be driven by a decrease in demand for long-term contracts.

In terms of generalizability, although our setting is the Beijing rental housing market, the insights gleaned should be generalizable because the economic framework behind our analyses is based on widely accepted assumptions in the economics and finance literature, such as the tradeoff between different investments and extrapolative expectations. Thus, we believe that our findings should serve as a useful starting point for future research on horizon risk in various rental markets.

Our study makes three main contributions to the literature. First, empowered by our unique micro data on rental contracts, we document the first systematic and plausibly causal evidence on the impact of housing price growth on landlords' rental supply duration, an important link between the home sale and home rental markets that is new to the literature.

Amid the extensive research on housing markets, most studies examine the sale or rental market in isolation. Some notable exceptions include Favilukis and Van Nieuwerburgh (2021), who find that out-of-town homebuyers increase housing prices and rents; Molloy, Nathanson, and Paciorek (2022), who find that housing supply constraints have larger effects on home prices than on rents, and Badarinza, Balasubramaniam, and Ramadorai (2023), who show that the matching functions in the housing and rental markets differ considerably across matching stages. Our research expands the understanding of the intricate relationship between housing price dynamics and rental housing supply.

Second, our analysis expands the literature on the effects of extrapolative housing market expectations. Housing prices exhibit short-run momentum (Case and Shiller, 1989; DiPasquale and Wheaton, 1994; Armona, Fuster, and Zafar, 2019) and long-run reversal (Cutler, Poterba, and Summers, 1991). Extrapolative expectations in the housing market, which can be rationalized by such housing price dynamics, affect individuals' home purchase, sale, and mortgage financing decisions (Glaeser and Nathanson, 2017; Adelino, Schoar, and Severino, 2018; Kuchler and Zafar, 2019; Bottan and Perez-Truglia, 2020; Gao, Sockin, and Xiong, 2020; Botsch and Malmendier, 2020; Gargano, Giacoletti, and Jarnecic, 2023; Kuchler, Piazzesi, and Stroebel, 2023). Our study expands this literature by providing new insights into the *cross-market* implications of extrapolative housing market expectations. Moreover, our findings suggest that landlords extrapolate past rent growth when making financial decisions, an aspect on which empirical evidence has been relatively scarce.

Third, we contribute to the literature on housing decisions by introducing horizon risk as a new dimension of housing considerations. The literature has linked various risks with housing choice. For example, Sinai and Souleles (2005) demonstrate the importance of rent risk (i.e., fluctuations in future rent payments) in the decision-making process between homeownership and renting. Malmendier and Wellsjo (2024) show that past inflation experiences predict homeownership, highlighting the role of the perceived risk of inflation. Adelino, Schoar, and Severino (2018) find that household perceptions of housing price risk explain homeownership choices. However, the literature has thus far paid limited attention to horizon risk in renting. Our study helps initiate this discussion by providing some basic facts regarding the horizon of rental housing supply.

Additionally, the PropTech platform in our study differs from other technology-enabled platforms, such as Zillow, which specializes in residential property sales (Fu, Jin, and Liu, 2022), iBuyers, which purchases and sells residential real estate and supplies liquidity to households (Buchak, Matvos, Piskorski, and Seru, 2020), and Airbnb, which mainly provides very short-term or temporary rental housing (Li, Kim, and Srinivasan, 2022). Therefore, our research contributes to the understanding of an emerging PropTech business model in the rental housing market, which can be dubbed "iRenters." Our findings indicate that these iRenter platforms can improve rental housing stability by rewarding individual landlords who offer long-term rental units. However, the PropTech platform may expose itself to spread risks as the rent received from tenants may fall below the fixed payments to landlords.

The rest of the paper proceeds as follows. Section 2 provides the institutional background. Section 3 provides a theoretical framework. Section 4 describes the data and empirical methodology. Section 5 presents the empirical results. Section 6 concludes the paper.

2 Institutional Background

2.1 Rental housing markets in China and worldwide

There is a significant demand for stable rental housing worldwide. In the U.S., more than one-third of residents are renters (Reher, 2021). In Europe, the homeownership rate ranges from less than 50% to up to 80% (Malmendier and Wellsjo, 2024), implying that the remaining 20% to 50% of households live in rented homes. China has a relatively high homeownership rate at roughly 90%, but this number is much lower for young households at approximately 55% (Glaeser et al., 2017). Moreover, there is a substantial mismatch in housing locations because a large population, especially young people, migrates from rural areas to major cities for better education and career prospects.[6] Thus, although these young people may own property in their hometowns, they often have to rent in the cities to which they migrate. As China's housing prices have grown rapidly in the past two decades (Glaeser et al., 2017), renting has become increasingly common, especially in major cities where the housing affordability crisis is more pronounced.

According to the Blue Book of Urban Rental Life 2021, the population living in rented homes in China will reach 260 million by 2030. The Ministry of Housing and Urban-Rural Development released in 2021 that nearly 70% of the migrant population lives in rented homes, with some of them having lived in these homes for an extended period. The Seventh National Census shows that the proportion of households living in rented homes in Beijing,

[6] This is consistent with Badarinza, Balasubramaniam, and Ramadorai (2019), who find that the share of assets in real estate is greater for the elderly than for the young for households in India and China, which is in part "a manifestation of more traditional family structures, where multiple generations may inhabit the same residence owned by the elderly head of the household."

Shanghai, and Shenzhen as of November 2020 reaches 35%, 39%, and 77%, respectively, which are well above the national average of 21%. Furthermore, surveys show that in first-tier cities (e.g., Beijing, Shanghai, Shenzhen, and Guangzhou), 75% of renters have lived in rented homes for over three years, 12% have lived in rented homes for over ten years, and 51% plan to rent for an additional five years, including 18% who plan to rent for another ten years.[7]

Although there appears to be substantial demand for long-term rentals, the duration of a typical rental contract remains short. According to a 2015 survey in 16 cities conducted by the China Real Estate Appraisers and Agents Society, approximately 80% of rental contracts have a duration of one year or less, creating potentially significant horizon risks for renters.[8] Furthermore, individual landlords historically dominate the supply side of the rental housing market in China, whereas institutional landlords remain in the development stage. Even in megacities such as Beijing, where the annual rental housing transactions exceeded 2 million contracts in 2016, institutional landlords only accounted for less than 20% of these transactions.[9] Thus, tenants have to rely on an individual leasing market plagued by high transaction costs, search frictions, and a lack of commitment, thus suffering from unstable rental periods, a lack of service, and a low level of transparency.[10] This pattern of high-friction, low-quality, short-term rental housing is also observed in developed countries, including the U.S., U.K., and Canada. The public and policymakers worldwide are aware of this issue. For example, a news report from The Guardian in May 2018 quotes from Lindsay

[7] See https://www.chinanews.com.cn/cj/2021/11-16/9609800.shtml.

[8] See https://xueqiu.com/1262848368/199980555.

[9] White Paper on Housing Development in Beijing, https://house.focus.cn/zixun/cd5116ff6fa810c6.html.

[10] See https://www.chinanews.com.cn/shipin/spfts/20210830/3582.shtml.

Judge, a senior policy analyst at the Resolution Foundation:[11]

> "We know that the private rented sector is the least secure and the lowest-quality tenure of all types, and that is obviously not a great place to bring up your kids [...] The vast majority of private rented contracts are assured shorthold tenancies, so in theory you could have to get out with two months' notice. That's grim for anybody if you don't want to leave, but if you have got children in school, your social networks, your support systems, these things are more challenging if you have got a family and you are trying to create a stable home."

2.2 PropTech rental platform

The PropTech rental platform in our study is one of the largest subleasing platforms in China. As of the end of 2021, it held approximately 20% of the market share in the long-term rental market in ten major cities in China, cumulatively serving approximately 500,000 homeowners and 5 million tenants. The platform's main tenants are young newcomers in large cities. While nonlocal young professionals may be overrepresented in our sample, this feature is desirable for our research purpose because this population is likely more exposed to the adverse effects of horizon risk than, for example, local young adults who have the option to live in their parents' homes and older ones who can afford their own homes.

Business model.—We illustrate the business model of the PropTech platform in Figure 1. The platform sources housing units from individual property owners, renovates these

[11] https://www.theguardian.com/society/2018/may/09/mental-health-crisis-generation-rent-millennials-own-home-wellbeing.

units using standardized template styles, and leases them at a premium to tenants. The platform profits from the margin between the rent received from tenants and the rent it pays to landlords, net of renovation and operational expenses. The profits can be risky because the platform promises to pay landlords a fixed monthly rent (plus a prescheduled annual increase), even though the units may be vacant or the rent paid by the tenants may unexpectedly drop. The platform benefits from diversifying away the idiosyncratic rent risks by pooling a large number of rental properties. However, the platform remains exposed to systematic risks, such as the possibility of an economic downturn. Overall, the platform likely creates economic value by (1) cost-efficiently renovating and managing properties and (2) pooling rent risks from individual landlords and providing hedging.

Early termination of contracts.—Another source of horizon risk stems from landlords' early termination of contracts. If landlords can terminate contracts early with little cost, then long-duration contracts do not necessarily have low horizon risk. The PropTech platform deters landlords from terminating contracts early by (duly) setting a high penalty—two or three months' rent plus the residual value of the renovation. This penalty is greater than the typical one month's rent in contracts directly signed between individual landlords and tenants in conventional rental markets.[12] The platform also has strong incentives to enforce the termination penalty because the renovation incurs an actual high upfront cost on the platform. In our sample, landlords' early terminations are rare (approximately 1.5%). Hence, we do not pursue studying early termination but rather focus on contract duration.

[12] There has been a public debate about whether the typical early termination penalty of one month's rent for landlords in the regular rental market is too low. Furthermore, rental contracts in regular rental markets often do not recognize tenants' renovation costs.

2.3 Housing market regulations

The Chinese government has adopted a series of policies to contain soaring home prices in top-tier cities. We focus on the Home Purchase Restriction (HPR) policy in Beijing, which was implemented in between late 2016 and March 2017. The policy targets speculative or investment housing purchases, especially of "nonordinary" housing units. Under this policy, the Beijing municipal government raised the down payment ratio for nonordinary units from 50% to 80% for non-first-time homebuyers. In contrast, the down payment ratio for ordinary units only increased by a much milder amount, from 50% to 60%.[13]

The HPR policy classifies nonordinary properties as those that (1) have a structural area above 140 square meters or (2) have a price per area above 39.6 thousand RMB or a total value above 4.68 million RMB. While the property size must be accurately recorded, the on-contract housing price is known to be susceptible to manipulation.[14] To avoid complications related to price manipulation, we define nonordinary properties based solely on the size threshold of 140 square meters. Our findings are robust under alternative classification schemes that consider transaction values. Because the policy aims primarily to reduce the speculative demand for nonordinary units, we label nonordinary units as the treatment group and ordinary units as the control group.

[13]Deng et al. (2022) show that the HPR policy shocks were "considerably effective in containing rising house prices in the regulated cities." We confirm this point in our data. We refer readers to Deng et al. (2022) for a thorough discussion of the HPR policy. Our identification, however, differs by exploiting the variation across nonordinary and ordinary units within the same regulated city (i.e., Beijing).

[14]For example, property owners may sell their properties at an on-paper price just below the cutoff price and collect the remainder under the table to avoid the high down payment. Therefore, even if the actual price (which we observe from the broker's website) is high, the unit's on-contract price (which we do not observe and is filed with the government agency) can still be low, making the unit an ordinary unit officially.

3 A Model of the Rental Supply Horizon

We provide an illustrative model of landlords' contract duration choice to organize our empirical analysis. The model has three periods: $t = 0, 1, 2$. A risk-neutral wealth-maximizing landlord is born at $t = 0$ with one unit of real estate asset (i.e., a house). The landlord solves the investment problem by comparing the expected payoff from each investment path.

Opportunity set.—At $t = 0$, the landlord chooses from three mutually exclusive investment opportunities with her real estate asset:

1. a short-term leasing contract, S, that expires in period 1,
2. a long-term leasing contract, L, that expires in period 2,
3. the real estate asset converted into a reserved asset, C, that generates interest income paid in period 1.

We capture the flexibility provided by short-term contracts through the assumption that if the landlord chooses L at $t = 0$, then she cannot switch to C or S at $t = 1$; if the landlord chooses S or C, then she is free to switch to either C or S at $t = 1$. Hence, the landlord chooses from the following set of investment paths:

$$\mathbf{\Phi} = \{(S, S), (L, L), (C, C), (S, C), (C, S)\}, \tag{1}$$

where the first element in each choice pair denotes the investment from $t = 0$ to $t = 1$, and the second element denotes the investment from $t = 1$ to $t = 2$.

Payoffs.—The long-term rental contract pays a rent of l in both periods and returns the housing unit to the landlord at $t = 2$. The short-term contract pays a rent of s_1 and returns the house at $t = 1$. The value of the property at $t = 0$ is p_0, and the interest rate is r_c; thus, the interest income from converting the house to cash is $r_c p_0$ paid at $t = 1$. The spot rent at $t = 1$, $\tilde{s}_2$, and housing prices at $t = 1$ and $t = 2$, $\tilde{p}_1$ and $\tilde{p}_2$, respectively, are random. We assume a simple distribution for $\tilde{s}_2$: the rent can increase from s_1 to s_2^H with a probability of π^H, decline to s_2^L with a probability of π^L, and remain at s_1 with a probability of π^M. We also assume a similar distribution for the housing price: $\tilde{p}_1$ can be high (p_1^H), remain the same as p_0 ($p_1^M = p_0$), or be low (p_1^L) with probabilities γ^H, γ^M, and γ^L, respectively.

To capture the idea that the rental, home sale, and bond markets are initially in equilibrium, we assume that $E[\tilde{s}_2] = s_1$, $E[\tilde{p}_1] = E[\tilde{p}_2] = p_0$, and $s_1 = r_c p_0 = c$, i.e., the rent and price are both expected to stay constant, and the landlord is indifferent between choosing the short-term contract and selling the property (and hence holding cash) at $t = 0$. We denote the quantity that equals s_1 and $r_c p_0$ as c. For simplicity, we assume that any income received at $t = 1$ cannot be reinvested.

Although both short-term rent and interest income are expected to remain constant over time, the landlord expects a higher overall payoff in the second period because of the option to switch between S and C. In particular, at $t = 1$ when $\tilde{s}_2$ and $\tilde{p}_1$ become observable, the landlord can choose between S and C depending on which one yields a higher payoff. Thus, at $t = 0$, the second-period expected payoff conditional on either S or C chosen at $t = 0$ is equal to the probability-weighted average payoffs under all possible realizations of $\tilde{s}_2$ and $\tilde{p}_1$, assuming that the landlord always chooses the investment with the highest payoff. We denote this expected second-period payoff as α.[15] The set of possible expected payoffs in the two periods is as follows:

$$\mathbb{P}(\mathbf{\Phi}) = \{(c, \alpha), (l, l)\}, \tag{2}$$

where the first and second elements in each payoff pair denote the payoffs in the first and second periods, respectively. To clarify, there are only two possible expected payoff paths because we assume that $s_1 = r_c p_0 = c$. Thus, choosing S or C at $t = 0$ yields the same expected payoffs.

Landlords' rental supply.—We are interested in when the landlord chooses (L, L). Because the second-period spot rent and housing prices are risky, the option to switch to a different type of investment is valuable. It can be easily shown that $\alpha > c$ because of this option to switch. This setup generates an upward-sloping term structure of rent (i.e., $s < l$) because long-term rent needs to compensate the landlord for the forgone option to switch to a different type of investment at $t = 1$. The landlord is indifferent between choosing among L, S, and C when the following condition holds:

$$l - c = \alpha - l. \tag{3}$$

That is, the extra rent collected in the first period by offering a long-term contract $(l - c)$ is

[15]The expression for α is as follows:

$$\alpha = \pi^H \gamma^H max\{s_2^H, r_c p_1^H\} + \pi^H (1 - \gamma^H) s_2^H + \gamma^H (1 - \pi^H) r_c p_1^H$$
$$+ \pi^M \gamma^M max\{s_2^M, r_c p_1^M\} + \pi^M \gamma^L s_2^M + \pi^L \gamma^M r_c p_1^M + \pi^L \gamma^L max\{s_2^L, r_c p_1^L\}.$$

exactly offset by the forgone option value $(\alpha - l)$ in the second period.

Hypotheses.—The home sale market and rental housing market conditions affect landlords' rental supply decisions by influencing the relative payoffs on L, S, and C. In this paper, we focus on the effects of housing price growth and rent growth. Housing price growth affects landlords' rental supply decisions in two ways. First, all else being equal, price growth increases the payoff from selling the house and investing the proceeds into a bond (C). Thus, after seeing a price growth, landlords may find C to be more profitable than both S and L and, as a result, will not enter the rental market. This direct "price effect" reduces the supply of both short-term and long-term rental housing.[16]

Second, past price growth increases landlords' *expectations* of future short-term price growth through extrapolative beliefs. Under this "expectation effect," even if C has already dominated both S and L after a large housing price growth, landlords may still (rationally) choose to rent out their properties for the short term because they anticipate even higher gains from switching to C in the next period. This choice is optimal if the housing price is expected to appreciate at a rate higher than the prevailing interest rate minus the short-term rent-to-price ratio.

In this paper, we focus on the expectation effect because it has clearer implications for our focal subject, the horizon of rental supply, and because our data are well suited for

[16]For readers who are interested in the direct effect of housing price growth on rental housing supply, we refer to the literature on housing price and transaction volume (e.g., Stein, 1995). This literature reveals a positive correlation between housing price and transaction volume, which is consistent with the phenomenon of would-be landlords selling their properties following price growth. In an extended model with market frictions such as search costs, the direct effect also reduces the long-term rental housing supply relative to the short-term supply because landlords may rent out the units only for the short term when they search for prospective buyers. In the empirical section, we test the role of search frictions using transaction volume growth to proxy for home sale market liquidity. Although this channel is potentially interesting, it is not our primary focus, and we refrain from pursuing this path too far.

studying this effect. We discuss the limitations of our data at the end of this section. Here, we state our hypotheses.

Hypothesis 1. *An increase in local housing price reduces the supply of long-term rental housing relative to short-term rental housing.*

A similar hypothesis emerges regarding rent growth expectations. If landlords extrapolate past rent growth into the future, then an increase in rent raises the perceived value of S in the subsequent period. Thus, all else being equal, landlords become less willing to choose L, which undesirably locks in the current long-term rent.

Hypothesis 2. *An increase in local rent reduces the supply of long-term rental housing relative to short-term rental housing.*

Both hypotheses follow the intuitive idea that landlords become less willing to supply long-term contracts when the alternatives (i.e., a sale or short-term rental) become more attractive in the next period. These hypotheses closely correspond to the implications derived from existing theories of the term structure of interest rates. For example, Cox et al. (1985) use a general equilibrium model to show that expectations and investment alternatives, among other factors, determine the term structure of bond prices. This correspondence stems from the fact that rental contract duration and bond maturity are conceptually similar if one views the house in our context as cash in the context of bond investment: landlords who offer long-term contracts can then be thought of as lenders who invest in long-term bonds. The horizon risk faced by renters corresponds to the rollover risk faced by firms that finance their long-term projects using short-term bonds.[17] In the empirical section, we test

[17]We acknowledge that, of course, horizon risk is not exactly identical to rollover risk, which is why we

Hypotheses 1 and 2 using rental contract duration, landlords' renewal decisions, and short- and long-term rental prices.

Empirical limitations.—Although our dataset provides a relatively clean setting for studying our proposed questions regarding the horizon of rental supply, we note that it has limitations: it contains only landlords who have chosen to rent out their properties through a platform oriented toward long-term rental, but not those landlords who have decided to sell their properties or rent through the regular rental market. This sampling bias places restrictions on the range of questions we can answer. In particular, we cannot speak to landlords' choice between leasing and selling their property. Furthermore, our analysis likely produces results that *understate* the impact of housing market conditions on the horizon of rental housing supply; this is because the landlords whom we do not observe—those who decide to sell or rent through the regular rental markets following a housing price increase—are precisely those who are most responsive to changes in housing market conditions. Thus, our results should be interpreted as a lower bound of the true effects.

4 Data and Empirical Methodology

4.1 Rental contracts

We obtain contract-level data from a leading PropTech rental platform in China. We focus on the rental housing market in Beijing because the platform has the largest market

refrain from using the term rollover risk in our study. One difference is that rollover risk can arise from issues from both the borrower and the lender, whereas the horizon risk we define is restricted to the risk arising from the landlord side only.

share and the longest operating period there. We obtain data on two types of contracts:

1. contracts between landlords and the PropTech platform (landlord-platform contracts),
2. contracts between the platform and tenants (tenant-platform contracts).

Our sample contains observations both before and after the HPR policy shock while excluding the COVID-19 pandemic period. We primarily focus on the duration of the first contract signed between landlords and the platform and exclude landlord-platform contracts that are renewals of expiring contracts because new contracts and renewals may not be comparable. Our final sample consists of 92,948 new landlord-platform contracts and 177,581 tenant-platform contracts in Beijing between January 2015 and December 2019.

We extract four sets of information: (1) landlord-platform contract information, such as the signing date, contract duration, renovation expenses, and rent paid to landlords; (2) tenant-platform contract information, such as the signing date, contract duration, rent received from tenants, and renewal status; (3) housing unit characteristics, such as home address, size, number of bedrooms, and building age; and (4) tenant characteristics, such as gender, age, educational background, and job industry. Table 1 provides the list of the variables and their definitions.

Landlord-platform contracts. Our main dependent variable is the duration of landlord-platform contracts (Duration). Panel A of Figure 2 shows that the duration of landlord-platform contracts typically ranges between three to five years; only a small number of landlord-platform contracts have a duration of one, two, or six years. Panel A of Table 2 shows that the mean contract duration is 3.88 years, which is much longer than the typical one-year duration observed in the regular rental housing market. Landlords' renewal rate with the PropTech rental platform is approximately 86%, with a standard deviation of 35%.[18]

Tenant-platform contracts. Panel B of Table 2 shows that the initial duration of the tenancy averages 0.79 years and is capped at one year. We caution that this short duration is due to the PropTech platform's policy and does *not* indicate a lack of long-term rental demand. Instead, it should be interpreted as a form of tenant protection offered by the platform—tenants are always granted the highest priority to renew the lease for the unit they currently occupy if the unit is still available. Alternatively, tenants can freely switch to other vacant rental units of their own choosing. Since the platform does not evict tenants who make timely rent payments and accommodates their renewal requests, it offers a more stable and predictable rental housing service than the regular rental market.

Panels B and C of Figure 2 show the distributions of the initial duration of tenant-platform rental contracts and tenants' total number of years with the PropTech platform (including renewals), respectively. While most tenants stay with the PropTech platform for no more than one year, a significant fraction of tenants choose to renew their leases at least once, suggesting that the one-year duration constraint is often binding and that some tenants demand longer-term rental housing. Once again, we caution that one cannot interpret the values in Panel C of Figure 2 as being representative of long-term rental demand because they are based on tenants' ex-post duration of the stay, and our sample period spans only five years, i.e., the maximum possible value in the sample is capped at five years. In addition, the frequency of short-duration stays is inflated even within our sample because the platform's

[18]Per the PropTech platform's request, we do not report statistics related to sensitive business information, such as those related to rent levels and renovation expenses. However, we do include these variables in our analyses.

market share expanded over time, and tenants in the later sample period have a smaller maximum possible duration of stay. In tests related to tenants' demand for long-term rental service, we rely on *cross-sectional* variations in tenants' initial duration, total duration, and renewals. We summarize these variables in Panel B of Table 2.

Rental property characteristics. Panel C of Table 2 shows that the average rental unit in our sample has a structural area of 72.32 square meters with a standard deviation of 28 square meters and was built approximately 17 years ago with a standard deviation of 7.5 years. Of these housing units, 29% have one bedroom, 49% have two bedrooms, and 22% have three or more bedrooms. Furthermore, 52% of the housing units are leased out as whole units, while the remaining 48% are shared units. Additionally, 64% have elevators; and 89% provide heating. The average green plot ratio is 31%

Tenant characteristics. Panel D of Table 2 shows that tenants' average age is approximately 33 years old, with a standard deviation of 5 years. The average commuting distance is 8.22 kilometers, with a standard deviation of 7.86 kilometers. Regarding gender, 48% of tenants are female. Only 6% of tenants are from Beijing. Regarding education and occupation, 50% have a bachelor's degree or higher, 29% work in the IT industry, and 13% work in the financial industry. Overall, these tenants appear to be educated, migrant, and early-career working professionals.

4.2 Housing market conditions

We manually collect housing transaction data in Beijing from a major real estate broker's website, which records over 64% of all second-hand housing transactions during our sample period and, therefore, should be largely representative of the Beijing housing market. Our housing market data contain 463,590 second-hand home sales transactions in the six main urban districts in Beijing between January 2013 and December 2019. These data allow us to construct the average price and number of transactions in the neighboring area for each rental unit.

Figure 3 shows the geographic distributions of the rental units (Panel A) and housing transactions (Panel B) side by side. The spatial pattern of rental units is diverse and closely resembles that of the housing transactions. The similarity in these spatial patterns helps validate our identifying assumption that individual landlords simultaneously consider the options of leasing and selling their properties and that the properties for sale are comparable to those for rent.

Price growth and rent growth. We define local housing price growth as the percentage change in the average per-square-meter housing price ($P_{i,t}$) relative to the price 12 months ago ($P_{i,t-12}$), which is calculated using all second-hand home transactions for properties within a two-kilometer radius around the rental property. Similarly, we define local rent growth as the percentage change in monthly rent ($R_{i,t}$) in the past 12 months, with the monthly rent for each rental unit calculated as the average per-square-meter rent in the deals signed between the platform and landlords within a two-kilometer radius in the past 12 months. Panel E of Table 2 shows that the average (median) local housing price growth is 13% (6%) per year, indicating that housing prices in Beijing have grown rapidly in our sample period. The price growth is right skewed, with the top quartile ranging from 27% to 53% and the bottom quartile ranging from −8% to −1%. The average (median) local rent grows by approximately 12% (11%) per year.

Figure 4 shows the quarterly trends in housing prices and growth rates between 2015 and 2019. The average housing price in Beijing increased from 40,000 RMB per square meter at the beginning of 2015 to nearly 80,000 RMB per square meter by the end of 2016, almost doubling over a short span of two years. The year-over-year price growth also increased, peaking at over 60%. This soaring trend plateaued after the rollout of the HPR policy in early 2017, with the year-over-year growth rate dropping from its peak of 60% to a negative value in less than one year. The average housing price in Beijing remained at approximately 70,000 RMB per square meter throughout 2018 and 2019.

Impacts of the HPR policy. The HPR policy aims to curb soaring property prices by increasing down payment requirements and mortgage interest rates, especially for nonordinary properties. The policy has apparently achieved this goal. The price of nonordinary housing units decreases significantly relative to that of their ordinary counterparts after 2017Q1. Figure 5 plots the price discount of nonordinary units relative to ordinary units using home transaction data in the two years before and after the HPR policy. We match each of the nonordinary units with one or multiple ordinary units according to property location, housing characteristics, and transaction time. Figure 5 shows that the price discount of nonordinary units increased sharply from period 0 to period 1, from approximately 3% to 7%, and then stabilized at approximately 5% until the end of the sample, indicating that the policy has managed to reduce the prices of nonordinary units relative to ordinary units.

4.3 Empirical methodology

4.3.1 Baseline regression

We start with an ordinary least squares (OLS) regression to examine the association between local housing price growth and the duration of landlord-platform contracts.

$$\text{Duration}_i = \alpha + \beta_1 \text{PriceGrowth}_i + \beta_2 \text{RentGrowth}_i + \boldsymbol{\eta}' \boldsymbol{X}_i + \boldsymbol{\gamma_m} + \boldsymbol{\gamma_d} + \varepsilon_i, \tag{4}$$

where i indexes the rental contract signed between the landlord and the PropTech platform. We include the following housing characteristics as control variables ($\boldsymbol{X}_i$): house age, the natural logarithm of size, the number of bedrooms, renovation expenses paid by the PropTech platform (as a ratio of annual rents), whether the building has an elevator and heating, and the green plot ratio. We include a full set of year-month fixed effects $\boldsymbol{\gamma_m}$ to control for time-specific shocks invariant to all rental contracts signed in the same month, such as inflation and macroeconomic policy changes. We also include district[19] fixed effects $\boldsymbol{\gamma_d}$ to absorb persistently different characteristics across districts that could affect contract duration but are unrelated to housing market conditions, such as the quality of schools and hospitals. Standard errors are double-clustered by month and residential block.

[19]China has a province/municipality-city-county-village four-tier local government hierarchy. Since Beijing is the capital city and a municipality, its districts are equivalent to prefecture-level cities in terms of administrative hierarchy.

4.3.2 Matched DID analysis

Our identification strategy exploits the HPR policy shock in Beijing in early 2017. We conduct a DID analysis with the following specification:

$$\text{Duration}_i = \alpha + \beta_1 I(\text{Nonordinary})_i \times \text{PostHPR}_i + \beta_2 I(\text{Nonordinary})_i + \boldsymbol{\eta}' \boldsymbol{X}_i + \boldsymbol{\gamma_m} + \boldsymbol{\gamma_d} + \varepsilon_i, \tag{5}$$

where i indexes the landlord-platform contract. We label rental housing units larger than 140 square meters as the treatment group (i.e., $I(\text{Nonordinary}) = 1$) and those below 140 square meters in size as the control group (i.e., $I(\text{Nonordinary}) = 0$). PostHPR_i equals one if the contract was signed after March 2017. $\boldsymbol{X}_i$, $\boldsymbol{\gamma_m}$, and $\boldsymbol{\gamma_d}$ are the control variables, year-month fixed effects, and the district fixed effects.

We adopt a matching approach to address the potential selection problem in our empirical analysis. Rather than using the entire sample to estimate the effect, we select a matched control group based on their "closeness" to the samples in the treated group. In particular, for each rental contract of nonordinary units, we match it with all the contracts of ordinary units that satisfy the following three criteria: (1) the rental contracts of the ordinary units are signed in the same period (either pre- or post-HPR) as are the nonordinary unit, (2) the ordinary units are located in the same block as the nonordinary unit, and (3) the ordinary units have the same number of bedrooms as the nonordinary unit. We drop the nonordinary units for which we cannot find a match. To the extent that our treated and control groups are comparable along the matched dimensions, we are able to rule out confounding factors associated with these housing characteristics.

4.3.3 Regression discontinuity analysis

We also exploit the 140-square-meter size cutoff to implement a regression discontinuity (RD) analysis to address the potential issue that the treated and control groups may not be comparable. In this test, we narrow our sample to the matched contracts whose underlying units have a size between 125 and 155 square meters. We follow Calonico, Cattaneo, and Titiunik (2015) to determine the optimal bandwidth, using both mean square error (MSE)- and coverage error rate (CER)-optimal bandwidth selectors for the sum of the regression estimates. Our MSE- and CER-optimal bandwidths are 4.13 and 2.17 square meters, respectively. We then perform regression analyses with these optimal bandwidths. Conceptually, this RD design is similar to the matched DID described above, but RD zooms in to a subsample within a narrow range of approximately 140 square meters and hence effectively adopts "having a similar size" as an additional matching criterion for the treated and control groups. The RD analysis yields results that are highly consistent with the matched DID. For brevity, we focus on discussing the matched DID results in the main text and report the RD results in the Appendix.

5 Empirical Results

5.1 Baseline results

Table 3 reports the results from the baseline regressions. Consistent with Hypotheses 1 and 2, the coefficients of housing price growth and rent growth are significantly negative across specifications. In Column (1), the coefficient of price growth is -0.46, implying that a one-standard-deviation increase in price growth (18%) is associated with a one-month decrease ($0.18 \times 0.46 = 0.083$ years, or 30.3 days) in contract duration, or 8% of the standard deviation of contract duration. Another way to interpret this estimate is that one in every twelve landlords would have their rental supply duration reduced by one year following an excess housing price growth (relative to the cross-sectional mean) of approximately 18% in the past twelve months.

In Column (2), we examine the association between landlords' contract duration and past local rent growth. The coefficient of rent growth is negative and statistically significant. The magnitude of -0.54 means that a one-standard-deviation increase in rent growth (8%) is associated with a decrease in contract duration of 0.043 years, or 15.8 days. Column (3) includes both price growth and rent growth in the regression to examine the marginal effects of housing price growth and rent growth. We find that the magnitude of the coefficient of price growth decreases only slightly from -0.46 to -0.43 and remains economically large and statistically significant. Similarly, the coefficient of rent growth decreases in magnitude by a small amount from -0.54 to -0.52 and maintains its economic and statistical significance. Overall, these results suggest that local housing price growth and rent growth significantly impact landlords' rental housing supply horizon and that these two effects are largely orthogonal.

As discussed in the model section, one caveat of this analysis is that our sample only includes the landlords who chose to lease their properties through the rental platform, which creates a sampling bias. This bias works against us finding the significant effects we document in Table 3. For example, when selling becomes more attractive after large price growth, landlords who do decide to sell will not to appear in our sample; instead, they may exit the rental market or rent out their properties only for the short-term through the regular rental market. Our sample does not include these landlords, who are by definition most responsive to housing price changes. Therefore, our estimates in Table 3 are likely biased toward zero and should be interpreted as a conservative lower bound of the true effects.

5.2 Robustness

We perform a series of robustness tests and present the results in the Appendix. Our results are robust to various alternative variable constructions, regression specifications, and alternative measures of housing market conditions. We briefly describe the results below.

Alternative variable construction. We change the variable construction methods for price growth and rent growth and present the regression results in Table A.1. In Column (1), we compute the "bedroom-number-adjusted" local price growth for each rental unit by using only transaction prices for the properties that have the same number of bedrooms as the rental unit. In Column (2), we use a six-month rather than a twelve-month look-back window when computing price growth and rent growth. In Column (3), we use a one-kilometer radius instead of two kilometers. In Column (4), we exclude the housing transactions in the same residential community as the rental housing unit when calculating price growth and rent growth, which helps alleviate endogeneity concerns.[20] Our results are robust to all of these alternative methods of variable construction.

Alternative regression specifications. In practice, the PropTech platform offers a

[20]For example, one of these concerns is that the price increase and the contract duration decrease of the unit may be driven by some unknown omitted characteristics of the unit.

menu of duration-rent combinations over which individual landlords and the platform negotiate. This negotiation process simultaneously determines the contract duration and rent. Therefore, rent should naturally hold significant explanatory power for contract duration.[21] In Panel A of Table A.2, we test whether the effects of price growth and rent growth are robust to controlling for rent level and we find the results to be robust despite the coefficients becoming smaller in magnitude.[22] In Panel B of Table A.2, instead of using OLS, we estimate Poisson regressions, which may be more appropriate for modeling discrete outcomes, and find that our results remain consistent and robust.

Within-block variation. In Table A.3, we replace the district fixed effects with more granular block fixed effects. Using only within-block variation, we find that price growth and rent growth remain significant predictors of contract duration. They constitute approximately 47% and 62% of the magnitude of the coefficients, respectively, in Table 3. These estimations help rule out differences across blocks as the only link between price (rent) growth and the rental supply horizon.

Housing market liquidity. Our model yields an additional prediction with respect to housing market liquidity. The profits from selling properties should be greater when the home sale market is more liquid. Thus, when liquidity conditions improve in the housing market, landlords may be more inclined to sell and therefore less willing to provide long-term contracts. We test this channel using the growth in transaction volume (constructed

[21] To illustrate, suppose that all three-year contracts pay a rent of x plus noise, and that all five-year contracts pay a rent of $x + y$ plus noise, where x and y are some constant; then, rent should explain a significant fraction of the variation in contract duration.

[22] A regression that includes rent level as an explanatory variable potentially suffers from a "bad control" problem because the underlying economic forces simultaneously affect both contract duration and rent. Controlling for rent, therefore, would be partly controlling for the very effect we try to measure. For this reason, we do not control for rent in our main specifications but only present it as a robustness test.

analogously to price growth) to proxy for changes in housing market liquidity. We find that housing transaction volume growth significantly and negatively predicts long-term rental supply even after controlling for price growth and rent growth, as shown in Column (1) of Table A.4. This result is consistent with our framework and lends additional support to our main conclusion.

5.3 Causality

To establish causality, we exploit the HPR policy as an exogenous shock to housing market conditions. We expect that the contract duration of nonordinary units should increase relative to the contract duration of ordinary units after the HPR policy because the option to sell a nonordinary unit in the near future has become relatively less valuable. In particular, due to price momentum and extrapolative beliefs, landlords of nonordinary units perceive that selling the property in the near future yields relatively poor payoffs. Thus, of the landlords in our sample (those who have chosen to remain in the rental market), fewer would be planning for a possible home sale in the next period and, therefore, should be more willing to supply longer-duration contracts.[23]

As a first step, we show that the HPR policy significantly impacted the relative pricing of ordinary and nonordinary units. As discussed above, Figure 5 shows that the nonordinary unit discount remains stable at approximately 3% before the HPR policy. This number jumped to above 7% immediately after the HPR policy took effect and then stabilized at

[23] The "direct effect" of the policy is that the price of nonordinary units declined relative to that of ordinary units. Hence, selling them and investing the proceeds into a bond will generate less income than before. This direct effect implies that the overall rental supply should increase but it does not have a clear implication for the horizon of rental supply without making further assumptions, as discussed in Section 3.

approximately 5% until the end of the sample period, suggesting that the policy has a strong adverse effect on the marketability of nonordinary units relative to ordinary units.

Panel A of Table 4 presents the results from our matched DID analysis. We consider three models that include different fixed effects. We find that the coefficients of the interaction term are significantly positive across all specifications: Column (1) shows that the coefficient of PostHPR$\times I$(Nonordinary) is 0.15, which suggests that after the rollout of the HPR policy, newly signed nonordinary units, on average, have a 0.15-year (or 1.8-month) bigger increase in contract duration than their ordinary counterparts do. This effect is quite sizable, potentially because the HPR policy managed to significantly alter landlords' expectations of housing price growth. Column (2) shows that our findings are robust to controlling for time fixed effects. Column (3) shows that after including the full set of control variables and time and district fixed effects, the coefficient of the interaction term shrinks to 0.10 and remains economically and statistically significant.

We conduct a balance test to validate that the nonordinary units are comparable along various dimensions with the matched ordinary units. Panel B of Table 4 reports the results, which show that the two groups are not systematically different, except that the nonordinary units are significantly larger in size (by definition) and are less likely to be rented out as a whole unit (possibly due to their larger size). Although nonordinary units have significantly lower rent spreads and are less likely to provide heating, the differences are small. Overall, the balance test confirms that our DID analysis likely identifies the causal impact of housing market prospects on landlords' choice of rental supply duration.

One may be concerned that the rental contract duration of nonordinary housing units responds to housing price growth differently than that of ordinary units even before the HPR policy; if so, then our results may not reflect the impact of an exogenous shock to housing market conditions. We test the parallel trend assumption by regressing the contract duration on a vector of interaction terms between I(Nonordinary) and semiannual period dummies. Our benchmark period is the semiannual period between October 2016 and March 2017, which is omitted from the regression.

Figure 6 depicts the estimated coefficients of the interaction terms against their corresponding semiannual periods. We see that the coefficients are not significantly different from zero in the pre-HPR period, supporting the parallel trends assumption prior to the HPR policy. After the implementation of the HPR policy in March 2017, however, the coefficients become significantly positive, indicating that landlords of nonordinary housing units increase their contract duration more than those of ordinary housing units do.

To further alleviate the concern that housing units of different sizes are not comparable, we apply a regression discontinuity (RD) approach that exploits the HPR policy cutoff in housing unit size. Because these tests yield the same conclusion as the DID analysis, we report their results in the Appendix for conciseness. Appendix Figure A.1 plots the binned-average contract duration around the 140-square-meter cutoff before and after the HPR policy. Before the policy, we see no apparent difference in contract duration between units that are just above and just below the threshold of 140 square meters. After 2017Q1, a discontinuity emerges at the cutoff, with a significant duration gap of 0.2 years (or 2.4 months). We report the corresponding regression results in Appendix Table A.6, which show that the interaction term PostHPR$\times I$(Nonordinary) is significantly positive. These results further support our hypothesis that housing market conditions causally affect landlords' willingness to supply long-duration rental contracts.

5.4 Heterogeneity and further analysis

5.4.1 Recent and extreme growth

If housing market conditions affect landlords' rental supply horizon through their perception of future returns on selling properties, then theories of extrapolative expectations provide additional predictions on what type of price growth would be more impactful (e.g., Glaeser and Nathanson, 2017, Malmendier and Nagel, 2016, Bordalo et al., 2018, Fuster et al., 2010 and Armona et al., 2019). We test these predictions to determine whether they provide further support for our proposed mechanism.

A common feature shared by extrapolative expectation models is that agents extrapolate more strongly on recent growth than on growth in the more distant past. Thus, we expect housing price growth in the distant past to be less predictive of landlords' contract duration than recent price growth. We test this hypothesis by regressing landlords' contract duration on recent local housing price growth, price growth lagged by 12 months, and price growth by 24 months.

Panel A of Table 5 presents the results. Consistent with the prediction, Column (1) shows that the coefficients of the 12- and 24-month lagged price growth are -0.55 and -0.51, respectively, which are approximately 24% smaller than the coefficient of -0.72 on the most recent price growth. We repeat the same test in Column (2) using rent growth and find a similar pattern. The coefficients of the two lagged values are -0.24 and -0.18, which are much smaller in magnitude than the coefficient of -0.65 on the most recent rent growth. These results continue to hold when both price growth and rent growth are included as explanatory variables, as shown in Column (3), suggesting again that growth extrapolations for price and rent have independent effects on landlords' rental housing supply decisions.

Another salient feature of an extrapolative belief is its convexity. That is, individuals appear to disproportionately extrapolate extreme past growth, potentially due to a representativeness bias (e.g., Bordalo et al., 2019). If this pattern holds in our data, then we expect extreme past growth to disproportionately affect landlords' supply decisions. To test this hypothesis, we include the interactions between past price growth (rent growth) and an indicator denoting whether the growth is in the top cross-sectional quintile. Panel B of Table 5 reports the regression results. Consistent with the convex extrapolation prediction, the coefficients of the interaction terms are significantly negative, meaning that extreme price growth and rent growth both disproportionally reduce landlords' rental housing supply horizon.

5.4.2 Landlord heterogeneity

We further exploit the heterogeneity among landlords to test our main hypothesis. Landlords hold their properties for different reasons. We expect that housing market conditions more strongly affect "speculative" landlords, who hold properties for investment or speculation purposes, than landlords who plan to hold properties for the long term (e.g., for future personal use). We use two landlord characteristics to proxy for the degree of their speculation: (1) the number of rental properties owned and (2) the landlord's age. We expect that landlords with multiple rental properties are more likely to hold these properties for investment or speculative purposes rather than for future personal use. Gargano and Giacoletti (2022) show that older individuals are more likely to rely on rental income and less likely to speculate. Hence, we expect that older landlords are less sensitive to changes in housing market conditions.

We test these hypotheses and report the results in Table 6. Column (1) shows that local housing price growth has a stronger effect on rental supply duration for landlords with multiple rental properties, as indicated by the significantly negative coefficient of -1.02 on the interaction term. The results become even stronger when we simultaneously include housing price growth and rent growth in Column (2). The coefficients of the interaction terms, Price Growth$\times I$(Multiproperty) and Rent Growth$\times I$(Multiproperty) are -1.11 and -0.76, respectively, suggesting again that housing and rental market conditions have independent effects on landlords' rental supply decisions. Columns (3) and (4) show that older landlords are less sensitive to changes in the housing market and rental market conditions when choosing contract duration, as indicated by the significantly positive coefficients of the interaction terms Price Growth$\times I$(Landlord Age) and Rent Growth$\times I$(Landlord Age). Taken together, the results in Table 6 lend additional support to our main hypothesis that housing market conditions affect landlords' rental supply horizon by affecting their expectations of the relative returns between different investment options.

5.4.3 Property heterogeneity

We also explore the role of property-level liquidity. We hypothesize that landlords who hold properties for investment purposes favor more liquid properties. Therefore, the contract duration of more liquid properties should be more sensitive to past housing price growth. Additionally, we test the role of renovation expenses. The hypothesis is that landlords who are willing to pay high renovation costs (indirectly through the rent spread charged by the platform) are more likely to be long-term property holders because interior conditions are barely valued during housing transactions. Thus, landlords with properties that incur high renovation expenses should be less sensitive to housing market conditions. We find results that are consistent with both hypotheses and present them in Appendix Table A.5.

5.5 Landlords' contract renewal rate

Our analysis thus far has focused solely on landlords' rental contract duration as the outcome variable. If our theory is correct, however, then we should also find an effect of housing market conditions on other related outcomes. The first alternative outcome that we examine is landlords' contract renewal with the PropTech platform. If landlords with expiring contracts anticipate a possible sale of their properties, then they may choose not to renew the contract with the platform to retain flexibility.

We test this hypothesis by regressing a renewal indicator on local housing price growth and control variables. Table 7 presents the results from the linear probability models. In Columns (1) and (3), the significantly negative coefficients of -0.26 indicate that a one-standard-deviation increase in local housing price growth (or 18% growth) reduces the likelihood of renewal by 4.68% (= 18×0.26), which is economically sizable compared to the unconditional mean (86%) and standard deviation (35%).

In our framework, rent growth should reduce the rental supply horizon but not induce landlords to exit the rental market. Therefore, rent growth should *not* impact landlords' willingness to renew with the platform. For falsification, we test the relationship between rent growth and the renewal rate and present the results in Column (2). We find that rent growth indeed does not significantly affect landlords' renewal decisions, as the estimated coefficient of rent growth, 0.09, is not significantly different from zero.[24] The coefficient of rent growth remains insignificant in Column (3), where price growth is also included as an explanatory variable.

5.6 Term structure of rents

The next alternative outcome that we examine is rent. If long-term rental supply decreases after a housing market boom, then we expect long-term rent to increase with this drop in supply. Thus, housing price growth should predict an increase in long-term rent relative to short-term rent. As a first step, we test whether the PropTech platform unconditionally rewards landlords for signing long-duration contracts by paying them higher rents, i.e., whether the platform offers an upward-sloping term structure of rents as predicted by the model in Section 3. Panel A of Table 8 shows that the term structure of rents is indeed upward-sloping. Both per-square-meter and monthly rents are significantly and positively

[24] If anything, one would expect that rent growth should increase landlords' willingness to renew. The sign of the estimated coefficient is consistent with this hypothesis.

associated with contract duration.

We then examine how housing price growth affects the term structure of rents and present the results in Panel B of Table 8. The coefficient of interest is that on the interaction term between price growth and the dummy for above-median duration, Price Growth×I(Duration>Median). The results show that the coefficients are positive and statistically significant across all four columns, suggesting that a rise in housing prices is associated with a counterclockwise rotation of the term structure of rent. Rent growth is also associated with a similar counterclockwise rotation of the rent term structure, although this effect is not statistically significant.

In robustness tests, we replace the district fixed effects with more granular block fixed effects. Panel B of Table A.3 shows that the rotational effect of price growth on the term structure of rents remains robust. The coefficient of Rent Growth×I(Duration>Median), however, becomes statistically significant in this specification. This result suggests that part of the district-level variation in rent following high rent growth offset the effect of our proposed mechanism. One possible explanation could be that after observing high rent growth in a residential block, landlords in neighboring blocks are attracted to the platform and start to rent out their properties through it. These landlords demand lower rents for longer-term contracts potentially because they enter the market as low-cost substitutes for the units in the focal block where rent has increased substantially. By focusing on the within-block variation (using block fixed effects), we are able to rule out unobserved mechanisms such as this "spatial substitution effect" and hence uncover the significant association between rent growth and the term structure of rents that our framework predicts.

5.7 Real effect: horizon matching and long-term rental demand

Does landlords' rental supply horizon have economic consequences for renters? In this subsection, we address this question by testing whether rental units with longer supply horizons attract renters with longer demand horizons. In particular, we examine how tenants' initial contract duration, ex-post total duration of stay, and contract renewal rate are associated with the ex-ante availability of the rental unit.

In the first two columns of Table 9, we regress tenants' initial duration on the remaining duration of landlord-platform contract as well as tenant-level characteristics.[25] The coefficients of the remaining duration, 0.62 and 0.57, are positive and significant, indicating a matching effect between tenants' demand horizon and landlords' supply horizon. The economic magnitudes, 0.62 and 0.57, however, are difficult to interpret because of the one-year cap on the tenant-platform contract duration imposed by the platform. In Columns (3) and (4), we replace the dependent variable with tenants' actual length of stay in the unit. The matching effect remains robust and becomes even stronger, with point estimates of 1.32 (without controls) and 1.21 (with controls). Taken together, the results suggest that housing units with longer supply horizons are matched with tenants who stay with the rental platform for longer periods.

Columns (2) and (4) reveal several interesting correlations between tenant duration and their characteristics. The results show that tenants with a shorter commute distance and

[25] As discussed in the Data section, an important institutional detail here is that even if renters plan to live in the same unit for multiple years, they cannot sign multiple-year contracts with the platform directly as it only offers tenants contracts with a duration of up to one year. However, the platform automatically provides priority renewal options to those tenants currently living in the units if these units are available for renewal. Thus, short-term contracts between tenants and landlords do not introduce additional horizon risk beyond that stemming from the landlords' side.

who are older, female, nonlocal, college-educated, and in the IT or finance industry appear to have higher demand for long-term rental housing. Tenants' rent also positively predicts the duration of stay. This evidence elucidates the potential micro-level determinants of the demand for long-term rental housing, which remain largely unknown to the literature and can be fruitful for future research.

In Table 10, we examine the determinants of tenants' renewal decisions, which is another proxy for the demand for long-term rental housing. In particular, we regress the tenant renewal indicator on landlords' remaining duration with the platform as well as past price growth, rent growth, and property- and tenant-level characteristics. The significantly positive coefficients of the remaining duration, 0.01, further suggest that landlords' contract duration has real consequences for tenants' behavior.

We also include price growth and rent growth as explanatory variables in these tests to examine how long-term rental demand may respond to housing market conditions. The significantly positive coefficients of price growth and rent growth in the first two rows in Table 10 suggest that long-term rental demand *increases* after high price growth and rent growth. These results help rule out the alternative explanation that the shortened duration of landlord-platform rental contracts following housing price growth and rent growth may be driven by a decrease in demand for long-term rental housing rather than a decrease in supply. Moreover, these estimates indicate that long-term rental supply tends to fall short precisely when tenants have a higher demand for long-term rental housing, which further elevates the welfare implications of our proposed economic link between housing market conditions and the horizon of rental supply.

6 Conclusion

Horizon risk in renting appears to be a pivotal factor to consider when studying the trade-offs surrounding people's housing decisions. The duration of rental contracts is a key determinant of this risk. We provide the first systematic and plausibly causal evidence on the determinants of landlords' willingness to supply long-term rental contracts. We overcome the empirical challenge of disentangling the supply-side and demand-side factors by utilizing a unique contract-level dataset from a large PropTech rental platform that signs contracts separately with landlords and renters.

We document a robust relationship in which landlords reduce the duration of rental contracts following local housing price growth. We establish causality by exploiting a change in housing market regulations as a quasi-natural experiment. Housing price growth also reduces landlords' likelihood of contract renewal and tilts the term structure of rents counterclockwise. Rent growth has a similar but independent effect on contract duration. These results are consistent with a model in which landlords extrapolate past price (rent) growth to form expectations for the future price (rent) and then evaluate different investment options based on these expectations to choose the optimal rental contract duration. In addition, we explore landlord- and property-level heterogeneity and find results that broadly support the proposed mechanism. We demonstrate the economic relevance of our findings by showing how landlords' contract duration may affect renters' behaviors.

Housing affordability crisis has become a pressing issue in many major cities worldwide, where a large population has to live in rented homes for extended periods of time. Policymakers such as those in the U.K. and China have become increasingly aware of the significant implications of a stable supply of long-term rental housing for social welfare. Our study serves as a useful step toward a better understanding of this supply of long-term rental housing. We believe that the insights gleaned from our findings should be generalizable to rental housing markets globally because the hypotheses we test are derived from widely accepted assumptions in economics and finance, such as the tradeoff between alternative investment opportunities and extrapolative expectations.

The new facts that we document also pave the way for future research to study other potentially interesting questions. For example, can variations in long-term rental supply help explain homeownership rates within and across countries? To what extent do people behave differently when they face different levels of horizon risk? We believe that future investigations that delve deeper into the economics of horizon risk can be fruitful.

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Table 1: Variable Definitions

Variable	Definition
Panel A: Landlord-platform contract characteristics	
Duration	The duration of the landlord-platform contract in years. We round the raw duration to the nearest integer for the less than 1% of contracts with noninteger duration.
Renovation	The total renovation expense spent by the rental platform on the property before leasing to tenants, scaled by the annual rent received by the landlord.
Rent Spread	The difference between the rent paid by the tenant and that received by the landlord, scaled by the rent received by the landlord.
I(Landlord Renewal)	= 1 if the landlord renews the lease with the rental platform when the original lease expires and 0 otherwise.
Panel B: Tenant-platform contract characteristics	
Tenant Initial Duration	The duration of the first rental contract signed by a tenant with the rental platform.
Tenant Total Duration	The total duration of all contracts signed by the tenant with the rental platform for the same housing unit, including all renewals.
Remaining Duration	The remaining duration of the contract between the landlord and the rental platform when the tenant rents the unit.
Tenant Rent	The monthly rent (in thousand RMB) paid by the tenant to the rental platform.
I(Tenant Renewal)	= 1 if the tenant renews with the rental platform for the same housing unit when the original contract expires and 0 otherwise.
Panel C: Housing characteristics	
Size	The property size (in m^2) of the structural area of the rental housing unit.
Property Age	The building age.
Green Ratio	The green plot ratio of the housing complex.
I(1 Bedroom)	= 1 if the housing unit has 1 bedroom and 0 otherwise.
I(3+ Bedrooms)	= 1 if the housing unit has 3 or more bedrooms and 0 otherwise.
I(Whole Unit)	= 1 if the housing unit is rented as a whole unit and 0 otherwise.
I(Elevator)	= 1 if the building of the housing unit has an elevator and 0 otherwise.
I(Heating)	= 1 if the housing unit has public heating service and 0 otherwise.
Panel D: Tenant characteristics	
Commute Distance	The distance (in kilometers) between the housing location and the tenant's work location.
Tenant Age	The age of the tenant in years.
I(Female)	= 1 if the tenant is female and 0 otherwise.
I(Local)	= 1 if the tenant is a Beijing local citizen and 0 otherwise.
I(Bachelor+)	= 1 if the tenant has a bachelor's degree or above and 0 otherwise.
I(IT Industry)	= 1 if the tenant works in the IT industry and 0 otherwise.
I(Finance Industry)	= 1 if the tenant works in the finance industry and 0 otherwise.
Panel E: Housing and rental market conditions	
Price Growth	The percentage change in property price ($P_{i,t}$) relative to the price 12 months ago ($P_{i,t-12}$). The price each month $P_{i,t}$ for each rental unit is calculated as the average per-square-meter price in all housing transactions for properties within a two-kilometer radius in the past 12 months.
Rent Growth	The percentage change in rent ($R_{i,t}$) relative to the rent 12 months ago ($R_{i,t-12}$). The rent each month ($R_{i,t}$) for each rental unit is calculated as the average per-square-meter rent in the deals signed between the platform and landlords within a two-kilometer radius in the past 12 months.
Rent-to-price	The average rent received by the landlords divided by the average home price within the 2-km radius.

Table 2: Descriptive Statistics

Variables	Mean	SD	Min	25^{th}	Median	75^{th}	Max
Panel A: Landlord-platform contract characteristics							
Duration	3.88	1.01	1.00	3.00	4.00	5.00	6.00
I(Landlord Renewal)	0.86	0.35	0.00	1.00	1.00	1.00	1.00
Panel B: Tenant-platform contract characteristics							
Tenant Initial Duration	0.79	0.26	0.25	0.53	0.98	1.00	1.00
Tenant Total Duration	1.04	0.66	0.25	0.53	0.99	1.20	3.34
Remain Duration	3.19	1.38	0.42	2.17	3.17	4.25	5.58
I(Tenant Renewal)	0.30	0.46	0.00	0.00	0.00	1.00	1.00
Panel C: Property characteristics							
Size	72.32	27.72	30.93	53.10	64.43	86.97	158.66
Property Age	16.82	7.47	2.00	11.00	16.00	21.00	38.00
Green Ratio	0.31	0.07	0.10	0.30	0.30	0.35	0.50
I(1 Bedroom)	0.29	0.45	0.00	0.00	0.00	1.00	1.00
I(3+ Bedrooms)	0.22	0.41	0.00	0.00	0.00	0.00	1.00
I(Whole Unit)	0.52	0.50	0.00	0.00	1.00	1.00	1.00
I(Elevator)	0.64	0.48	0.00	0.00	1.00	1.00	1.00
I(Heating)	0.89	0.32	0.00	1.00	1.00	1.00	1.00
Panel D: Tenant characteristics							
Tenant Age	32.92	4.74	25.00	30.00	32.00	35.00	51.00
Commute Distance	8.22	7.86	0.13	1.78	6.16	12.35	39.85
I(Female)	0.48	0.50	0.00	0.00	0.00	1.00	1.00
I(Local)	0.06	0.24	0.00	0.00	0.00	0.00	1.00
I(Bachelor+)	0.50	0.50	0.00	0.00	1.00	1.00	1.00
I(IT Industry)	0.29	0.45	0.00	0.00	0.00	1.00	1.00
I(Finance Industry)	0.13	0.33	0.00	0.00	0.00	0.00	1.00
Panel E: Housing market conditions							
Price Growth	0.13	0.18	−0.08	−0.01	0.06	0.27	0.53
Rent Growth	0.12	0.08	−0.05	0.07	0.11	0.16	0.38

This table reports the summary statistics of our main variables. Panel A summarizes the variables constructed from 92,948 landlord-platform contracts. Panel B summarizes the variables constructed from 177,581 tenant-platform contracts. Panels C and D present the characteristics of rental units and tenants, respectively. Panel E summarizes the local housing price growth and rent growth around the housing unit in each rental transaction. We do not report statistics related to rent levels per the PropTech platform's request.

Table 3: Housing Price Growth and Rental Supply Horizon

Dependent variable: Duration	(1)	(2)	(3)
Price Growth	−0.46***		−0.43***
	(0.14)		(0.15)
Rent Growth		−0.54***	−0.52***
		(0.12)	(0.12)
		(*Control variables*)	
Renovation	1.79***	1.79***	1.79***
	(0.09)	(0.09)	(0.09)
Rent Spread	−0.48***	−0.49***	−0.49***
	(0.06)	(0.06)	(0.06)
log(Size)	0.04	0.04	0.04
	(0.03)	(0.03)	(0.03)
Property Age (in 10 years)	0.06***	0.06***	0.06***
	(0.01)	(0.01)	(0.01)
Green Ratio	−0.12	−0.11	−0.11
	(0.08)	(0.08)	(0.08)
I(1 Bedroom)	−0.14***	−0.14***	−0.14***
	(0.02)	(0.02)	(0.02)
I(3+ Bedrooms)	0.12***	0.12***	0.12***
	(0.02)	(0.02)	(0.02)
I(Whole Unit)	0.03	0.03	0.02
	(0.03)	(0.03)	(0.03)
I(Elevator)	0.00	−0.00	−0.00
	(0.01)	(0.01)	(0.01)
I(Heating)	−0.02	−0.03	−0.03
	(0.02)	(0.02)	(0.02)
District F.E.	Yes	Yes	Yes
Year-month F.E.	Yes	Yes	Yes
N	92,948	92,948	92,948
Adjusted R^2	0.25	0.25	0.25

This table reports the results from regressions in which the dependent variable is the duration of landlord-platform contract. Price Growth (Rent Growth) is the local housing price (rent) growth measured using home purchase (rental) transactions within a two-kilometer neighborhood of a rental unit. Control variables include renovation expenses, rent spread, and other housing characteristics. We include year-month and district fixed effects in all specifications. Standard errors in parentheses are clustered by year-month and residential block. ***, **, and * indicate $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively.

Table 4: HPR Policies and Rental Supply Duration: DID Analysis

Panel A: DID regression results			
Dependent variable: Duration	(1)	(2)	(3)
Post-HPR×I(Nonordinary)	0.15***	0.15***	0.10**
	(0.05)	(0.05)	(0.04)
Post-HPR	0.23***		
	(0.05)		
I(Nonordinary)	−0.01	−0.02	−0.02
	(0.04)	(0.04)	(0.04)
Controls	No	No	Yes
District F.E.	No	No	Yes
Year-month F.E.	No	Yes	Yes
N	6,980	6,980	6,980
Adjusted R^2	0.02	0.04	0.27

Panel B: Balance tests	Nonordinary (N=2,061)	Ordinary (matched sample) (N=4,919)	Diff.
Size	150.05	111.10	38.95***
Price Growth	0.20	0.20	0.00
Rent Growth	0.13	0.13	0.00
Renovation	0.26	0.25	0.01
Rent Spread	0.22	0.23	−0.02**
Property Age	12.60	12.86	−0.26
Green Ratio	0.35	0.34	0.00
I(Whole Unit)	0.03	0.08	−0.06***
I(Elevator)	0.87	0.85	0.02
I(Heating)	0.80	0.84	−0.04*

Panel A reports the results from DID regressions in which the dependent variable is landlords' contract duration with the rental platform. Panel B reports the balance test results. Nonordinary (ordinary) units are the properties with sizes above (below) 140 square meters. The sample includes each of the nonordinary units and all matching ordinary units that are located in the same residential block, have the same number of bedrooms, living rooms, and renovation expenses, and are signed in the same pre- or post-HPR period. Post-HPR equals one if the month is after March 2017 and zero otherwise. Control variables include renovation expenses, rent spread, and housing characteristics (same as in Table 3). We include year-month and district fixed effects. Standard errors are clustered by year-month and residential block. ***, **, and * indicate $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively.

Table 5: Recent and Extreme Growth

Panel A: Lagged housing price growth and rent growth

Dependent variable: Duration	(1)	(2)	(3)
Price Growth	-0.72^{***}	-0.44^{**}	-0.69^{***}
	(0.15)	(0.16)	(0.16)
Price Growth Lagged by 12 Months	-0.55^{***}		-0.52^{***}
	(0.15)		(0.153)
Price Growth Lagged by 24 Months	-0.51^{***}		-0.49^{***}
	(0.14)		(0.14)
Rent Growth	-0.50^{***}	-0.65^{***}	-0.59^{***}
	(0.12)	(0.16)	(0.16)
Rent Growth Lagged by 12 Months		-0.24^{*}	-0.15
		(0.13)	(0.13)
Rent Growth Lagged by 24 Months		-0.18^{**}	-0.12
		(0.08)	(0.08)
Controls	Yes	Yes	Yes
District F.E.	Yes	Yes	Yes
Year-month F.E.	Yes	Yes	Yes
N	84,914	84,914	84,914
Adjusted R^2	0.25	0.25	0.25

(continued)

Panel B: Extreme housing price growth and rent growth

Dependent variable: Duration	(1)	(2)	(3)
Price Growth$\times I$(Price Growth $\in$ Top 20%)	-0.10^{*}		-0.10^{*}
	(0.06)		(0.05)
I(Price Growth $\in$ Top 20%)	0.02		0.02
	(0.02)		(0.02)
Rent Growth$\times I$(Rent Growth $\in$ Top 20%)		-0.50^{**}	-0.50^{**}
		(0.19)	(0.19)
I(Rent Growth $\in$ Top20%)		0.02	0.02
		(0.03)	(0.03)
Price Growth	-0.38^{*}	-0.44^{***}	-0.38^{*}
	(0.20)	(0.14)	(0.20)
Rent Growth	-0.51^{***}	0.02	0.02
	(0.12)	(0.16)	(0.16)
Controls	Yes	Yes	Yes
District F.E.	Yes	Yes	Yes
Year-month F.E.	Yes	Yes	Yes
N	92,948	92,948	92,948
Adjusted R^2	0.25	0.25	0.25

Panel A reports the results from regressions in which the dependent variable is landlords' contract duration and the explanatory variables are price growth, rent growth, and their lagged values. Panel B includes an indicator that equals one if price (rent) growth is in the top cross-sectional quintile and zero otherwise, and its interaction with price (rent) growth. All regressions include the full set of control variables as in the previous tables, district fixed effects and year-month fixed effects. Standard errors in parentheses are clustered by year-month and residential block. ***, **, and * indicate $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively.

Table 6: Heterogeneity Effects on Rental Supply Duration: Landlord Characteristics

Dependent variable: Duration	(1)	(2)	(3)	(4)
I(Multi-property)	-0.46^{***}	-0.34^{***}		
	(0.06)	(0.08)		
Price Growth$\times I$(Multi-property)	-1.02^{***}	-1.11^{***}		
	(0.22)	(0.22)		
Rent Growth$\times I$(Multi-property)		-0.76^{**}		
		(0.32)		
Landlord Age			0.70^{***}	0.52^{***}
			(0.05)	(0.08)
Price Growth$\times$Landlord Age			0.46^{**}	0.57^{***}
			(0.21)	(0.21)
Rent Growth$\times$Landlord Age				1.38^{**}
				(0.53)
Price Growth	-0.02	0.02	-0.64^{***}	-0.70^{***}
	(0.16)	(0.16)	(0.18)	(0.18)
Rent Growth	-0.58^{***}	-0.20	-0.56^{***}	-1.28^{***}
	(0.13)	(0.19)	(0.12)	(0.29)
Controls	Yes	Yes	Yes	Yes
District F.E.	Yes	Yes	Yes	Yes
Year-month F.E.	Yes	Yes	Yes	Yes
N	86,754	86,754	86,754	86,754
Adjusted R^2	0.31	0.31	0.27	0.27

This table reports the results from regressions in which the dependent variable is landlords' contract duration. I(Multi-property) is an indicator that equals one if the landlord has more than one property with the platform. Landlord Age is the age of the landlord, in years, divided by 100. We include year-month and district fixed effects. Standard errors in parentheses are clustered by year-month and residential block. ***, **, and * indicate $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively.

Table 7: Landlords' Contract Renewal Rate

Dependent variable: I(Landlord Renewal)	(1)	(2)	(3)
Price Growth	-0.26^{**}		-0.26^{**}
	(0.11)		(0.11)
Rent Growth		0.09	0.08
		(0.06)	(0.06)
Duration	0.07^{***}	0.07^{***}	0.07^{***}
	(0.01)	(0.01)	(0.01)
Controls	Yes	Yes	Yes
District F.E.	Yes	Yes	Yes
Year-month F.E.	Yes	Yes	Yes
N	13,742	13,742	13,742
Adjusted R^2	0.50	0.50	0.50

This table reports the results from regressions in which the dependent variable is a renewal indicator I(Landlord Renewal) that equals one if the landlord renews the contract with the platform when it expires and zero otherwise. The regressions include the full set of control variables and year-month and district fixed effects. Standard errors in parentheses are clustered by year-month and residential block. ***, **, and * indicate $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively.

Table 8: Term Structure of Rents

Dependent variable:	Rent per m^2		Monthly Rent	
	(1)	(2)	(3)	(4)
Panel A: Term structure of rents				
Duration	1.02***		71.38***	
	(0.20)		(14.28)	
I(Duration=4)		2.37***		157.55***
		(0.51)		(36.46)
I(Duration≥5)		3.49***		233.12***
		(0.33)		(27.32)
N	92,948	92,948	92,948	92,948
Adjusted R^2	0.69	0.69	0.71	0.71
Panel B: Impact of housing price and rent growth				
Price Growth×I(Duration>Median)	2.63**	2.94**	163.30*	185.78*
	(1.18)	(1.26)	(91.65)	(99.97)
Rent Growth×I(Duration>Median)		3.86		279.61
		(3.47)		(279.94)
I(Duration>Median)	1.94***	1.44***	131.89***	96.01**
	(0.25)	(0.55)	(23.47)	(48.46)
N	92,948	92,948	92,948	92,948
Adjusted R^2	0.69	0.69	0.71	0.71
All Panels:				
Controls	Yes	Yes	Yes	Yes
District F.E.	Yes	Yes	Yes	Yes
Year-month F.E.	Yes	Yes	Yes	Yes

This table reports the results from regressions in which the dependent variables are per-square-meter rent and monthly rent. The explanatory variables in Panel A include landlords' contract duration, an indicator that equals one if the duration equals four years, and an indicator that equals one if the duration is above four years. In Panel B, the explanatory variables include an indicator that equals one if the duration is above the cross-sectional median and its interactions with price growth and rent growth. All regressions include the full set of controls, district fixed effects and year-month fixed effects. Standard errors in parentheses are clustered by year-month and residential block. ***, **, and * indicate $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively.

Table 9: Horizon Matching between Tenants and Landlords

Dependent variable:	Tenant Initial Duration		Tenant Total Duration	
	(1)	(2)	(3)	(4)
Remaining Duration	0.62***	0.57***	1.32***	1.21***
	(0.08)	(0.08)	(0.33)	(0.32)
Commute Distance		−0.03***		−0.16***
		(0.01)		(0.03)
Tenant Age		0.09***		0.59***
		(0.02)		(0.08)
I(Female)		0.50***		3.33***
		(0.14)		(0.48)
I(Local)		−1.16***		−2.70***
		(0.27)		(0.64)
I(Bachelor+)		2.50***		10.45***
		(0.25)		(1.32)
I(IT Industry)		2.30***		6.52***
		(0.22)		(0.91)
I(Finance Industry)		1.61***		6.41***
		(0.26)		(1.10)
log(Tenant Rent)		2.79***		7.28***
		(0.37)		(1.12)
Controls	No	Yes	No	Yes
District F.E.	No	Yes	No	Yes
Year-month F.E.	Yes	Yes	Yes	Yes
N	177,581	177,581	177,581	177,581
Adjusted R^2	0.14	0.15	0.17	0.19

This table reports the results from regressions in which the dependent variable is tenants' initial rental duration and total rental duration. The explanatory variables include landlords' remaining contract duration when tenants sign the initial contract. In addition to the property-level control variables, we also control for a set of tenant characteristics: age, gender, education, occupation, rent, and commute distance. We include contract expiration year-month and district fixed effects. Standard errors in parentheses are clustered by year-month and residential block. ***, **, and * indicate $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively. All coefficients and standard errors are multiplied by 100.

Table 10: Tenants' Contract Renewal Rate

Dependent variable: I(Tenant Renewal)	(1)	(2)	(3)
Price Growth	0.16***		0.15***
	(0.05)		(0.05)
Rent Growth		0.19***	0.19***
		(0.03)	(0.03)
Remaining Duration	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)
Tenant Past Duration	0.24***	0.24***	0.24***
	(0.02)	(0.02)	(0.02)
Controls	Yes	Yes	Yes
Block F.E.	Yes	Yes	Yes
Year-month F.E.	Yes	Yes	Yes
N	217,980	217,980	217,980
Adjusted R^2	0.21	0.21	0.21

This table reports the results from regressions in which the dependent variable is a renewal indicator I(Tenant Renewal) that equals one if the tenant renews the contract for the same housing unit with the platform when it expires and zero otherwise. The regressions include the full set of property-level and tenant-level control variables, year-month fixed effects and block fixed effects. Standard errors in parentheses are clustered by year-month and residential block. ***, **, and * indicate $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively.

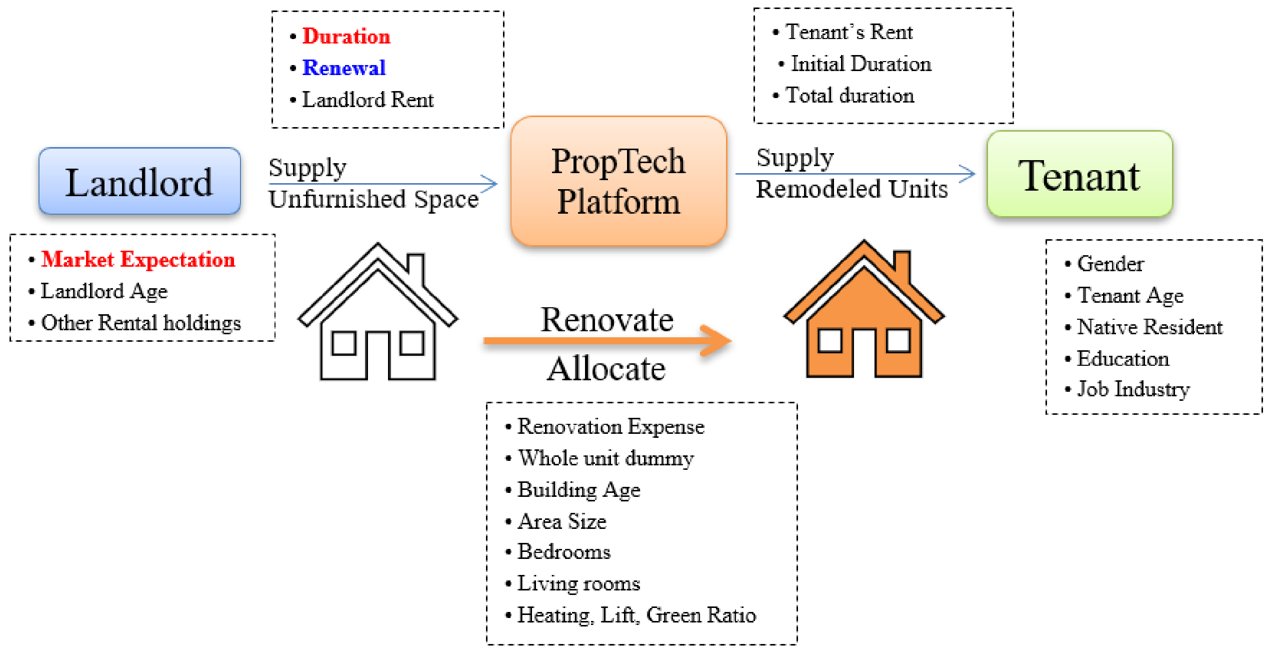


Figure 1
Roles of the PropTech Rental Platform

This figure illustrates the business model of the PropTech platform, which sources rental units from individual landlords, furnishes the units based on standardized templates, and supplies them to tenants through its website and mobile application.

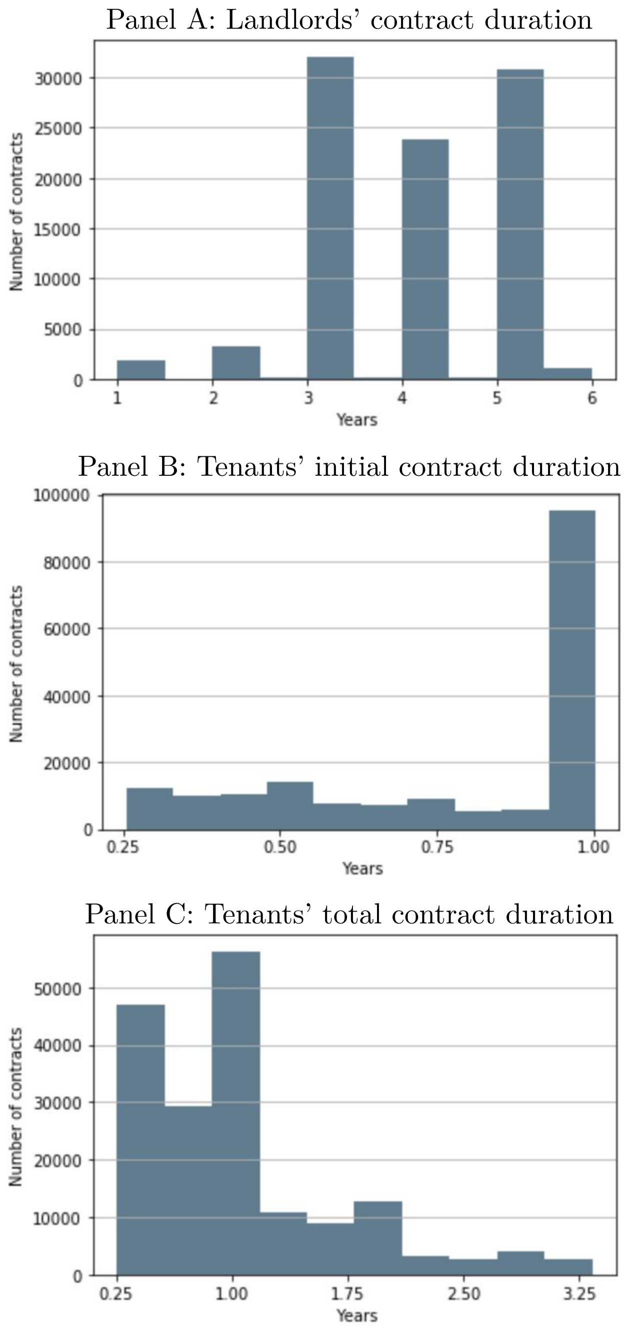
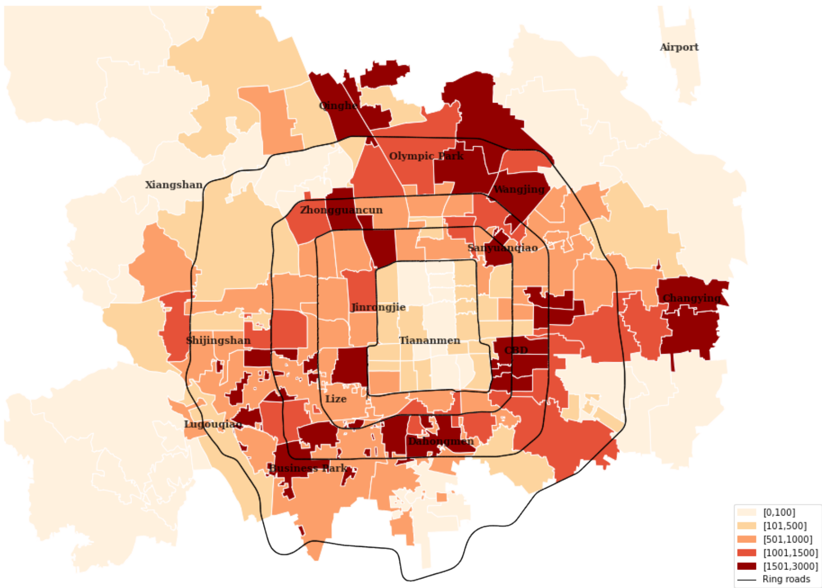
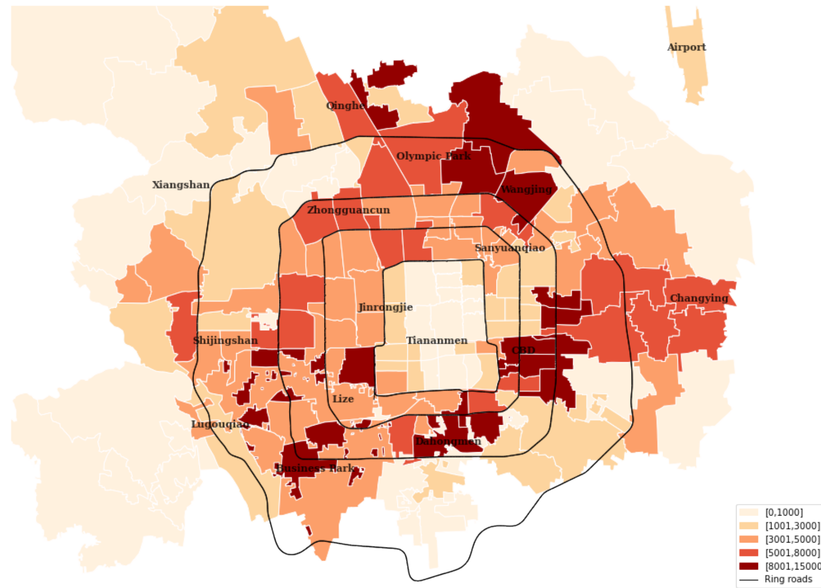


Figure 2
Duration of Rental Contracts

This figure shows the distributions of landlords' contract duration (Panel A), tenants' initial contract duration (Panel B), and tenants' total contract duration (Panel C). The sample contains 92,948 landlord-platform contracts and 177,581 tenant-platform contracts signed between January 2015 and December 2019 in Beijing, China.



Panel A: Rental transactions



Panel B: Home purchase transactions

Figure 3
Spatial Distribution of Rental and Home Purchase Transactions

This figure shows the spatial distribution of our sample transactions between 2015 and 2019 in Beijing, China. Panel A contains 92,948 rental contracts signed between individual landlords and the PropTech platform. Panel B contains 463,590 second-hand home purchase transactions collected from a major real estate broker's website (Lianjia.com).

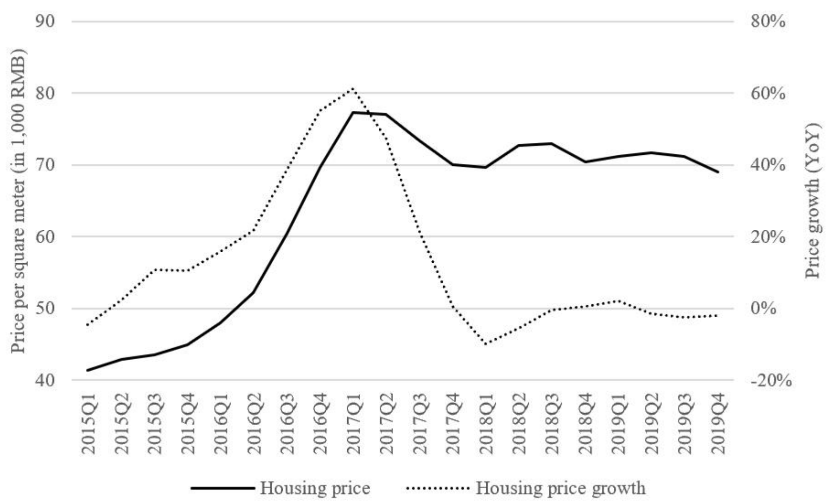


Figure 4
Growth Trends of Housing Prices

This figure shows the quarterly aggregate price trends in the home sale market in Beijing between 2015 and 2019. It displays the average per-square-meter housing price (solid line) and its year-over-year growth (dotted line).

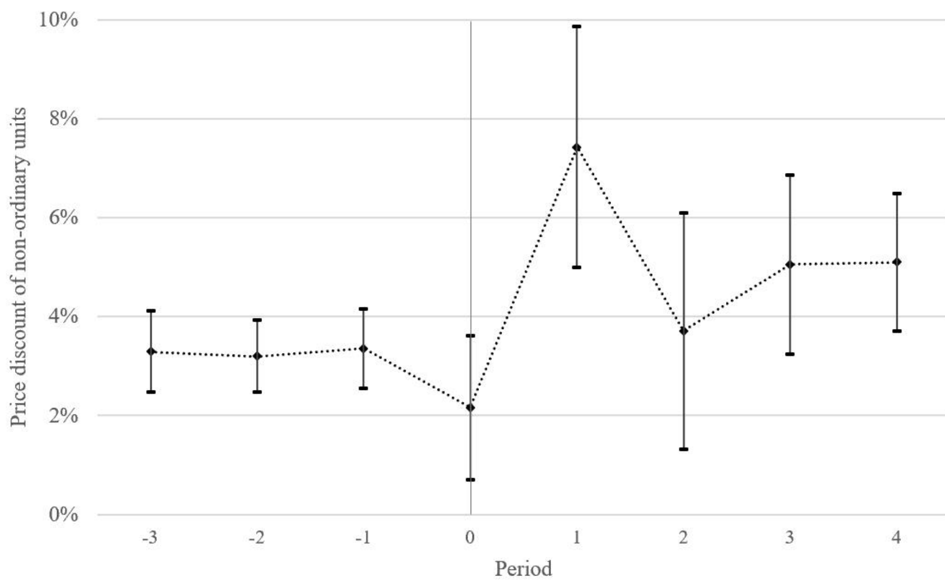


Figure 5
Price Discounts of Nonordinary Units

This figure shows the price discounts of nonordinary units relative to ordinary units by semi-annual periods before and after the HPR policy, which was implemented between October 2016 and March 2017 (Period 0). The discount of a nonordinary unit is equal to the average (per-square-meter) price of the matched ordinary units minus the price of the nonordinary unit, scaled by the average price of the matched ordinary units. Nonordinary (ordinary) units are properties with structural areas above (below) 140 square meters. We match each nonordinary unit with ordinary units that (1) are located in the same residential block, (2) have the same number of bedrooms, living rooms, and renovation status (i.e., none, simple, or premium as labeled on the real estate broker's website), and (3) are signed in the same pre- or post-HPR period. For each nonordinary-unit transaction in month t, we compute its price discount relative to all matched ordinary-unit transactions between months $t-2$ and t. The dotted line indicates the average discount in each period. The solid bars represent the 95% confidence intervals from a t-test against the null that the discount is equal to zero.

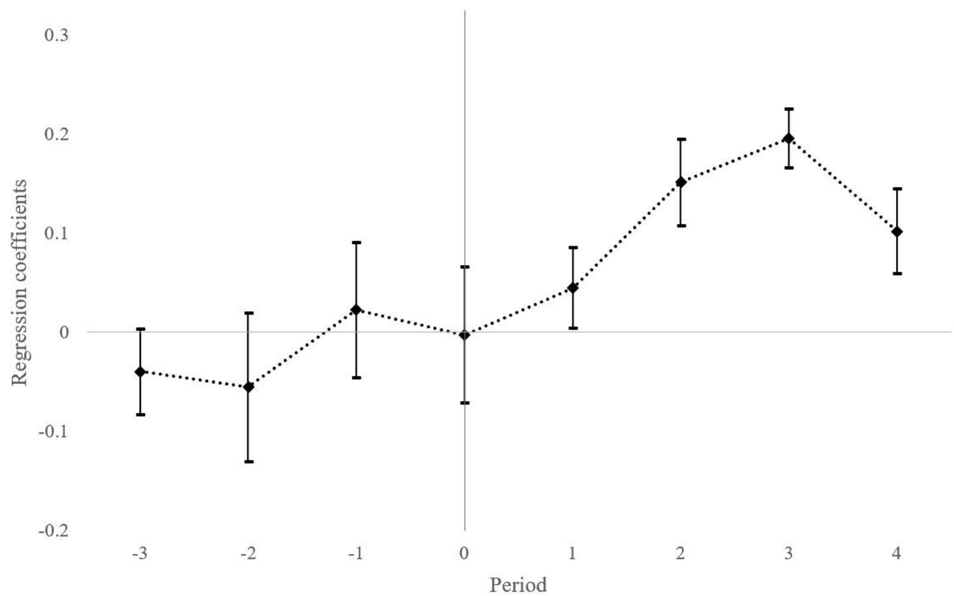


Figure 6
Pre-trend Analysis

This figure shows the regression coefficients of the interaction terms between semiannual period dummies and the nonordinary unit dummy, where the dependent variable is landlord-platform contract duration. Our sample covers the semiannual period before and after the HPR policy, which was implemented between October 2016 and March 2017 (Period 0). Nonordinary (ordinary) units are properties with structural areas above (below) 140 square meters. We match each nonordinary unit with ordinary units that (1) are located in the same residential block, (2) have the same number of bedrooms, living rooms, and renovation expenses, and (3) are signed in the same pre- or post-HPR period. The 95% confidence interval is computed with standard errors double-clustered by time and block.

Appendix

Table A.1: Alternative Variable Construction

Dependent var: Duration	Room-adjusted (1)	6-month look-back (2)	1-km radius (3)	Exclude own block (4)
Price Growth	-0.40^{***}	-0.26^{**}	-0.29^{***}	-0.35^{**}
	(0.14)	(0.11)	(0.10)	(0.14)
Rent Growth	-0.23^{***}	-0.29^{**}	-0.24^{***}	-0.36^{**}
	(0.07)	(0.11)	(0.06)	(0.14)
Controls	Yes	Yes	Yes	Yes
District F.E.	Yes	Yes	Yes	Yes
Year-month F.E.	Yes	Yes	Yes	Yes
N	92,744	92,940	92,143	80,801
Adjusted R^2	0.25	0.25	0.25	0.25

This table repeats the regression results in Column (3) of Table 3 with alternative variable definitions. In Column (1), we measure the price growth and rent growth using transactions of units that have the same number of bedrooms as the rental unit instead of using all transactions. In Column (2), we measure price growth and rent growth using transactions within a six-month look-back window. In Column (3), we measure price growth and rent growth using transactions within a one-kilometer radius instead of a two-kilometer radius. In Column (4), we measure price growth and rent growth using transactions excluding the samples in the block of the subject rental property. Standard errors in parentheses are clustered by year-month and residential block. ***, **, and * indicate $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively.

Table A.2: Alternative Regression Specifications

Panel A: Include rent as control variable			
Dependent variable: Duration	(1)	(2)	(3)
Price Growth	-0.35^{***}		-0.32^{***}
	(0.10)		(0.11)
Rent Growth		-0.52^{***}	-0.51^{***}
		(0.10)	(0.09)
Controls	Yes	Yes	Yes
Block F.E.	Yes	Yes	Yes
Year-month F.E.	Yes	Yes	Yes
N	92,948	92,948	92,948
Adjusted R^2	0.25	0.25	0.25

Panel B: Results of Poisson regressions			
Dependent variable: Duration	(1)	(2)	(3)
Price Growth	-0.13^{***}		-0.12^{***}
	(0.04)		(0.04)
Rent Growth		-0.15^{***}	-0.14^{***}
		(0.03)	(0.03)
Controls	Yes	Yes	Yes
Block F.E.	Yes	Yes	Yes
Year-month F.E.	Yes	Yes	Yes
N	92,948	92,948	92,948

This table repeats the analysis in Table 3 with alternative regression specifications. In Panel A, we include rent per square meter as an additional control variable. In Panel B, we estimate coefficients using Poisson regression instead of OLS. Standard errors in parentheses are clustered by year-month and residential block. ***, **, and * indicate $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively.

Table A.3: Regressions with Block Fixed Effects

Panel A: Contract duration			
Dependent variable: Duration	(1)	(2)	(3)
Price Growth	-0.22^{***}		-0.20^{**}
	(0.09)		(0.09)
Rent Growth		-0.33^{***}	-0.32^{***}
		(0.06)	(0.06)
Controls	Yes	Yes	Yes
Block F.E.	Yes	Yes	Yes
Year-month F.E.	Yes	Yes	Yes
N	92,948	92,948	92,948
Adjusted R^2	0.28	0.28	0.28

Panel B: Term structure of rent			
Dependent Variable: Rent per m^2	(1)	(2)	(3)
Price Growth$\times I$(Duration>Median)	0.95^{***}		1.23^{***}
	(0.30)		(0.30)
Rent Growth$\times I$(Duration>Median)		2.69^{***}	3.45^{***}
		(0.84)	(0.86)
I(Duration>Median)	2.32^{***}	2.15^{***}	1.88^{***}
	(0.08)	(0.11)	(0.13)
Controls	Yes	Yes	Yes
Block F.E.	Yes	Yes	Yes
Year-month F.E.	Yes	Yes	Yes
N	92,948	92,948	92,948
Adjusted R^2	0.89	0.89	0.89

This table repeats the analysis in Table 3 in Panel A and the analysis of Table 8 in Panel B. We include block fixed effects instead of district fixed effects in these regressions. We exclude property age, I(Elevator), I(Heating), and green plot ratio from control variables because they have little variation within blocks. Standard errors in parentheses are clustered by year-month and residential block. ***, **, and * indicate $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively.

Table A.4: Effects of Volume Growth

Dependent Variable:	Duration (1)	Rent per m^2 (2)
Volume Growth	-0.17^{***}	-17.98^{***}
	(0.04)	(2.22)
Price Growth	-0.57^{***}	-44.07^{***}
	(0.15)	(8.35)
Rent Growth	-0.47^{***}	2.01
	(0.12)	(6.35)
Volume Growth$\times I$(Duration>Median)		1.16^{**}
		(0.49)
Price Growth$\times I$(Duration>Median)		4.22^{***}
		(1.42)
Rent Growth$\times I$(Duration>Median)		0.01
		(3.72)
I(Duration>median)		1.69^{***}
		(0.54)
Controls	Yes	Yes
District F.E.	Yes	Yes
Year-month F.E.	Yes	Yes
N	92,948	92,948
Adjusted R^2	0.25	0.69

This table investigates the effects of volume growth. In Column (1), we include volume growth as an independent variable to the regression in Column (3) of Table 3. In Column (2), we include volume growth and its interaction terms with I(Duration>Median) as independent variables to the regression in Column (2) of Panel B in Table 8. We also include volume growth as an explanatory variable. We compute volume growth as the percentage change in the total number of second-hand housing transactions within a two-kilometer neighborhood in the past 12 months relative to this value computed 12 months ago. Standard errors in parentheses are clustered by year-month and residential block. ***, **, and * indicate $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively.

Table A.5: Heterogeneity Effects on Rental Supply Duration: Property Characteristics

Dependent Variable: Duration	(1)	(2)	(3)
Price Growth×I(3+ Bedrooms)	0.46***		
	(0.10)		
Rent Growth×I(3+ Bedrooms)	0.63***		
	(0.18)		
Price Growth×I(Whole Unit)		−0.34**	
		(0.14)	
Rent Growth×I(Whole Unit)		−0.55*	
		(0.30)	
Price Growth×Renovation			1.72***
			(0.31)
Rent Growth×Renovation			0.28
			(0.71)
Price Growth	−0.53***	−0.27*	−1.06***
	(0.15)	(0.15)	(0.21)
Rent Growth	−0.66***	−0.28	−0.71***
	(0.13)	(0.17)	(0.24)
Controls	Yes	Yes	Yes
District F.E.	Yes	Yes	Yes
Year-month F.E.	Yes	Yes	Yes
N	92,948	92,948	92,948
Adjusted R^2	0.25	0.25	0.26

This table reports the regression results where the dependent variable is landlords' contract duration. Independent variables include a 3-bedroom indicator, a whole-unit-rental indicator, and renovation expense and their interactions with price growth and rent growth. We include the full set of control variables and year-month and district fixed effects. Standard errors in parentheses are clustered by year-month and residential block. ***, **, and * indicate $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively.

Table A.6: HPR Policies and Contract Duration: RD Analysis

	MSE-optimal bandwidth ($4.13m^2$)		CER-optimal bandwidth ($2.17m^2$)	
Dependent Variable: Duration	(1)	(2)	(3)	(4)
Post-HPR×I(Nonordinary)	0.22***	0.20**	0.31**	0.27**
	(0.08)	(0.08)	(0.12)	(0.12)
I(Nonordinary)	−0.08	−0.06	−0.09	−0.10
	(0.07)	(0.11)	(0.10)	(0.15)
Controls	No	Yes	No	Yes
District F.E.	No	Yes	No	Yes
Year-month F.E.	Yes	Yes	Yes	Yes
N	1,403	1,403	903	903
Adjusted R^2	0.06	0.27	0.09	0.28

This table reports the results from a regression discontinuity design, where the dependent variable is the landlords' contract duration. We restrict our sample to contracts signed between 2015Q2 and 2019Q1, with sizes between 125 and 155 square meters. Following Calonico et al. (2019), we use MSE- and CER-optimal bandwidths. The sample includes each of the nonordinary units and all matching ordinary units that satisfy three requirements: (1) are located in the same residential block; (2) have the same number of bedrooms, living rooms, and renovation expenses; and (3) are signed in the same pre- or post-HPR period. Post-HPR equals one if the month is after March 2017 and zero otherwise. Control variables include renovation expenses, rent spread, and housing characteristics. We include year-month and district fixed effects. Standard errors in parentheses are clustered by year-month and residential block. ***, **, and * indicate $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively.

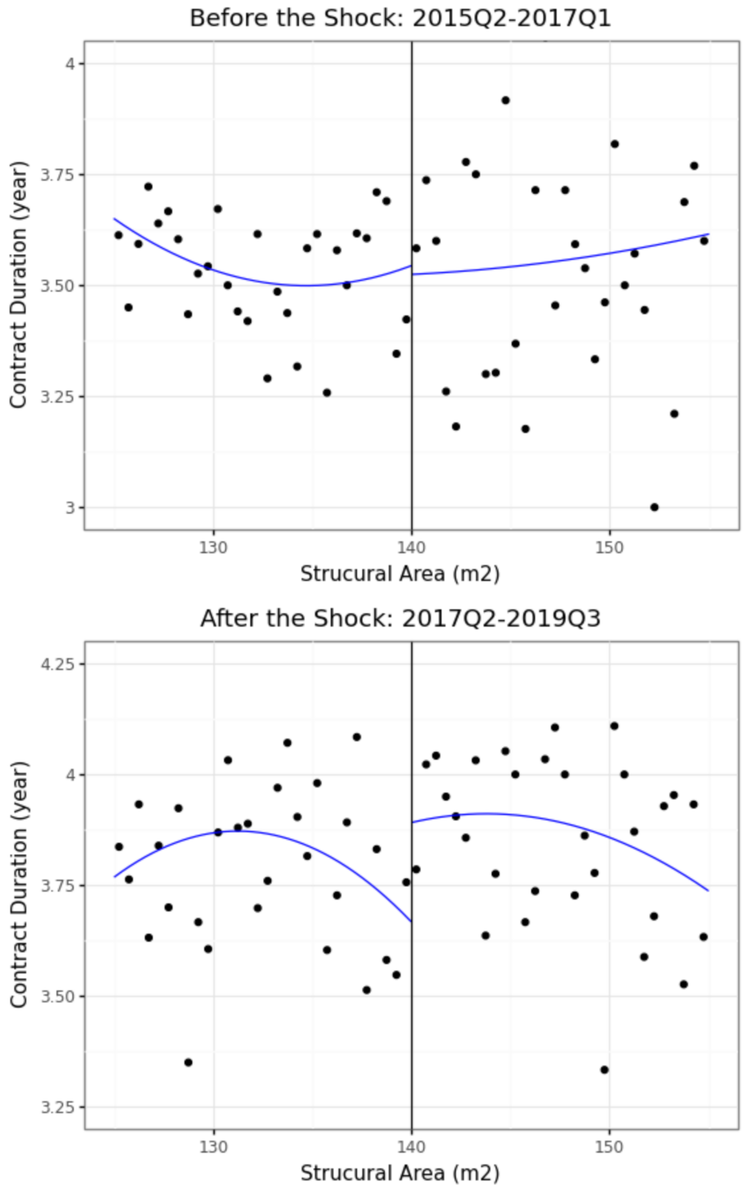


Figure A.1
Regression Discontinuity Analysis around HPR Policy Shock

This figure shows the average duration of landlord-platform contracts around the HPR policy cutoff of 140 square meters. The sample period in the upper (lower) panel is between 2015Q2 and 2017Q1 (between 2017Q2 and 2019Q3), i.e., before (after) the HPR policy. We restrict the sample to those rental units with sizes between 125 and 155 square meters. We select the number of bins using the mimicking variance evenly spaced method and the spacing estimators as in Calonico et al. (2015). We use a second-order global polynomial to approximate the population conditional mean functions.