ISSN: 1648-715X / eISSN: 1648-9179

VILNIUS TECH
Vilnius Gediminas Technical University

INTERNATIONAL JOURNAL OF STRATEGIC PROPERTY MANAGEMENT

2026
Volume 30
Issue 1
Pages 1–15
https://doi.org/10.3846/ijspm.2026.25135

# MARKET EFFECTS OF GOVERNMENT REFERENCE PRICE FOR RESALE HOUSING TRANSACTIONS

Yanjiang ZHANG[1,2], Danni XING[2], Xiaofen YU[1,2*], Xiao YU[2]

[1] *Chinese Academy of Housing and Real Estate, Zhejiang University of Technology, Hangzhou, China*
[2] *School of Management, Zhejiang University of Technology, Hangzhou, China*

**Article History:**
- received 21 January 2025
- accepted 22 July 2025

**Abstract.** This paper investigates the market effects of a reference price policy (the RP policy, hereafter) for resale housing of selected residential projects in Shenzhen, China. The RP policy sets ONE reference price per square meter for each regulated residential project, and requires housing listing prices as well as banks' valuation in mortgage lending to be below the reference price, but it does not limit transaction prices. Using housing listing, transaction, and rental data, we have two findings. First, the policy lowers the probability of transaction in the regulated projects, which prolongs home sellers' time on the market; the deeper the reference price is below the would-be listing price of a residential project, the more substantial the probability of transaction is reduced. But we do not find evidence that it significantly reduces housing transaction prices. Second, the RP policy induces more homes in regulated projects to be leased out and reduces housing rents. We explain the two findings as the outcome of home buyers' and sellers' reference-dependent and regret-avoidant behaviors. Additionally, we discuss the spillover of the policy effects from regulated to unregulated projects, as well as the possible confounding effect of the RP policy' role as finance constraint for buyers.

**Keywords:** reference price, behavior, reference dependence, regret avoidance, market liquidity.

**Online supplementary material:** Supporting information for this paper is available as online supplementary material at https://doi.org/10.3846/ijspm.2026.25135

*Corresponding author. E-mail: *yxf@zjut.edu.cn*

## 1. Introduction

Reference price is widely used by market players and governments to intervene in prices through influencing sellers and buyers' behaviors. It appears in various forms and thus operates through different mechanisms. While numerous studies have investigated the impact of reference prices on consumption goods market, its effects on asset market are insufficiently understood.

It is common for manufacturers to set non-binding suggested retail prices (SRPs) as reference points to influence consumer perception and guide retailer pricing. The mechanism is that transaction probability drops substantially if the retail price of a product is set above the reference price, because consumers show reference-dependent demand pattern (De los Santos et al., 2018; Fabrizi et al., 2016; Puppe & Rosenkranz, 2011). SRPs may also serve as a signal of production costs, helping reduce information asymmetry and promote more efficient transactions (Buehler & Gärtner, 2013; Lubensky, 2017).

Governments also implement reference prices, either intentionally or unintentionally, to intervene in markets. For example, in Wellington, New Zealand, the release of housing valuation data, which was estimated for property taxation, unintentionally served as reference prices for buyers and sellers and significantly influenced the actual property transaction prices (Levy et al., 2016). In Shenzhen China, the local government set and released reference prices (in price per square meter) for selected residential projects (the RP policy, hereafter), requiring that listing prices above the reference prices were not allowed to be listed by any real estate brokers (refer to Section 2.1 for details of the policy). Arestis et al. (2023) find that the RP policy in Shenzhen acted as a negative demand shock, thus reduced transaction volume and transaction prices. Reference price policies extend beyond the housing market to industries with strong public service functions and natural monopolies, such as pharmaceuticals, railways, and electricity. Numerous studies on drug pricing demonstrate that reference prices tend to lower transaction prices (Brekke et al., 2011; Kaiser et al., 2014). The underlying mechanism involves that reference prices enhance competition in the pharmaceutical market and increase consumer price sensitivity (which further intensifies competition), thereby leading to a reduction in equilibrium prices. Higher-priced drugs are frequently substituted by

Copyright © 2026 The Author(s). Published by Vilnius Gediminas Technical University

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (*http://creativecommons.org/licenses/by/4.0/*), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

lower-priced and homogeneous alternatives (Brekke et al., 2011; Podnar et al., 2007).

Housing is an important asset whose market is characterized by high information asymmetry, low liquidity and thus low information efficiency, which makes its functioning substantially different from consumption goods market and other asset markets. For example, in a housing market, government's reference prices are the only prevalent pricing information which we expect to be more influential to buyers and sellers' reservation prices (Garmaise & Moskowitz, 2004; Levy et al., 2016). In addition, for a housing market, we can easily obtain individual housing listing (for sale) records, transaction contracts, and rental contracts, which facilitates us to identify the impacts of government's reference prices on buyers and sellers' behaviors separately. Therefore, we would like to investigate how the RP policy in Shenzhen reduce housing market liquidity (the illiquidity effect, hereafter) as well as reveal how housing buyers and sellers' behaviors contribute to this effect.

The Shenzhen government carried out the RP policy on February 8, 2021, to curb housing speculation, increase information transparency, and put the market participants' behaviors back in order. This policy was followed by several major cities such as Ningbo, Chengdu, Dongguan, Hefei, Jinhua, Wuxi, Xi'an, and Guangzhou in China. The Shenzhen government selected part of residential projects citywide (the regulated projects, hereafter), set ONE reference price (in Yuan per square meter) for ONE regulated project, and required that resale listing price of any housing unit in a regulated project should not exceed the reference price for the project (the reference price role, hereafter). In addition, banks are also required to apply the reference prices for property valuation for mortgage lending (the finance constraint role, hereafter). It's worth noting that the RP policy doesn't impose restrictions on transaction prices. We try splitting the reference price role of the RP policy from its finance constraint role, and investigate how buyers and sellers' behavioral anomalies in response to the reference price role cause market illiquidity. Specifically, we would like to ask several research questions. First, how does the RP policy affect housing selling probability, transaction volume and transaction prices (the illiquidity effect, hereafter)? How can behavioral anomaly, which is a combination of reference-dependence and regret-avoidance, of housing buyers and sellers explain the illiquidity effect? Second, will the illiquidity effect spill over to the rental housing market, i.e., sellers hold and lease out their housing in face with the illiquidity effect (the rental effect, hereafter)? Third, will the policy effect spillover from regulated projects to unregulated projects (the spillover effect, hereafter)? Applying several datasets including housing listing, transaction and rental records from January 2019 to December 2022, we have the following findings.

First, in terms of the illiquidity effect, we employ a Cox proportional hazards model to examine changes in housing transaction probability. We find that before the RP policy, the selling probability of regulated projects is significantly higher than unregulated projects; however, after the policy is implemented, the regulated projects' selling probability significantly declines relative to the unregulated projects. The deeper the reference price is below the would-be listing price of a residential project (listing price discrepancy, hereafter), the more substantial the decline is. Then we employ a regression discontinuity in time (RDiT) model to provide more evidence for the illiquidity effect. We find no evidence that the RP policy significantly reduces housing transaction prices, but a decrease in transaction volumes is observed. Second, we demonstrate that the illiquidity effect forces sellers to lease out their homes. We find that the RP policy induces more regulated housing to be leased out and reduces housing rents. Third, we obtain some suggestive evidence for spillover effects of the policy. The policy's impact on listing prices extends to unregulated projects, leading to a significant decrease in their listing prices too. We also observe that the illiquidity effect spills over to unregulated projects, where transaction probabilities decrease, transaction prices remain stable, and transaction volumes fall. Finally, we discuss the possibility that RP policy's finance constraint role might serve as a confounding factor that drives the illiquidity effect. The results indicate that this concern should not pose a significant threat to the findings.

This paper adds to the understandings about how reference price works in an asset market with low information efficiency from two aspects. As the first aspect, it provides empirical evidence on the role of buyers' behavioral anomalies in face of reference prices. Most existing studies explain the positive correlation between price and transaction volume in housing markets as the outcome of housing sellers' reference-dependence and loss aversion (Andersen et al., 2022; Zhou et al., 2021), while the housing buyers' behavioral anomalies are insufficiently investigated. Some existing papers use data collected from behavioral experiments and demonstrate that both housing buyers and sellers uses past transaction prices as reference points (Bao & Saunders, 2023; Paraschiv & Chenavaz, 2011). As suggested by Bao and Saunders (2023), more empirical evidence using actual housing transaction data is needed, given too few discussions on reference dependence of housing investors. In our paper, we reveal that the RP policy in Shenzhen reduced the market liquidity but without reducing transaction prices, which indirectly evidences that the RP policy changed buyers' reference prices differently from that of sellers, thus narrowing down the overlapping region between buyers' and sellers' reservation prices and lowers the probability of transactions.

As the second aspect, the paper provides empirical evidence about the spillover effects of the reference prices in a housing market. We demonstrate that the illiquidity effect of the reference prices may spillover from regulated projects to the non-regulated projects. In addition, the illiquidity effect indirectly forced home sellers to lease out their properties and thus reduced housing rents, which is consistent with findings by Zhang et al. (2024). These spillover effects, either intended or unintended, are widely observed in the impacts of more directly price control policies such as housing rent controls (Autor et al., 2014; Mense et al., 2023) and drug price ceilings (Li & Wu, 2022).

It also contributes to the literature on investors' reference price formation. Two papers have used evidence from controlled behavioral experiments to investigate the reference point formation of investors (Baucells et al., 2011; Paraschiv & Chenavaz, 2011). Baucells et al. (2011) conclude that reference price is best described as a combination of the first and the last price of the time series, and intermediate prices play a substantially smaller role. Paraschiv and Chenavaz (2011) investigate the formation of housing sellers' and housing buyers' reference prices separately. They find that the seller's reference price largely depends on market evolution, and the buyer's reference price could be influenced by information manipulation. Our findings are consistent with the conclusion of Paraschiv and Chenavaz (2011), and we find that the government-set reference prices lower buyers' reference prices more than that of sellers.

In addition, it is also related to the studies on housing listing strategy. For sellers, a decision on listing price is the trade-off between transaction price and time on market; and for buyers, listing prices signal sellers' motivation to sell and also unobserved factors about the listed houses (Anderson et al., 2014; Anglin et al., 2003; Haurin et al., 2010). This study provides a new scenario where housing listing prices are capped, and thus the role of listing prices in a housing market is substantially changed. For example, our evidence on spillover of listing price changes to the unregulated projects suggest that the listing prices are more used as a tool to attract potential buyers' visits.

The paper proceeds as follows. Section 2 provides the institutional background of the RP policy and raises our research propositions; Section 3 describes the methodology, including data, variables and research design; Section 4 presents the empirical results; and Section 5 concludes.

## 2. Background and research propositions

### 2.1. Institutional background

During the housing booming period between 2016 and 2022 in China, speculation and irregular market practices were prevalent in resale housing segment in major cities. For example, homeowners within a same residential project colluded against potential buyers by listing and asking extraordinarily high prices[1]. These activities tended to happen during the market booming period and destabilized the whole housing market, given that scale of resale housing segment in terms of transaction volume has been larger than new sale housing segment in China's major cities since 2023[2]. To curb housing speculation, increase information transparency, and put the market participants' behaviors back in order, Shenzhen carried out the RP policy on February 8, 2021, which was followed by several major cities including Ningbo, Chengdu, Dongguan, Hefei, Jinhua, Wuxi, Xi'an, and Guangzhou.

The Shenzhen government set reference prices (in price per square meter) for 3,595 out of 5,700[3] residential projects citywide, with ONE unique reference price for ONE residential project, and most of the reference prices were lower than the market listing prices, as shown in Table A1 in Appendix. The reference price acted as a ceiling for housing listing prices within a regulated residential project, listing prices above the reference price were not allowed to be posted by any real estate brokers; it also served as the ceiling for property valuation in mortgage lending, and banks were required by the government to employ the reference prices as ceilings for housing valuation[4].

The government determined the reference price of a residential project based on the project's housing transaction prices registered to the government system (hereafter, the registered transaction prices)[5] over the past year before the RP policy was implemented. The reference prices were never adjusted until when the RP policy was abandoned, which means the reference prices were fixed regardless of changes in market price or registered transaction prices during the research period.

Both buyers and sellers of resale homes have the incentive to report the registered transaction prices lower than actual transaction prices. Agarwal et al. (2020) find that the actual transaction prices of resale homes in major cities in China are 23.3% higher than the registered transaction prices. Thus, the reference prices of most residential projects also fell below their market listing prices and actual transaction prices. We also observe that discrepancy between reference prices and market listing prices (listing price discrepancy, hereafter) varied across different regulated projects. We take the difference in listing price discrepancy across projects as random, as it was mainly caused by how much the home traders decided to lower their registered transactions prices relative to actual transaction prices in the previous year (the registered transaction prices serve as the basis for government to construct reference prices).

The RP policy in Shenzhen has triggered heated debates, with critics asserting that it reduces price efficiency[6]. Policymakers had clarified that the RP policy remained in place[7] until April 2023, and the reference prices were not

[1] Refer to URL: https://www.chinacourt.org/article/detail/2021/04/id/5978427.shtml, accessed on June 3th, 2024.

[2] Refer to URL: https://www.stats.gov.cn/sj/sjjd/202401/t20240117_1946664.html, accessed on Nov 5th, 2024.

[3] This figure is an estimate, combining the official list of regulated projects and the housing records from the largest real estate brokerage firm in China.

[4] Refer to URL: https://www.southcn.com/node_f0c8f19014/42c9a6b20f.shtml, accessed on June 3th, 2024.

[5] Refer to URL: https://weibo.com/ttarticle/p/show?id=230940603123481313526, accessed on May 27th, 2024.

[6] Refer to URL: https://finance.sina.cn/2021-02-21/detail-ikftpnny8944157.d.html?from=wap, accessed on May 23th, 2024.

[7] Refer to URL: https://baijiahao.baidu.com/s?id=1728630264253442225&wfr=spider&for=pc, accessed on May 23th, 2024.

revised throughout the period. Banks started to abandon reference prices as the basis for property valuation since April 20, 2023[8]. On May 6, 2024, as disclosed by a leading real estate agency in Shenzhen, houses above the reference prices were permitted to be listed, which means the reference price policy was removed[9]. We employ the study period between January 2019 and December 2022, with a stable policy and market environment throughout.

## 2.2. Research propositions

Section 2.1 briefly describes the RP policy and how it works. In the following discussion, we elaborate its effects on housing trading and rental behaviors as our research propositions. It is important to note that, the paper will focus on the RP policy's role as a non-binding reference price. The RP policy's another role, which is a fixed ceiling for property valuation in banks' mortgage lending (hereafter, the finance constraint role), may act as a negative demand shock to the regulated projects, and could be a confounding factor. We will try to remove the cofounding effect in empirical design and discuss them in Section 4.3.

### The illiquidity effect

Behavioral economics provides a valuable framework for understanding how market participants form price expectations and make trading decisions. Two well-established behavioural patterns, reference dependence (Kőszegi & Rabin, 2006; Tversky & Kahneman, 1991) and regret avoidance (Loomes & Sugden, 1982), have been widely used to explain anomalies in asset pricing.

A growing literature also shows that buyers and sellers in housing markets exhibit these behavioural patterns (Andersen et al., 2022; Bao & Saunders, 2023; Fioretti et al., 2022; Paraschiv & Chenavaz, 2011; Strack & Viefers, 2019; Zhou et al., 2021). The RP policy introduced an exogenous price anchor that may have asymmetrically shaped buyer and seller behaviours. Sellers tend to anchor their expectations to past market highs or their own purchase prices (Genesove & Mayer, 2001), making them reluctant to lower asking prices. This hesitation often stems from a desire to avoid the psychological loss and anticipated regret associated with selling below a perceived fair value (Guo, 2023). In contrast, buyers, uncertain about whether they are overpaying, are more likely to adopt the official reference price as a credible benchmark and lower their willingness to pay. Moreover, under limited information and cognitive constraints, market participants often rely on pricing heuristics (Barberis & Thaler, 2003), which further exacerbates asymmetry in price expectations and raises negotiation frictions.

Building on this behavioural foundation, we draw from housing search theory to explain how the RP policy may affect market liquidity. According to this theory, transactions occur only within the overlapping region between the distributions of buyers' and sellers' reservation prices (Genesove & Han, 2012; Han & Strange, 2015; Kopczuk & Munroe, 2015; Slemrod et al., 2017). The RP policy narrows this overlapping region by anchoring buyers to lower valuations while sellers remain committed to higher pre-policy prices, thereby reducing the probability of matching. Based on the discussion above, we propose our first research proposition:

Proposition A: *the illiquidity effect*

*The RP policy may reduce probability of transaction and prolong listed homes' time on market in the regulated projects*;

*and the deeper the listing price discrepancy is*, *the larger the illiquidity effect will be*.

### The rental effect

Landlords adjust between selling, renting, and holding properties in response to changing market conditions (Cook et al., 2024). When housing prices reach a peak, they tend to sell to realize capital gains. Conversely, when market conditions deteriorate or price expectations are constrained, they are more likely to rent out properties to avoid losses associated with below-market sales while anticipating a recovery in housing prices (Demers & Eisfeldt, 2022; Desmond & Wilmers, 2019; Zhang et al., 2024). This tendency becomes more pronounced when there is a substantial discrepancy between expected and achievable prices, or when properties are likely to remain on the market for a long period.

The RP policy introduces a reference pricing mechanism that imposes an upper bound on listing prices. This constraint reduces flexibility for price negotiation, disrupts expectations for both buyers and sellers, and enlarges the gap between sellers' asking price and buyers' willingness to pay. Sellers may be deterred by prolonged listing periods and reduced negotiation margins. In response, they are more likely to lease their properties to maintain short-term cash flow and ease liquidity constraints. This strategic shift increases short-term rental supply and may exert structural effects on local rent levels and volumes of rental housing. The effect is expected to be more pronounced in regulated projects with greater discrepancies between reference prices and market values. Based on the discussion above, we propose our second research proposition:

Proposition B: *the rental effect*

*The RP policy reduces housing rent and raises rental transaction volume in the regulated projects.*

# 3. Methodology

## 3.1. Data and variables

This paper uses housing data at individual level from the largest real estate brokerage firm in China. There are four

[8] Refer to URL: https://www.cls.cn/detail/1329050, accessed on May 23th, 2024.

[9] Refer to URL: https://static.cdsb.com/appstatic/articles/20240508/2536c79fcefe8ad1915739465b2181de.html, accessed on May 23th, 2024.

**Table 1.** Variable definitions

| Variable | Definitions |
|---|---|
| *UPrice* | The unit price of a transacted (or listed) resale house, in yuan per square meter |
| *Volume* | The newly transacted (or listed) number of resale houses in each residential project, summed up at the monthly level |
| *TOM* | The time (days) from housing listing on real estate platform to transaction |
| *Treat* | A binary variable that indicates the observation belongs to a treatment group or control group, with a treatment group of 1 and a control group of 0. See the empirical design section for specific divisions |
| *Post* | A binary variable that indicates the observation occurred before or after the policy implementation, equals 1 if occurred in the month of the policy and after, and 0 otherwise |
| *Size* | The building area of a housing unit, in square meters |
| *Bedroom* | The number of bedrooms of a housing unit |
| *Living Room* | The number of living rooms of a housing unit |
| *Toilet* | The number of toilets of a housing unit |
| *South* | A binary variable that indicates the orientation of a housing unit, which equals 1 if any room of a housing unit faces south, and 0 otherwise |
| *Floor* | The floor level of a housing unit, classified as low, medium, and high |
| *Build Height* | The total number of floors in a residential building where a certain housing unit is located |
| *Furnishment* | The decoration status of a housing unit: 1 (well decoration), 2 (basic decoration), 3 (bare decoration) and 4 (others) |
| *Build Year* | The construction year of a residential project |
| *Price Index* | The growth rate of transaction (or listing) prices at the city level, using January 2019 as the base, in monthly frequency |

*Note*: This table reports the definitions of the main variables. The detailed definitions are based on the resale housing data but also suit the rental housing data.

datasets[10], including resale housing transaction data, resale housing listing data, rental housing listing data and rental housing transaction data, respectively.

Resale housing transaction data covers transaction records between January 2019 and December 2022. Each housing transaction record contains information on transaction price, transaction date, time-on-market, administrative district, project name, longitude and latitude of the project where the housing unit is in. It also provides hedonic attributes of the transacted housing unit, such as building area (or housing size), floor level, building year, building height, decoration status, number of bedrooms, number of living rooms, and number of toilets. We use this dataset to test the policy impact on housing trading behavior.

Resale housing listing data covers listing records between January 2019 and December 2022. Each housing listing record contains information on listing price, listing date, and other attributes consistent with those in resale housing transaction data. We use this dataset to test the spillover effect on unregulated projects.

Rental housing listing data and rental housing transaction data covers records between June 2020 and December 2022 and between March 2020 and December 2022, respectively. The main variables are listing/transaction rent and listing/transaction volumes. Apart from decoration status, other attributes are consistent with those in resale housing listing data. These two datasets are used to test housing rental effect.

We also have information on 3,595 regulated residential projects (hereafter residential project list), collected from the official website of the local government[11], including administrative district, project name, and reference price. Then we match this residential project list with four microlevel housing datasets on the condition of administrative district and project name, marking whether an observation in the housing dataset is regulated and corresponding reference price if so. It is worth noting that the naming conventions of the residential projects in the housing datasets may differ from those in the residential project list. For example, a project labeled with or without the suffix 'Garden' may indicate the same project, but this discrepancy can impact the identification when matching in Stata, treating them as different project. To address this issue, we manually compared project names across all datasets, ensuring consistent naming conventions.

Table 1 gives variable definitions, and Table A2 in Appendix reports summary statistics of main variables. Panel A and Panel B display data on resale housing transaction and resale housing listing records, respectively, categorized by whether a housing unit is in regulated projects. We observe that the average listing price of housing in regulated projects is 71,279 (in Yuan per square meter) and the average transaction price of housing in regulated projects is 64,690 (in Yuan per square meter). The prices

[10] This article only focuses on residential apartments which accounts for over 90% of China's urban housing and does not include other types of housing like detached and semi-detached houses.

[11] This list is from the Shenzhen Housing and Urban-Rural Development Bureau. Refer to URL: http://zjj.sz.gov.cn/attachment/0/749/749839/8545737.pdf, accessed on May 23th, 2024.

are higher compared with those in unregulated projects. The housing hedonic attributes in two groups are similar, except for the *Build Year*, which is longer in regulated projects. Panel B suggests that the selling probability of housing in regulated projects is higher, because the average time on market (*TOM*) is shorter. Panel C and D present data on rental housing listing and rental housing transaction records, specifically for regulated projects. The average listing rent is 93.55 (in Yuan per square meter) and the average transaction rent is 84.86 (in Yuan per square meter).

## 3.2. Research design

### The illiquidity effect

To identify the impact of the RP policy on housing market illiquidity, we employ two complementary empirical strategies. The primary approach adopts a Cox proportional hazards model to examine how the RP policy affects the time on market (TOM), a direct measure of transaction speed and a widely used proxy for market liquidity. As a supplementary strategy, we implement a RDiT design to test for structural breaks in transaction prices and volumes around the time of policy implementation, offering additional evidence of liquidity disruptions.

### Cox proportional hazards model for time-on-market

We initially construct a survival dataset by combing housing listing and transaction information based on resale housing transaction dataset. We select observations which were listed between January 2019 and December 2022, and those observations who were sold after December 2022 are considered as right-censored. The Cox proportional hazards model is designed as follows:

$$h(t)_i = h_0(t) \cdot \exp(\alpha \cdot Post + \beta \cdot X_i), \tag{1}$$

where: $h(t)_i$ is the hazards rate of housing unit *i* to be sold on date *t*; $h_0(t)$ denotes the baseline hazards, which is not given a particular parameterization; $X_i$ is a vector of hedonic housing attributes, including *Size*, *Bedroom*, *Living Room*, *Toilet*, *South*, *Floor*, *Build Height*, *Furnishment* and *Build Year*; *Post* represents the RP policy, which equals 1 if the listing date of the observation is on or after the date of the RP policy implementation, and 0 otherwise. The coefficient $\alpha$ reflects the impact of the RP policy on housing selling probability.

### RDiT model for transaction prices and volumes

In the RDiT framework, the running variable is time in dates or months. Our research time window covers from February 2019[12] to December 2022. The model is specified as follows:

$$Y_{ijt} = Con + \alpha D_t + Z\left(T_t - T_t^*\right) + Z\left(T_t - T_t^*\right) \times D_t + \gamma X_{ijt} + \varepsilon_{ijt}, \tag{2}$$

where: $Y_{ijt}$ is the dependent variable, including natural logarithm of housing unit transaction prices (daily frequency), housing transaction price index (monthly frequency), and transaction volumes (daily frequency); $D_t$ is the treatment variable, with 1 indicating transaction records after the RP policy, and 0 otherwise; $T_t$ is the running variable in number of days (or months); $T_t^*$ is the number of days (or months) when the RP policy was implemented; $Z\left(T_t - T_t^*\right)$ represents a polynomial function of $\left(T_t - T_t^*\right)$; $X_{ijt}$ is a vector of hedonic attributes, including *Size*, *Bedroom*, *Living Room*, *Toilet*, *South*, *Floor*, *Build Height*, *Furnishment* and *Build Year*; $\varepsilon_{ijt}$ is the error term.

We estimate the RDiT model using a nonparametric quadratic local polynomial fitting with heteroskedasticity-robust standard errors. A triangular kernel is applied, and the optimal bandwidth is selected by minimizing mean squared error. The specification includes a time trend in housing transaction prices. Following Hausman and Rapson (2018), and Imbens and Lemieux (2008), we additionally control for the first lag of the dependent variable in the specifications for both the transaction price index and transaction volume. All estimations are conducted separately for regulated and unregulated residential projects.

### The rental effect

Given the limited time span of rental housing data, we concentrate on regulated project samples[13] and apply a fixed-effect multiple linear regression model to examine the impact of the RP policy on the rental housing market. The model is specified as follows:

$$Y_{ijt} = Con + \alpha Price\ Discrep_j + \gamma X_{ijt} + \delta_j + \varphi_t + \varepsilon_{ijt}, \tag{3}$$

where: $Y_{ijt}$ is the dependent variable, consisting of the unit rent and volumes, denoted by *UPrice* and *Volume*, respectively; $Price\,Discrep_j$ is the independent variable, measuring the degree of listing price discrepancy, as a proxy for treatment intensity. A higher value indicates a greater deviation between the market listing price and the reference price, reflecting a stronger treatment intensity. Rental housing listing data is used to explore the changes in listing rent and listing volumes, and rental housing transaction data is used to explore the changes in transaction rent and transaction volumes. As for housing hedonic attributes, all variables are consistent with those in Equation (1), except for lacking information on decoration status. If the rental effect exists, we expect the coefficient a to be negative when the dependent variable is *UPrice* and to be positive when the dependent variable is *Volume*.

We further clarify how the listing price discrepancy variable is constructed and justify its use as a proxy for policy treatment intensity. For each regulated project, it is

---

[12] As the transaction price index is constructed using January 2019 as the benchmark, we uniformly set February 2019 as the starting point for the RDiT analysis.

[13] Unregulated projects are not directly constrained by the RP policy, and lack reference price information, making the calculation of listing price discrepancy unfeasible.

defined as the ratio of the market listing price to the government reference price, where the former is calculated as the average listing price during the six months preceding the RP policy (i.e., August 2020 to January 2021). This variable is constructed at the project level to reduce noise from unit-level heterogeneity. A potential concern is that listing price discrepancy may be endogenously correlated with unobserved housing characteristics or seller expectations. For example, projects with higher discrepancies may naturally exhibit lower liquidity, independent of policy effects. To mitigate this concern, we control for a rich set of housing attributes and cluster standard errors at the project level. Furthermore, we examine the pre-policy relationship between listing price discrepancy and market liquidity in later sections, further supporting its validity as a proxy for treatment intensity.

## 4. Empirical results

### 4.1. The illiquidity effect

#### Main evidence: RP policy and housing transaction probability

Table 2 reports results of survival analysis. Column (1) presents samples of regulated housing, while column (2) uses unregulated housing. Both the coefficients of *Post* are negative and significant at the 1% level, indicating that the RP policy reduces the probability of housing transactions. As for the magnitude, the coefficient of *Post* in column (1) is –0.753, while in column (2) it is –0.697, showing that the liquidity reduction of regulated housing may be more significant compared with unregulated housing. Following a similar approach, column (3) and (4) explore how the selling probability varies between regulated housing and unregulated housing before and after the RP policy, by substituting *Post* with *Treat* in Equation (1). The coefficient of *Treat* in column (3) is 0.031 (significant at the 5% level), suggesting that regulated housing sells faster than unregulated housing before the RP policy. However, after the RP policy, the coefficient of *Treat* is –0.056 (significant at the 10% level), indicating a more substantial decline in liquidity for regulated housing.

To enhance the comparability of coefficients, we incorporate *Treat* and *Post* into one model. Specifically, using the pre-policy observations of unregulated housing as the benchmark, we test the relative coefficient changes for regulated housing before the policy, regulated housing after the policy, and unregulated housing after the policy. The estimation is presented in column (5) of Table 2. Before the RP policy, the selling probability of regulated housing is significantly higher than those in unregulated projects, for the coefficient of $Treat_1 \times Post_0$ is 0.027 and significant at the 10% level. After the RP policy, the relative selling probability of regulated housing and unregulated housing both decreases, with a more pronounced decline for the regulated housing.

We also examine the heterogeneous effects of policy treatment intensity. For each regulated project, we classify the listing price discrepancy into five groups based on its distribution and estimate five separate Cox proportional hazards models using Equation (1). Table 3 presents the results. As the listing price discrepancy increases, the

**Table 2.** The illiquidity effect

| Indep. Var. | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | Regulated project samples | Unregulated project samples | Full samples (before) | Full samples (after) | Full samples |
| | Hazards rate *h*(*t*) | | | | |
| *Post* | –0.753*** | –0.697*** | | | |
| | (0.02) | (0.03) | | | |
| *Treat* | | | 0.031** | –0.056* | |
| | | | (0.01) | (0.03) | |
| $Treat_1 \times Post_1$ | | | | | –0.727*** |
| | | | | | (0.02) |
| $Treat_1 \times Post_0$ | | | | | 0.027** |
| | | | | | (0.01) |
| $Treat_0 \times Post_1$ | | | | | –0.696*** |
| | | | | | (0.03) |
| Controls | Yes | Yes | Yes | Yes | Yes |
| Observations | 20,531 | 9,874 | 23,778 | 6,627 | 30,405 |
| Log pseudolikelood | –173760.53 | –77387.90 | –218612.20 | –37784.01 | –269018.24 |

*Note*: This table reports results from Cox proportional hazards model estimating the effect of the RP policy on housing transaction probability. The dependent variable is hazards rate, *h*(*t*). Column (1) uses samples of housing in regulated projects, column (2) uses those in unregulated projects, and the main independent variable is *Post*. Column (3) uses full samples before the policy, column (4) uses full samples after the policy, and the main independent variable is *Treat*. Column (5) pools all samples and uses pre-policy unregulated units as the benchmark. Standard errors are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

**Table 3.** The illiquidity effect of price discrepancy of different magnitudes

| Indep. Var. | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | $r < 1.2$ | $1.2 \le r < 1.3$ | $1.3 \le r < 1.4$ | $1.4 \le r < 1.5$ | $1.5 \le r$ | Regulated project samples before policy |
| *Post* | –0.415*** | –0.784*** | –0.924*** | –1.118*** | –1.240*** | |
| | (0.04) | (0.03) | (0.04) | (0.07) | (0.10) | |
| *Price Discrep* | | | | | | 0.902*** |
| | | | | | | (0.06) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 5,011 | 7,472 | 4,599 | 1,814 | 1,080 | 15,688 |
| Log pseudolikelood | –36182.443 | –56201.962 | –32763.41 | –11125.466 | –6140.117 | –137746.53 |

*Note*: This table presents Cox proportional hazards estimates of how listing price discrepancy affects the transaction probability of regulated housing. The dependent variable is hazards rate, $h(t)$. The treatment intensity is measured by the ratio of reference price to average market listing price over a six-month period before the policy; higher values reflect greater deviation from market prices. Projects are grouped into five bins by listing price discrepancy. Columns (1) to (5) report estimates separately for each group. Column (6) uses pre-policy data to examine the baseline relationship between price discrepancy and transaction probability. Standard errors are reported in parentheses. *** denote significance at the 1% level, respectively.

absolute value of the *Post* coefficient generally increases in magnitude, ranging from –0.415 to –1.240. All coefficients are statistically significant at the 1% level. These results suggest that stronger treatment intensity leads to greater illiquidity effects. We also analyze the relationship between listing price discrepancy and transaction probability using pre-policy data from regulated projects. The results are presented in column (6) of Table 3 and we find that projects with higher listing price discrepancies exhibited higher transaction probabilities before the policy. This supports our identification strategy by showing that greater discrepancy reflects stronger market distortion and is associated with a larger liquidity decline after the policy.

### Supplementary evidence: RDiT on transaction prices and volumes

Table 4 reports the RDiT estimation results. In columns (1) and (2), no breakpoints are detected. Whether examining the unit transaction price or transaction price index, we find no clear evidence that the RP policy significantly lowers housing transaction prices. In the meanwhile, in column (3), we observe a significant decrease in transaction volume. The reduction in regulated projects is –18.968 (significant at the 1% level), while for unregulated projects it is –9.536 (significant at the 1% level). Compared with unregulated projects, the transaction volume of regulated projects has decreased to a greater extent. The RDiT estimation serves as additional evidence supporting the earlier observation of a decrease in transaction probability.

The price stickiness in the short-term highlights the role of reference-dependent and regret-avoidant behaviours as key mechanisms driving market illiquidity. Faced with government's reference prices which are mostly lower than the would-be listing prices and actual transaction prices, sellers tend to sell at before-policy prices to avoid regretting selling low, while buyers are more comfortable

**Table 4.** RDiT analysis on trading behavior

| Indep. Var. | (1) | (2) | (3) |
|---|---|---|---|
| | Housing transaction data | | |
| | Log unit transaction price | Transaction price index | Transaction volumes |
| Panel A. Subsamples of regulated projects | | | |
| Coefficient | –0.037 | 0.999 | –18.968*** |
| | (0.04) | (134.28) | (4.20) |
| Bandwidth | 197.308 | 9.626 | 270.552 |
| Observations | 27,297 | 46 | 1,342 |
| Panel B. Subsamples of unregulated projects | | | |
| Coefficient | –0.075 | –1.242 | –9.536*** |
| | (0.07) | (75.38) | (2.27) |
| Bandwidth | 194.880 | 11.433 | 255.984 |
| Observations | 13,449 | 46 | 1,244 |

*Note:* This table reports RDiT estimates of trading behavior. The dependent variables are: (1) log unit transaction price, (2) transaction price index, and (3) transaction volumes. Panel A presents results for regulated projects, and Panel B for unregulated ones. Standard errors are shown in parentheses. *** denote significance at the 1% level, respectively.

to buy at lower prices to avoid regretting paying too much. Thus, the overlapping region between the reservation prices of buyers and sellers decreases, transactions become more difficult to happen, and the market liquidity is reduced. Furthermore, the market may have entered a liquidity trap, as the RP policy implicitly constrains price adjustments and weakens the normal clearing mechanism. As a result, market adjustment is reflected more in reduced transaction volumes and prolonged time on market than in price declines.

Additional robustness checks, including tests of the Cox proportional hazards model and graphical diagnostics for the RDiT regressions, are presented in Section 1 of the online supplementary material. Furthermore, given the time-series nature of the data, we examine potential autoregression and non-stationarity in the RDiT estimates. The detailed analyses and results are reported in Section 2 of the online supplementary material.

## 4.2. The rental effect

Table 5 reports results of the rental effect. Columns (1) and (2) report regression results using rental housing listing data. For each unit increase in the degree of listing price discrepancy, listing rent decreases, as the coefficient is –238.56 (significant at the 1% level), and listing volumes increase, as the coefficient is 0.468 (significant at the 1% level). Columns (3) and (4) present regression results using rental housing transaction data. For each unit increase in the degree of listing price discrepancy, transaction rent decreases, as the coefficient is –150.36 (significant at the 1% level), and transaction volumes increase, as the coefficient is 0.684 (significant at the 1% level). Thus, the proposition is proven. The findings in this section also suggest that regulating a specific market may inadvertently trigger spillover effects in related markets, leading to unintended consequences.

## 4.3. Additional discussions

In this section, we will discuss some suggestive evidence about the spillover effects of RP policy from regulated projects to unregulated projects, as well as the confounding effect of the RP policy's role as finance constraint.

### Spillover to unregulated projects

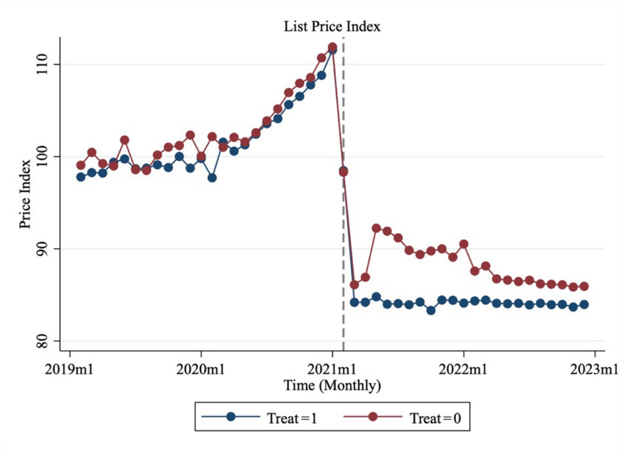
The RP policy may spill over from regulated projects to unregulated projects. On the one hand, the RP policy's impact on listing prices of regulated projects may spill over to the unregulated projects, as listing price reduction in regulated projects could prompt strategic responses by sellers in unregulated projects. Housing listing prices serve as signals for sellers' reservation prices and willingness to sell (de Wit & van der Klaauw, 2013; Yavas & Yang, 1995), and influence buyer's visits and probability of selling and final transaction prices (Han & Strange, 2016; Knight et al., 1994). As a result, the listing price decrease for regulated housing shapes the price judgement of homeowners in unregulated projects. There is also certain degree of substitutability between housing in regulated and unregulated projects, thus homeowners of unregulated projects would like to reduce listing prices accordingly to compete for attracting views by potential buyers.

We have obtained some suggestive evidence for the listing price spillover effect. First, we construct hedonic indexes for housing listing prices, with January 2019 as the base, as shown in Figure 1. It depicts the price changes of regulated housing and unregulated housing. In the two years before the policy, housing prices experienced a sustained increase, reaching the peak in one month prior to the RP policy; following the policy implementation, there was a dramatic decline in listing prices, which have since remained at lower levels. We observe similar price trends across two subsamples, but with a more pronounced decline in regulated projects. Second, we plot RDiT trend to highlight the policy breakpoint and present it in Figure 2. It displays the natural logarithm of housing unit listing prices

**Table 5.** The rental effect

| Indep. Var. | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | Rental listing data | | Rental transaction data | |
| | *UPrice* | *Volume* | *UPrice* | *Volume* |
| *Price Discrep* | –238.564*** | 0.468*** | –150.361*** | 0.684*** |
| | (32.78) | (0.05) | (20.87) | (0.13) |
| Constant | 429.183*** | 1.507*** | 301.393*** | 0.478*** |
| | (42.38) | (0.09) | (26.94) | (0.17) |
| Observations | 142,631 | 142,631 | 61,617 | 61,617 |
| Adj. $R^2$ | 0.757 | 0.776 | 0.849 | 0.731 |
| Controls | Yes | Yes | Yes | Yes |
| Project FE | Yes | Yes | Yes | Yes |
| Year by Month FE | Yes | Yes | Yes | Yes |

*Note*: This table reports the rental spillover effect of the RP policy. The dependent variable is *UPrice* and *Volume*, and the main independent variable is *Price Discrep*. In each column, we control for the fixed effects at year-month and project level, and hedonic attributes. Columns (1) and (2) use rental housing listing data; columns (3) and (4) use rental housing transaction data. Robust standard errors clustered at the project level are reported in parentheses. Standard errors are reported in parentheses. *** denote significance at the 1% level, respectively.




*Note*: This figure plots Shenzhen's resale housing listing price index in monthly frequency. The index is a hedonic index applying resale housing listing records. The sample period is from February 2019 to December 2022, in which January 2019 is the base (Price index = 100). It depicts price index of regulated projects and unregulated projects.

**Figure 1.** Resale housing listing price index

and we observe a significant decline in listing prices across two samples as the RP policy implemented. Meanwhile, unregulated housing shows a brief rebound, with listing prices subsequently remaining below pre-policy levels. Figures 1 and 2 collectively demonstrate that the RP policy has negatively affected listing prices of unregulated housing.

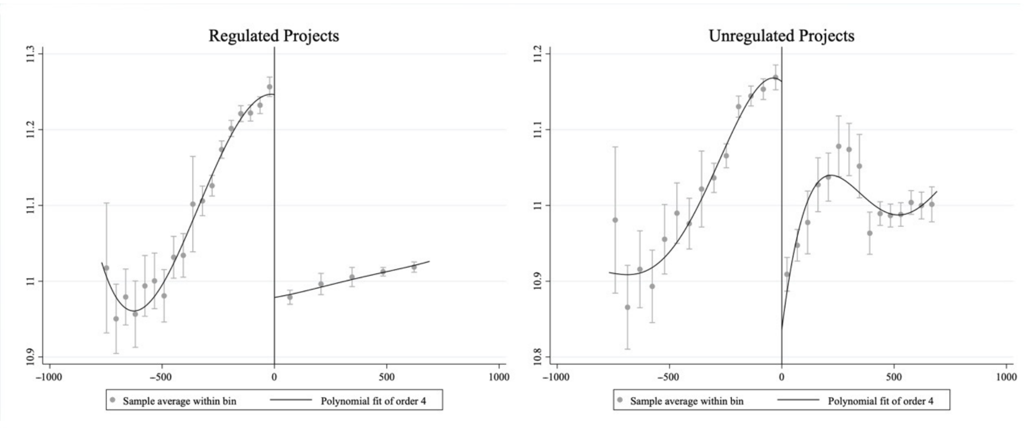
On the other hand, the illiquidity effect of the RP policy may also spill over to the unregulated projects. If homeowners in the unregulated projects lower listing prices without reducing reservation selling prices, this may produce a signal of price softening (Kryzanowski & Wu, 2023) in the unregulated projects for buyers and further reduces buyers' reservation prices. As a result, the liquidity in unregulated projects will be reduced. We have also obtained some suggestive evidence. In Table 2, the coefficient of *Post* in column (2) is –0.697 (significant at the 1% level) and the coefficient of $Treat_0 \times Post_1$ in column (5) is –0.696 (significant at the 1% level), both reflecting a decrease in selling probability for unregulated housing after the RP policy. Additionally, in Panel B of Table 4, the first two columns detect no breakpoints, which means that transaction prices of unregulated housing do not experience an immediate decline. But in column (3), the coefficient of transaction volumes is –9.536 (significant at the 1% level), showing a significant reduction in transaction volumes.

In summary, potential spillover effects may bias our estimates of the illiquidity effect downward, as the identification relies on comparing regulated and unregulated projects before and after the RP policy. This bias, if present, would make our estimates conservative and does not harm the robustness of the results.

### The RP policy's finance constraint role

The finance constraint role of the RP policy may serve as a negative demand shock to regulated projects (Armstrong et al., 2019; Deng et al., 2024), and thus reduce sellers' reservation prices and listing prices, which could be the confounding cause of the illiquidity effect. Meanwhile, existing literature indicates that buyers tend to be more responsive to negative demand shocks than sellers (Genesove & Han, 2012; Lamorgese & Pellegrino, 2022), as sellers are reluctant to accept potential losses. Given the inefficiency of the housing market, the impact of the negative demand shock is uncertain.

We would like to argue that this concern should not pose a significant threat to the findings. Reference prices were estimated based on registered transaction prices which were initially used for mortgage lending. In this regard, the reference prices serving as the ceiling for property valuation do not necessarily decrease banks' property valuation as long as market housing price do not increase too much. Agarwal et al. (2020) estimate that the actual transaction prices of resale homes in major cities in China are 23.3% higher than the registered transaction prices;




*Note*: This figure shows fitted graphs for RDiT function on housing listing prices. The dependent variable is the natural logarithm of unit listing price per square meter (daily frequency). The two graphs in the figure depict the RDiT fits for regulated project samples and unregulated project samples, respectively.

**Figure 2.** RDiT function fit on listing prices

**Table 6.** The finance constraint role of the RP policy

| Indep. Var. | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | Regulated project samples | Unregulated project samples | Full samples (before) | Full samples (after) | Full samples |
| | Hazards rate *h*(*t*) | | | | |
| *Post* | –0.762*** | –0.700*** | | | |
| | (0.02) | (0.03) | | | |
| *Treat* | | | 0.029** | –0.063** | |
| | | | (0.01) | (0.03) | |
| $Treat_1 \times Post_1$ | | | | | –0.739*** |
| | | | | | (0.02) |
| $Treat_1 \times Post_0$ | | | | | 0.026** |
| | | | | | (0.01) |
| $Treat_0 \times Post_1$ | | | | | –0.700*** |
| | | | | | (0.03) |
| Controls | Yes | Yes | Yes | Yes | Yes |
| Observations | 19,849 | 9,445 | 23,215 | 6,079 | 29,294 |
| Log pseudolikelood | –167964.42 | –73840.401 | –212933.32 | –34268.173 | –259015.41 |

*Note*: This table excludes the finance constraint role of the RP policy. We select regulated project samples whose listing price discrepancy is between 1.43 and 1, as well as unregulated project samples, and then conduct Equation (1). The dependent variable is hazards rate, *h*(*t*). Column (1) uses samples of housing in regulated projects, column (2) uses those in unregulated projects, and the main independent variable is *Post*. Column (3) uses full samples before the policy, column (4) uses full samples after the policy, and the main independent variable is *Treat*. Column (5) pools all samples and uses pre-policy unregulated units as the benchmark. Standard errors are reported in parentheses. ** and *** denote significance at the 5% and 1% levels, respectively.

typically, the listing price exceeds the actual transaction price by about 5%, implying that the bank mortgage accounts for approximately 70% of the listing price[14]. Therefore, regulated projects with a listing price discrepancy of 1.43 or less are unlikely to face binding financial constraints due to the RP policy, allowing for a cleaner identification. We focus on regulated project samples with the listing price discrepancy between 1.43 to 1, as well as unregulated project samples, and conduct regressions as in Table 2. The results are presented in Table 6, which further confirm the robustness of our findings.

## 5. Conclusions

This paper investigates the market effects of the RP policy for resale housing in Shenzhen, China. Using housing listing, transaction, and rental data, we have two main findings. First, the policy lowers the probability of transaction in the regulated projects, which prolongs home sellers' time on the market; the deeper the reference price is below the would-be listing price of a residential project, the more substantial the probability of transaction is reduced. But we do not find evidence that it significantly reduces housing transaction prices. Second, the RP policy induces more homes in regulated projects to be leased out and reduces housing rents. In addition, we discuss the policy spillover effects from regulated to unregulated projects, uncovering impacts on listing prices and transaction probability on the unregulated projects. Regarding the possible confounding effect of the RP policy' role as finance constraint for home buyers, we argue that this concern should not pose a significant threat to the findings.

This paper holds important policy implications. The RP policy is a housing policy newly invented by Shenzhen government, and it was quickly learned and applied by other major cities. While the government aimed to regulate market participants' listing behavior, improve information transparency and deter housing speculation through imposing reference prices, it instead reduced market liquidity and this illiquidity effect spilled over to the whole resale housing market. Our findings highlight the necessity for policymakers to consider behavioral anomalies in the housing market to minimize unintended consequences. In our case, home buyers and sellers held different attitudes to the reference prices, which reduced the market liquidity. This experience may apply to other asset markets.

Due to methodological and data limitations, this paper focuses on identifying the short-term effects of the RP policy. First, the RDiT framework is designed to capture local effects around the policy cutoff and is not well suited for tracing long-term dynamics. Second, the dataset ends in December 2022. Since early 2023, China's housing market has experienced substantial adjustment driven by macroeconomic shocks, credit tightening, and shifting expectations. These overlapping factors make it difficult to disentangle the long-term effect from other confounding

[14] Suppose the listing price of a housing unit is 105, then its actual transaction price is about 100 and the registered transaction price is bout 77. Thus, the registered transaction price accounts for approximately 73% of the listing price.

influences. Third, alternative strategies such as DiD are challenged by behavioral spillovers from regulated to unregulated projects, which may bias the estimated treatment effects towards zero. While this study focuses on short-term effects of the RP policy, it recognizes the lack of long-term evidence as a limitation. Some prior studies may provide useful insights. For example, Levy et al. (2016) show that the housing valuation data released by the government in Wellington, which was estimated for property taxation, unintendedly served as reference prices for both buyers and sellers and made actual property transaction prices converge to the valuation prices. If Wellington's experience also applied to China's major cities in the long term, then the government should revise rather than remove the reference prices to help guide and stabilize the market during periods of housing price decline. However, we remain cautious about this possibility, as asset prices should ultimately reflect underlying fundamentals rather than administratively set benchmarks. Future research could apply structural modelling approaches to assess the long-term impact of the RP policy.

## Funding

This work was supported by Major Humanities and Social Sciences Research Projects in Zhejiang higher education institutions under Grant No. 2024QN106; Special Research Project on Think Tank Development for Enhancing National Influence (Zhejiang Provincial Philosophy and Social Sciences Planning Office) under Grant No. ZKZD2024013; College Students' Scientific and Technological Innovation Activity Plan and Xinmiao Talent Plan of Zhejiang Province under Grant No. 2024R403B058.

## Disclosure statement

The authors report there are no competing interests to declare.

## References

Agarwal, S., Li, K. Y., Qin, Y., Wu, J., & Yan, J. B. (2020). Tax evasion, capital gains taxes, and the housing market. *Journal of Public Economics*, *188*, Article 104222. https://doi.org/10.1016/j.jpubeco.2020.104222

Andersen, S., Badarinza, C., Liu, L., Marx, J., & Ramadorai, T. (2022). Reference dependence in the housing markets. *American Economic Review*, *112*(10), 3398–3440. https://doi.org/10.1257/aer.20191766

Anderson, R. I., Brastow, R. T., Turnbull, G. K., & Waller, B. D. (2014). Seller over-pricing and listing contract length: The effects of endogenous listing contracts on housing markets. *Journal of Real Estate Finance and Economics*, *49*(3), 434–450. https://doi.org/10.1007/s11146-013-9440-1

Anglin, P. M., Rutherford, R., & Springer, T. M. (2003). The trade-off between the selling price of residential properties and time-on-the-market: The impact of price setting. *Journal of Real Estate Finance and Economics*, *26*(1), 95–111. https://doi.org/10.1023/a:1021526332732

Arestis, P., Lai, M. S., & Hou, J. (2023). The effects of reference pricing on housing market: Evidence from Shenzhen China. *Panoeconomicus*, *70*(1), 1–27. https://doi.org/10.2298/pan220629015A

Armstrong, J., Skilling, H., & Yao, F. (2019). Loan-to-value ratio restrictions and house prices: Micro evidence from New Zealand. *Journal of Housing Economics*, *44*, 88–98. https://doi.org/10.1016/j.jhe.2019.02.002

Autor, D. H., Palmer, C. J., & Pathak, P. A. (2014). Housing market spillovers: Evidence from the end of rent control in Cambridge, Massachusetts. *Journal of Political Economy*, *122*(3), 661–717. https://doi.org/10.1086/675536

Bao, H. X. H., & Saunders, R. (2023). Reference dependence in the UK housing market. *Housing Studies*, *38*(7), 1191–1219. https://doi.org/10.1080/02673037.2021.1935767

Barberis, N., & Thaler, R. (2003). A survey of behavioral finance. In G. M. Constantinides, M. Harris, & R. Stulz (Eds.), *Handbook of the economics of finance* (Vol. 1, Part B, pp. 1053–1128). Elsevier. https://doi.org/10.1016/S1574-0102(03)01027-6

Baucells, M., Weber, M., & Welfens, F. (2011). Reference-Point formation and updating. *Management Science*, *57*(3), 506–519. https://doi.org/10.1287/mnsc.1100.1286

Brekke, K. R., Holmas, T. H., & Straume, O. R. (2011). Reference pricing, competition, and pharmaceutical expenditures: Theory and evidence from a natural experiment. *Journal of Public Economics*, *95*(7–8), 624–638. https://doi.org/10.1016/j.jpubeco.2010.11.015

Buehler, S., & Gärtner, D. L. (2013). Making sense of nonbinding retail-price recommendations. *American Economic Review*, *103*(1), 335–359. https://doi.org/10.1257/aer.103.1.335

Cook, T. M., Rongerude, J., Mueller, E., & Kuhlmann, D. (2024). Providing rental housing: A systematic literature review of residential rental property owner decision making. *Journal of Planning Literature*, *39*(4), 535–547. https://doi.org/10.1177/08854122241239571

De los Santos, B., Kim, I. K., & Lubensky, D. (2018). Do MSRPs decrease prices? *International Journal of Industrial Organization*, *59*, 429–457. https://doi.org/10.1016/j.ijindorg.2018.02.008

de Wit, E. R., & van der Klaauw, B. (2013). Asymmetric information and list-price reductions in the housing market. *Regional Science and Urban Economics*, *43*(3), 507–520. https://doi.org/10.1016/j.regsciurbeco.2013.03.001

Demers, A., & Eisfeldt, A. L. (2022). Total returns to single-family rentals. *Real Estate Economics*, *50*(1), 7–32. https://doi.org/10.1111/1540-6229.12353

Deng, Y. H., Han, C. Y., Li, T., & Wang, Y. L. (2024). The effectiveness and consequences of the government's interventions for Hong Kong's residential housing markets. *Real Estate Economics*, *52*(2), 324–365. https://doi.org/10.1111/1540-6229.12472

Desmond, M., & Wilmers, N. (2019). Do the poor pay more for housing? exploitation, profit, and risk in rental markets. *American Journal of Sociology*, *124*(4), 1090–1124. https://doi.org/10.1086/701697

Fabrizi, S., Lippert, S., Puppe, C., & Rosenkranz, S. (2016). Manufacturer suggested retail prices, loss aversion and competition. *Journal of Economic Psychology*, *53*, 141–153. https://doi.org/10.1016/j.joep.2016.02.001

Fioretti, M., Vostroknutov, A., & Coricelli, G. (2022). Dynamic regret avoidance. *American Economic Journal: Microeconomics*, *14*(1), 70–93. https://doi.org/10.1257/mic.20180260

Garmaise, M. J., & Moskowitz, T. J. (2004). Confronting information asymmetries: Evidence from real estate markets. *Review of Financial Studies*, *17*(2), 405–437. https://doi.org/10.1093/rfs/hhg037

Genesove, D., & Han, L. (2012). Search and matching in the housing market. *Journal of Urban Economics*, *72*(1), 31–45. https://doi.org/10.1016/j.jue.2012.01.002

Genesove, D., & Mayer, C. (2001). Loss aversion and seller behavior: Evidence from the housing market. *The Quarterly Journal of Economics*, *116*(4), 1233–1260. https://doi.org/10.1162/003355301753265561

Guo, S. W. (2023, October 23). *Reference price updating in the housing market.* SSRN. https://ssrn.com/abstract=5092150

Han, L., & Strange, W. C. (2015). The microstructure of housing markets: Search, bargaining, and brokerage. In *Handbook of regional and urban economics* (Vol. 5, pp. 813–886). Elsevier. https://doi.org/10.1016/B978-0-444-59531-7.00013-2

Han, L., & Strange, W. C. (2016). What is the role of the asking price for a house? *Journal of Urban Economics*, *93*, 115–130. https://doi.org/10.1016/j.jue.2016.03.008

Haurin, D. R., Haurin, J. L., Nadauld, T., & Sanders, A. (2010). List prices, sale prices and marketing time: An application to U.S. housing markets. *Real Estate Economics*, *38*(4), 659–685. https://doi.org/10.1111/j.1540-6229.2010.00279.x

Hausman, C., & Rapson, D. S. (2018). Regression discontinuity in time: Considerations for empirical applications. *Annual Review of Resource Economics*, *10*, 533–552. https://doi.org/10.1146/annurev-resource-121517-033306

Imbens, G. W., & Lemieux, T. (2008). Regression discontinuity designs: A guide to practice. *Journal of Econometrics*, *142*(2), 615–635. https://doi.org/10.1016/j.jeconom.2007.05.001

Kaiser, U., Mendez, S. J., Ronde, T., & Ullrich, H. (2014). Regulation of pharmaceutical prices: Evidence from a reference price reform in Denmark. *Journal of Health Economics*, *36*, 174–187. https://doi.org/10.1016/j.jhealeco.2014.04.003

Knight, J. R., Sirmans, C. F., & Turnbull, G. K. (1994). List price signaling and buyer behavior in the housing market. *The Journal of Real Estate Finance and Economics*, *9*(3), 177–192. https://doi.org/10.1007/BF01099271

Kopczuk, W., & Munroe, D. (2015). Mansion tax: The effect of transfer taxes on the residential real estate market. *American Economic Journal-Economic Policy*, *7*(2), 214–257. https://doi.org/10.1257/pol.20130361

Kőszegi, B., & Rabin, M. (2006). A model of reference-dependent preferences. *The Quarterly Journal of Economics*, *121*(4), 1133–1165. https://doi.org/10.1093/qje/121.4.1133

Kryzanowski, L., & Wu, Y. T. (2023). Signaling effects of recurrent list-price reductions on the likelihood of house sales. *Journal of Financial Research*, *46*(1), 99–130. https://doi.org/10.1111/jfir.12308

Lamorgese, A. R., & Pellegrino, D. (2022). Loss aversion in housing appraisal: Evidence from Italian homeowners. *Journal of Housing Economics*, *56*, Article 101826. https://doi.org/10.1016/j.jhe.2022.101826

Levy, D., Dong, Z., & Young, J. (2016). Unintended consequences: The use of property tax valuations as guide prices in Wellington, New Zealand. *Housing Studies*, *31*(5), 578–597. https://doi.org/10.1080/02673037.2015.1105935

Li, J., & Wu, D. (2022). The price effect of drug price ceilings: Intended and unintended consequences. *Management Science*, *68*(8), 5758–5777. https://doi.org/10.1287/mnsc.2021.4166

Loomes, G., & Sugden, R. (1982). Regret theory: An alternative theory of rational choice under uncertainty. *The Economic Journal*, *92*(368), 805–824. https://doi.org/10.2307/2232669

Lubensky, D. (2017). A model of recommended retail prices. *The RAND Journal of Economics*, *48*(2), 358–386. https://doi.org/10.1111/1756-2171.12179

Mense, A., Michelsen, C., & Kholodilin, K. A. (2023). Rent control, market segmentation, and misallocation: Causal evidence from a large-scale policy intervention. *Journal of Urban Economics*, *134*, Article 103513. https://doi.org/10.1016/j.jue.2022.103513

Paraschiv, C., & Chenavaz, R. (2011). Sellers' and buyers' reference point dynamics in the housing market. *Housing Studies*, *26*(3), 329–352. https://doi.org/10.1080/02673037.2011.542095

Podnar, K., Molj, B., & Golob, U. A. (2007). How reference pricing for pharmaceuticals can increase generic share of market: The Slovenian experience. *Journal of Public Policy* & *Marketing*, *26*(1), 89–101. https://doi.org/10.1509/jppm.26.1.89

Puppe, C., & Rosenkranz, S. (2011). Why suggest non-binding retail prices? *Economica*, *78*(310), 317–329. https://doi.org/10.1111/j.1468-0335.2009.00827.x

Slemrod, J., Weber, C., & Shan, H. (2017). The behavioral response to housing transfer taxes: Evidence from a notched change in DC policy. *Journal of Urban Economics*, *100*, 137–153. https://doi.org/10.1016/j.jue.2017.05.005

Strack, P., & Viefers, P. (2019). Too proud to stop: Regret in dynamic decisions. *Journal of the European Economic Association*, *19*(1), 165–199. https://doi.org/10.1093/jeea/jvz073

Tversky, A., & Kahneman, D. (1991). Loss aversion in riskless choice: A reference-dependent model. *The Quarterly Journal of Economics 106*(4), 1039–1061. https://doi.org/10.2307/2937956

Yavas, A., & Yang, S. (1995). The strategic role of listing price in marketing real estate: Theory and evidence. *Real Estate Economics*, *23*(3), 347–368. https://doi.org/10.1111/1540-6229.00668

Zhang, Y. J., Tu, Y., & Deng, Y. H. (2024). Duration-dependent transaction tax effects on sellers and their behaviors. *Real Estate Economics*, *52*(1), 140–183. https://doi.org/10.1111/1540-6229.12441

Zhou, T. Y., Clapp, J. M., & Lu-Andrews, R. (2021). Is the behavior of sellers with expected gains and losses relevant to cycles in house prices? *Journal of Housing Economics*, *52*, Article 101750. https://doi.org/10.1016/j.jhe.2021.101750

## APPENDIX

**Table A1.** Distribution of the regulated projects

| Districts | Distribution of the regulated projects announced by the government | Distribution of regulated projects covered in our sample | | |
|---|---|---|---|---|
| | | Total regulated project samples in our dataset | Samples with reference prices lower than market listing prices | Samples with reference prices not lower than market listing prices |
| Guangming | 30 | 12 | 11 | 1 |
| Nanshan | 699 | 327 | 316 | 11 |
| Pingshan | 38 | 20 | 20 | 0 |

*End of Table A1*

| Districts | Distribution of the regulated projects announced by the government | Distribution of regulated projects covered in our sample | | |
|---|---|---|---|---|
| | | Total regulated project samples in our dataset | Samples with reference prices lower than market listing prices | Samples with reference prices not lower than market listing prices |
| Bao'an | 429 | 220 | 214 | 6 |
| Yantian | 166 | 70 | 67 | 3 |
| Futian | 719 | 388 | 382 | 6 |
| Luohu | 710 | 289 | 285 | 4 |
| Longhua | 218 | 84 | 84 | 0 |
| Longgang | 557 | 251 | 234 | 17 |
| Qianhai | 1 | No obs. | No obs. | No obs. |
| Dapeng | 28 | No obs. | No obs. | No obs. |
| Total | 3,595 | 1,661 | 1,613 | 48 |

*Note*: The Shenzhen government applied the RP policy to 3,595 residential projects in total. But only 1,661 of the regulated projects are in our sample. This table displays the locational distribution of regulated projects in different administrative districts of Shenzhen. We calculated the average listing price of each regulated projects for the six months before the RP policy as the market listing price and compared it with the reference price set by the government.

**Table A2.** Summary statistics

| Variables | Treat = 0 | | | Treat = 1 | | |
|---|---|---|---|---|---|---|
| | *N* | Mean | Sd | *N* | Mean | Sd |
| Panel A. Resale housing transaction data | | | | | | |
| *UPrice* | 13,449 | 60,419 | 23,841 | 27,297 | 64,690 | 24,197 |
| *Volume* | 13,449 | 3.255 | 2.922 | 27,297 | 2.847 | 2.530 |
| *TOM* | 13,449 | 130.3 | 167.8 | 27,297 | 122.7 | 161.3 |
| *Size* | 13,449 | 79.81 | 34.70 | 27,297 | 75.41 | 33.94 |
| *Bedroom* | 13,449 | 2.516 | 1.046 | 27,297 | 2.315 | 1.002 |
| *Living room* | 13,449 | 1.386 | 0.621 | 27,297 | 1.317 | 0.600 |
| *Toilet* | 13,449 | 1.384 | 0.570 | 27,297 | 1.285 | 0.513 |
| *South* | 13,449 | 0.710 | 0.454 | 27,297 | 0.647 | 0.478 |
| *Floor* | 13,449 | 1.942 | 0.849 | 27,297 | 1.924 | 0.856 |
| *Build height* | 13,449 | 26.36 | 9.401 | 27,297 | 24.96 | 8.717 |
| *Furnishment* | 13,449 | 2.993 | 1.229 | 27,297 | 2.978 | 1.201 |
| *Build year* | 13,449 | 2,009 | 6.165 | 27,297 | 2,006 | 5.885 |
| Panel B. Resale housing listing data | | | | | | |
| *UPrice* | 37,178 | 68,570 | 29,622 | 73,381 | 71,279 | 29,216 |
| *Volume* | 37,178 | 5.473 | 4.496 | 73,381 | 4.802 | 4.290 |
| *Size* | 37,178 | 90.17 | 42.48 | 73,381 | 85.12 | 40.61 |
| *Bedroom* | 37,178 | 2.778 | 1.120 | 73,381 | 2.577 | 1.095 |
| *Living room* | 37,178 | 1.462 | 0.608 | 73,381 | 1.398 | 0.591 |
| *Toilet* | 37,178 | 1.510 | 0.649 | 73,381 | 1.391 | 0.588 |
| *South* | 37,178 | 0.761 | 0.427 | 73,381 | 0.708 | 0.454 |
| *Floor* | 37,178 | 1.952 | 0.834 | 73,381 | 1.946 | 0.840 |
| *Build height* | 37,178 | 27.00 | 9.975 | 73,381 | 24.95 | 8.805 |
| *Furnishment* | 37,178 | 2.543 | 1.387 | 73,381 | 2.505 | 1.365 |
| *Build year* | 37,178 | 2,007 | 6.963 | 73,381 | 2,004 | 6.569 |

| | *N* | Mean | Sd |
|---|---|---|---|
| Panel C. Rental housing listing data | | | |
| *UPrice* | 162,894 | 93.55 | 39.85 |
| *Volume* | 162,894 | 12.20 | 13.50 |
| *Size* | 162,894 | 75.31 | 37.87 |
| *Bedroom* | 162,894 | 2.266 | 1.032 |

*End of Table A2*

| Variables | Treat = 0 | | | Treat = 1 | | |
|---|---|---|---|---|---|---|
| | *N* | Mean | Sd | *N* | Mean | Sd |
| *Living room* | 162,894 | | 1.361 | | 0.636 | |
| *Toilet* | 162,894 | | 1.248 | | 0.509 | |
| *South* | 162,894 | | 0.725 | | 0.446 | |
| *Floor* | 162,894 | | 1.933 | | 0.851 | |
| *Build height* | 162,894 | | 23.02 | | 10.78 | |
| *Build year* | 162,894 | | 2,003 | | 7.295 | |
| Panel D. Rental housing transaction data | | | | | | |
| *UPrice* | 70,484 | | 84.86 | | 32.86 | |
| *Volume* | 70,484 | | 5.605 | | 5.791 | |
| *Size* | 70,484 | | 69.06 | | 31.72 | |
| *Bedroom* | 70,484 | | 2.096 | | 0.962 | |
| *Living room* | 70,484 | | 1.285 | | 0.648 | |
| *Toilet* | 70,484 | | 1.196 | | 0.433 | |
| *South* | 70,484 | | 0.706 | | 0.456 | |
| *Floor* | 70,484 | | 1.915 | | 0.859 | |
| *Build height* | 70,484 | | 22.91 | | 10.70 | |
| *Build year* | 70,484 | | 2,003 | | 7.207 | |

*Note*: This table reports the summary statistics of the main variables. The definitions of the variables are presented in Table 1.