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Paper by invitation

The Effects of Reference Pricing on Housing Market: Evidence from Shenzhen China

Summary: This paper investigates an unprecedented regulation measure in the housing market, reference pricing, with evidence from Shenzhen China. We use a unique panel dataset, obtained through questionnaires to real estate agents, to document the effects of the policy on the housing market. The hypotheses that trading volume and house price decrease are validated by the data, while the one that turnover time increases is not supported. We discuss potential mechanisms that may explain these effects. Meanwhile, we infer estate-level discount factors that are not public information. Based on these factors, we forecast reference prices for the subsequent year. Overall, this paper fills the gap in the field of reference pricing effects on the housing market.

Keywords: Reference pricing, Housing price, Housing market.

JEL: E64, O18, R31.

Global house prices have kept increasing in the last two decades, except for a small turnaround after the 2007-2008 financial crisis. Even though most economic indicators have deteriorated, three quarters of the 60 countries entered into the IMF's Global House Price Index have experienced an increase in house prices during 2020 (International Monetary Fund 2021)[1]. To avoid housing-related risks to financial stability and real economy (Min Zhu 2014), a series of substantial regulations have been applied to the housing markets, such as the macroprudential policies. On 8 February 2021, an unprecedented measure, reference pricing (hereafter RP), was implemented in Shenzhen, China, one of the most successful special economic zones. That is, the government set reference prices for almost every estate in the city. Since then, another 14 first- and second-tier cities in China have issued reference prices for the local housing markets. In this paper, we focus on this pilot experiment and investigate the effects of the policy on Shenzhen housing market outcomes.

With the aim of stabilizing house price and decreasing the speculation of second-hand house price, the RP policy issued by Shenzhen government constitutes several components. It not only provides a list of reference prices at estate level for the second-hand housing market, but also stipulates that the price is the evaluation price of the bank. Therefore, the policy indirectly stipulates loan-to-value (LTV). Although the policy is not a macro-prudential policy, it touches on the essence of the application

[1] **International Monetary Fund.** 2021. IMF Global Housing Watch. https://www.imf.org/external/research/housing/index.htm (accessed December 10, 2021).

of macro-prudential policy in the housing market. On the other hand, the policy requires that any listing price higher than the corresponding reference price is not allowed. Meanwhile, no owner is willing to sell below the reference price, the listing price below the reference price hardly exists. These two facts lead to the reality that only the RP is public information.

Meanwhile, final transaction price is no longer public. The information transparency of the housing market reduces, which may increase the search cost of homebuyers. Overall, these features of the RP policy may invoke widespread effects on Shenzhen housing market.

We document several stylized facts of Shenzhen housing market by using a unique panel transaction level data covering 2018 through December of 2021, which allows us to compare the before- and after-RP implementation outcomes of the housing market. The *post*-regulation transaction data is collected through questionnaires on main housing intermediary companies in Shenzhen. Due to possible existence of duplicate contracts, our dataset on transaction price is likely to be more reliable than officially recorded data. Thus, the dataset constitutes one of our main contributions. The *pre*-regulation transaction data is scrapped from one of the largest housing intermediary companies in China. To guide the empirical analysis, we mainly rely on the demand-supply theory to form hypotheses on the effects of the RP policy. Finally, some other critical issues are discussed, so as to present a complete analysis of the impacts of RP as a policy in regulating housing markets.

Our main findings are threefold. First, the trading volume has decreased significantly, while the house price has decreased noticeably since the implementation of the policy. They are consistent with the hypotheses delivered by a leftward shift of the demand curve. Depending on how the supply curve shifts, given the market conditions, the magnitude of these decreases and the direction of the change in house price may vary. Second, the cross-section ordinary least squares (OLS) regression analysis shows that the positive correlation of reference price, and transaction price, have weakened over time. This further implies a cooling down effect of RP on house price. Last, based on discount factors, which is the ratio of reference price to historical price, we are able to conduct an experiment in forecasting reference price for the subsequent year and in illustrating the shift of demand caused by the LTV component of the RP.

This paper contributes in the following ways. First, it adds evidence to the literature of the effects of RP on the housing market, or more generally on the effects of RP in regulating any market. Since RP is seldom implemented for this market, our paper is also relevant to policymakers who may consider using RP to regulate the housing market. For future studies on evaluating the effectiveness of price-related regulations, our paper also provides evidence with a unique transaction level data when there is information on non-transparency. Second, since one important component of Shenzhen RP regulation is the restriction on LTV ratio, this study also adds evidence to the literature of evaluating the effects of macro-prudential policy in regulating the housing market.

The rest of the paper is organized as follows. Section 1 reviews the relevant literature, and Section 2 presents the theoretical framework. Section 3 presents the data

and empirical evidence on the effects of RP. The last section summarises and concludes.

1. Literature Review

Our study is mainly based in two strands of the literature: one on RP for other markets, the other one on the determinants of housing market outcomes. The former focuses on the RP regulation, while the latter addresses the housing market context.

1.1 RP for Other Markets

Among other regulations, RP is popular across countries in regulating the pharmaceutical market. Reference price of a certain medicine may be set based on prices of identical or similar medicines in the country (internal RP) or from one or several other countries (external RP); it may be set for different policy goals such as containing health expenditure of a government by using reference price as reimbursement limit or negotiating to lower prices of targeted medicines. The World Health Organization documents that 24 of 30 OECD countries and approximately 20 of 27 European Union countries as of 2015, use external RP (World Health Organization - WHO 2015, p. 14), although the regulation varies largely across countries in terms of the calculation of reference prices. WHO (2021) documents a select set of case studies of specific country pharmaceutical pricing policies.

Although there are more empirical studies investigating the effectiveness of RP for pharmaceutical markets (e.g. Kurt R. Brekke, Tor Helge Holmas, and Odd Rune Straume 2015; Hanna Koskinen et al. 2015; Nika Marđetko and Mitja Kos 2018), only a few of them have proposed theoretical models to incorporate the effect of RP for the market. To analyze potential effects of RP regulation implemented in 1989 in Germany, Peter Zweifel and Luca Crivelli (1996) propose a duopoly model in which some physicians may choose to take the substitutions of a given medicine that is priced above the reference price. The model thus predicts a price decreasing effect of RP. When examining the effects of (internal) RP of pharmaceuticals in Germany, the Netherlands, and New Zealand, Patricia M. Danzon and Jonathan D. Ketcham (2004) narratively described a kinked demand model to predict the effects. In the framework of the model, patient and physician demand is expected to be more elastic at prices above the RP because of substitution, unless they are informed about any distinction in products. Consequently, RP should stimulate competition of the market.

However, the realized effects of RP will be mitigated by cross-market spillover effects and actual condition of price elasticity of demand and other cofounding policies. More recently, in a series of studies on price regulations on pharmaceutical market, Brekke and his co-authors have proposed models with different features of the market to address the corresponding effect of interest (Brekke, Astrid L. Grasdal, and Holmas 2009; Brekke, Holmas, and Straume 2011, 2015; Brekke, Chiara Canta, and Straume 2016). These models mostly investigate the effects of RP through differentiating the impacts of the policy on market competition for brand-name and generic drugs.

Housing market differs from the pharmaceutical market greatly. Among many obvious distinctions, housing properties are immovable and thus much less likely than medicines to be substituted by other properties, due to unique location, structure, surroundings and so on. Moreover, housing properties are more of an asset product, while medicines are more like necessary goods to patients; consumers of these two types of products should behave significantly different. Another critical difference between the two markets occurs when constructing RP, prices of the same products from other countries or of different but similar products are used for the pharmaceutical market. However, to construct RP for housing market in a given market, it is almost impossible to find comparable properties from other places to determine the reference price. Only cost information and past prices of the particular market are potentially suitable, the former of which is not easy to apply. So, it is difficult to directly apply the aforementioned theoretical frameworks to analyze the effect of RP in housing market.

However, these frameworks shed light on the study of RP for housing market at least in the following ways. First, it should be helpful if we specify which outcomes of RP we target. For pharmaceutical market, price of drugs, reimbursement levels, availability of new drugs and out-of-pocket sub-charges to patients are of most interest. For housing market, should the main policy goal be just to decrease house price? Second, we should capture key features of a given housing market correctly. In the abovementioned models, the pharmaceutical market is considered as competitive, even though for some types of drugs the producers have certain monopoly power. On the other hand, the housing market might be more heterogeneous across countries, provinces or even cities. Larger cities with net inflows of residents are more likely to be selling markets. Thus, the effect of RP might be more likely to be city heterogeneous. Last, while in a pharmaceutical market the welfare is distributed among firms, consumers and governments, it is among individual sellers, buyers and government in a second-hand housing market. Moreover, we cannot invoke innovation in new "properties" of houses in the similar sense as producing new drugs, different players in the two markets may interact strategically differently. These are issues we need to resolve when modeling RP for the housing market. Other theoretical studies incorporating RP in different frameworks include Richard A. Briesch et al. (1997) on markets of consumption goods like butter and coffee among others.

1.2 Determinants of Housing Market Outcomes

Studies on the effects of RP on the housing market are scarce, since the policy is seldom implemented on this market. However, we find the well-known framework described in Jeremy C. Stein (1995), which studies the role of expectation and loan-to-value ratio on the housing market rather than enlightening. In the model of Stein (1995), it is assumed that the rental market is absent; there is a minimum down payment requirement for purchasing a new home; sellers of an old house have to repay the outstanding debt immediately when they sell. Given these propositions, household's liquidity constraint can be lifted when house prices arise, so that trading volume also increases. Conversely, trading volume and house prices can decrease simultaneously in bad times of the market. This model illustrates one channel through which trading volume changes in the same direction as house prices.

Studies addressing the role of expectation illustrate another possible channel through which the RP policy affects the Shenzhen housing market. In the study of the US housing-bust around the Great Recession, Greg Kaplan, Kurt Mitman, and Giovanni L. Violante (2020) build an overlapping-generation model of the US economy with a housing sector and complete markets. They find that a shift in beliefs is the main driver of movements in house prices, but not a change in credit conditions. In an earlier study, Edward L. Glaeser, Joshua D. Gottlieb, and Joseph Gyourko (2012) find that easy credit conditions such as low interest rates, high approval rates, and high loan-to-value ratios, are not the main drivers of the boom periods in the 1990s and 2000s of the US housing market. Even in the period with the strongest predictive power (2000-2005), the interest rate can only account for 45 percent of the increase in house values in the US. The authors suggest that "wildly unrealistic expectations" by home buyers (Glaeser et al. op. cit. p. 39) might be an alternative explanation of the booms. There are more findings on addressing the importance of expectation in impacting house prices (e.g. Robert J. Shiller 2015; Christopher L. Foote and Paul S. Willen 2018). As stated by Monika Piazzesi and Martin Schneider (2016) in the review of housing market and macroeconomic, "details of expectation ... play a key role" (Piazzesi and Schneider 2016, p. 5). More recently, Theresa Kuchler, Piazzesi, and Johannes Stroebel (2022) reviews determinants and impacts of housing market expectations.

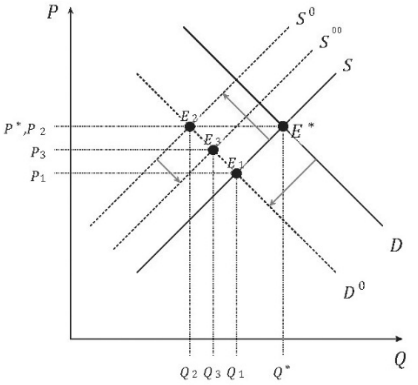
As mentioned in the Introduction, the RP policy implemented in Shenzhen is accompanied by a *de facto* increase on the down-payment ratio that buyers can obtain from financial institutions. That is, the LTV ratio is lowered after the regulation. Regarding the effect of LTV on housing market, Rag Nymoen, Kari Pedersen, and Jon Ivar Sjåberg (2019) and Björn Richter, Moritz Schularick, and Illhiock Shim (2019), among others, find considerable effect of limits on LTV ratio on house prices by using cross-country level panel data, while Christina Kinghan, Yvonne McCarthy, and Conor O'Toole (2019) find no significant effect of the regulation for the new house market on house prices by using micro level data for Ireland. On the other hand, Jed Armstrong, Hayden Skilling, and Fang Yao (2019) find that in New Zealand, restricting LTV ratio decrease house prices by using micro data. Using micro level data for Brazil, Douglas de Araujo et al. (2020) show that limits on LTV ratio change the amount of down-payments that buyers take and they switch to more affordable houses. Nitzan Tzur-Ilan (2019) shows that LTV limits result in borrowers choosing more affordable housing units. In the studies of Philip Arestis and Ana Rosa González-Martínez (2014, 2015, 2017), the authors address the endogeneous relationship between demand for credit and demand for housing, which implies a more complicated relationship between LTV and outcomes of housing market. In addition, studies addressing the Chinese context are also relevant to our study. Among others, Arestis and Sixia Zhang (2020) examine whether housing markets of different cities in China are subject to irrational bubbles. He Ge (2013) develops an equilibrium-oriented housing supply management model and tests it with Chengdu, a city in central China, to examine the effectiveness of housing supply management on regulating the market.

Overall, all these strands of literature shed light on possible impacts of RP on housing market. We rely on empirical evidence to discuss how compatible these studies are with the realized effects of the policy.

2. Theoretical Framework

While the Shenzhen RP has multiple components, it may affect housing markets through all channels as described above. We incorporate these impacts in a demand-supply diagram and form our hypotheses on trading volume and house price. We also refer to the predictions of the model of trade in the housing market as proposed by Stein (1995) to validate the demand-supply analysis. To supplement the hypotheses and draw an additional hypothesis regarding turnover time, we also incorporate other economic elements.

E^* in Figure 1 is supposed to be the initial equilibrium when RP is absent. We start with the impact of the *de facto* restriction on the LTV ratio as part of the RP, which imposes more credit constraints on potential buyers. This may have two impacts on the D-S diagram. First, the stricter cap on the LTV acts as a quasi-increase in house price, although actual house price does not change, thus the demand moves from E^* to the left along the original demand curve. This would create an excess supply and lead to a decreased trading volume. We do not illustrate this process in the figure, since house price does not actually increase. The second impact of the *de facto* restriction on the LTV ratio is that the demand curve shifts downward. That is, demand decreases at any given price. This can be the case if the tightness on down-payment, results in a reduction of effective demand for houses at all price levels, when the demand is distributed in appropriate ways. In the Appendix, we illustrate a simple thought experiment (Table A.1) to show how the demand curve could shift downward when a stricter cap on the LTV is imposed.



Source: Own construction.

Figure 1 Expected Effects of RP on Housing Market

The discount factor is not identical across estates, so the reduction in demand may vary across these estates. For simplicity, we illustrate the second impact of the down-payment requirement component of RP as a shift of the demand curve from D to $D^{'}$. When only this impact is at play, we can derive the following two hypotheses from the shift of equilibrium from $E^*(P^*, Q^*)$ to $E_1(P_1, Q_1)$:

Hypothesis 1: *Trading volume decreases after the introduction of the RP policy.*

Hypothesis 2a: *When the demand-side effect of RP dominates, house price decreases.*

The above two hypotheses are also consistent with predictions from the model as proposed by Stein (1995). One of the key ingredients of the model is the down payments. All families in the model are repeated sellers and buyers, so each family is endowed with one unit of housing stock at the beginning of the time periods. In the presence of negative shocks to house prices, the net value of house they currently own depreciates, which consequently restrains them from paying higher down payment for a new house after they sell the old house and pay off the mortgage. In the end, both trading volume and house prices will drop in such a market. Similarly, there will be self-reinforcing effects from positive shocks to house prices and trading volume. The mechanism that paves the way for the aforementioned processes is that "the maximum loan size is an increasing function of the market value of the house" (Stein 1995, p. 385). In consistent with this model, the Shenzhen RP is a negative shock to the market, so we expect decrease in both trading volume and house prices. Moreover, one component of the policy directly increases the down payment for new purchases, which further enhances the decrease through restraining families from affording the down payment. The key difference between the predictions of Stein (1995) and those of the demand-supply framework is that in the former model, a change in trading volume is more of a consequence in response to a change in house prices through down payments. In the demand-supply framework, change in trading volume is caused directly by lower LTV.

The downward shift of demand may also result from other components of the RP toolbox. Most importantly, the RP policy may have overturned the positive expectation of buyers on the Shenzhen housing market. Thus, the demand is discouraged at any given price. The impact of RP on expectation is likely to be more widespread, so the supply side is also affected. Consequently, the magnitude of changes in trading volume and price, and the direction of changes in price may vary given the demand-supply framework.

At the time of RP being implemented, Shenzhen housing market was still at heat, regardless of the launch of several other regulations within half a year before. In an incomplete survey, Shenzhen government has launched at least six regulations on its housing market during 15th of July 2020 to 1st of February, 2021. For example, on 30th, July 2020, the government requires intermediaries not to list prices to an unreasonably high level, which aims at restricting overly heated transaction price but main only result in a "cool down" in the public "perceived" market. However, only since the RP regulation has been launched, tones about Shenzhen housing market have become more conservative in terms of expecting an increase of the prices. Once search for "Shenzhen reference pricing" (in Chinese), we can find that the majority of news, articles or reports mentions the turn of expectation on the housing market. It is more widely accepted that to exploit high returns from investing in housing market becomes more and more difficult, given the challenges faced by governments to cope with the high debt ratio in housing market related industries. Overall, such an impact on the

expectation of the market may have dynamic effects on the supply side of Shenzhen housing market as well.

Specifically, upon the implementation of the RP regulation, the suppliers may have become more reluctant to sell their properties given the restrictions to list prices above RP and persistently optimistic expectation of the market. Corresponding to this impact, the supply curve will shift to the left-hand side. If the shock results in the shift of supply from S to S', equilibrium price will increase from P_1 to P_2, the same level as P^*. The trading volume will decrease further from Q_1 to Q_2. If the supply shifts further to the left, house price will become larger than P^*, while the trading volume decreases even more. When the supply curve shifts less than S', the trading volume will decrease less than Q_2 and the price will be lower than P_2.

As the positive expectation on housing market is recovered over time, the supply curve S' will shift back to S''. Consequently, holding constant the demand, the equilibrium will shift from E_2 to E_3, accompanied by a decrease in house price and increase in trading volume. Thus, we further supplement the hypothesis of house price:

Hypothesis 2b: *When housing supply decreases substantially enough, house price increases.*

The given analysis only illustrates potential effects of the RP on trading volume and house price for a few simple cases. The actual magnitude and direction of the effects on these two variables depends on the elasticity of supply and demand curves, the interplay with other factors affecting the market, which are more difficult to capture. Empirical evidence is thus necessary to examine the actual impact of the RP policy.

Except for these impacts, the RP policy may also affect the market through increasing searching cost. Search cost refers to the cost related to obtaining relevant product information. Under the referencing price policy, the listing price of the owner is no longer public information, so the search cost of home buyers rises (Paul M. Anglin 1997, among others), leading to a longer transaction period. Thus, we have one additional hypothesis:

Hypothesis 3: *The turnover time will increase after the introduction of the RP policy.*

The above hypotheses describe the relationships between three outcome variables and the RP policy. The system of functions that captures the relationship can be summarized as follows:

$$\frac{\partial P}{\partial RP} < 0,\ given\ \frac{\partial Demand}{\partial RP} < 0$$

$$\frac{\partial Volume}{\partial RP} < 0,\ given\ \frac{\partial Demand}{\partial RP} < 0\ and\ \frac{\partial Supply}{\partial RP} < 0$$

$$\frac{\partial Turnover}{\partial RP} > 0,\ given\ \frac{\partial information\ cost}{\partial RP} > 0,$$

where RP refers to the implementation of the policy, but not the value of the referenced prices. Note that the marginal change of house price with respect to the implementation of RP less than zero is not definite. As mentioned before, depending on how elastic of both demand and supply, house price may rise or decline after the implementation of the policy.

As a composition of several components, the Shenzhen RP policy can be captured by the following function:

$$RP = f(LTV,\ expectation,\ information\ cost),$$

where LTV corresponds to the fact that banks issue mortgages based on referenced prices but not marketing prices; "expectation" corresponds to the fact that the RP policy also alters the expectation of the housing market as illustrated before; "information cost" captures the fact that alone with the RP policy, information on final transaction price and listing prices that are larger than the referenced prices is no longer public.

3. Empirical Evidence

3.1 The Data

Since February 8th, 2021, the Shenzhen RP policy has been imposed on the city's second-hand housing market. Our datasets are retrieved for this market for the period before and after the regulation issued. Except for the post-regulation dataset, we also make use of the following datasets: (1) the list of reference price, which is for 3,959 estates, which covers almost all second-hand apartments in Shenzhen. This list is retrieved from the open data platform of the city and has been the same since it was issued. Figure A.1 in the Appendix presents the distribution of reference prices for the five regions that have the largest number of estates covered by the RP list; (2) the transaction data before the regulated price, which is scrapped from the official website of "Lianjia", one of the largest ll housing intermediary companies in China. It covers 95,768 transactions that can be dated back to 2010; (3) the monthly aggregate trading volume data of the Shenzhen housing market, which is from the open data platform of the city.

The *post*-regulation transaction dataset is the key dataset that allows us to analyze house-price response to the regulation. It includes more than 8,000 post-regulation transactions, which cover eight consecutive months since the regulation is issued (February-September). These transactions compose 30% of total number of transactions in Shenzhen for the same period, which is approximately 27,600 as reported by the government. The dataset contains information on the name of estate, from which we can also identify the location of it, listing price, final price, size, and turnover time.

This post-regulation transaction dataset is so unique that it constitutes one of the main contributions of our paper. To collect the data, we conduct questionnaires directly on several estate agents from different housing intermediary companies. Under the RP policy, estate agents are not allowed to list the owner's asking price, and only the reference price announced by the government is public information. This makes it more difficult than ever to obtain second-hand housing transaction data in Shenzhen. Since estate agents are the ones who are in direct contact with buyers and sellers throughout

the entire home buying process, they are the insiders of the final true transaction value between buyers and sellers.

Our dataset is unique and sufficiently large for several reasons. Especially, it contains final transaction price that should be even more reliable than what have been recorded by the official statistics department in Shenzhen. If the housing market strictly implements the "three prices in one", that is, the transaction price, loan evaluation price and tax evaluation price involved in the second-hand housing transaction, are the same; there is no incentive for sellers and buyers to manipulate the official transaction data. However, under the RP policy, the bank will take reference prices as the basis for loan evaluation, so it is inevitable that there will be "three price inconsistency" in the housing market, resulting to the possibility that the official transaction price data is manipulated.

While the data reported at the official department, is the figure written on a transaction contract, the latter data might be flawed for reasons to manipulate loans that can be obtained from banks. Since the implementation of RP, the selling price of an estate is not allowed to be higher than the government reference price. Thus, home sellers and buyers are almost forced by the policy to write a contract price no larger than the corresponding reference price, when they report the price to the estate registration center. In other words, although there is a three-in-one price regulation in the housing market, because many owners are reluctant to sell their houses at reference prices, which are lower than the market prices, some of the funds are private transactions and are not included in the registered transaction price. Let alone the fact that the dataset is not available even just for academic use. Since official data is the data source of many true estate-related data platforms, the Shenzhen second-hand housing-transaction data provided by these data platforms is flawed.

3.2 Stylized Facts

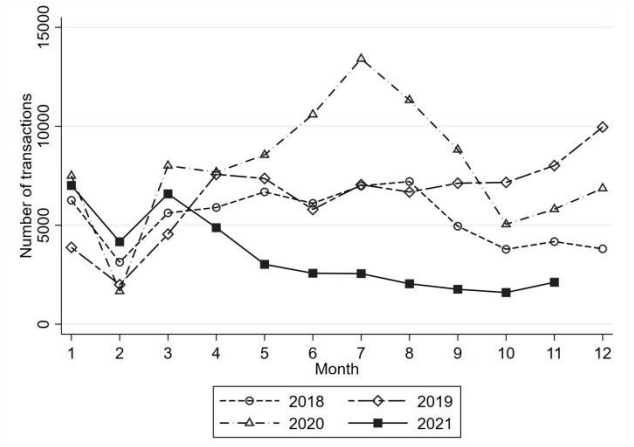
Given the above datasets, we can uncover several interesting stylized facts about transactions in the Shenzhen housing market, before and after the RP policy.

3.2.1 The Trading Volume Has Decreased Significantly

As presented in Figure 2, the city level aggregate data show that the number of traded estates from January through November in 2021 is much lower than that in the corresponding months for 2018-2020. There is a drop in trading volume in February every year, because this month coincides with Chinese Lunar New Year when a large proportion of people working in Shenzhen go back to their home city to celebrate the festival. Since April 2021, the trading volume has been constantly decreasing. The dynamics of monthly number of transactions in 2021 is in sharp contrast to those in previous years. Since there is no other regulation directly targeted at Shenzhen housing market, issued around the same time as the RP policy being introduced, the constant and significant drop in the trading volume is likely to be a consequence of the regulation under study.

The declining trend is consistent with our Hypothesis 1, as a consequence of a shift of demand to the left due to the de facto decrease in LTV and less positive

expectation in the market. Beyond the demand-supply framework, we may interpret the drop in different ways. If we believe that the trading volume in previous years reflect a more normal status of supply and demand of housing properties, the trading volume after the RP regulation was implemented, which reflects a suppression to the market. Either sellers or buyers, or both, are just postponing their selling or buying decisions regardless of a larger true "trading" potential. That means, the market is suppressed and a considerable amount of sellers and buyers are mismatched, so they do not trade, regardless of actual demand and supply. The rationale behind this is that the ones about Shenzhen market, upon the implementation of the RP, were still rather optimistic, even though there were several other restrictions implemented before that, as mentioned in the last section. It is possible that such optimism has lasted even after the PR policy was introduced, so that most sellers, including those with true need of selling their properties, are not willing to sell with unsatisfying prices. Meanwhile, the market becomes rather non-transparent in listing price and final transaction price. With reference prices as the most accessible information, potential buyers become more suspicious of paying higher price for a property. Both forces have resulted in the large drop in the trading volume.



Notes: The figure is drawn on data of second-hand housing properties in Shenzhen.

Source: The data is retrieved from the open data platform of the city, which can be found at: https://opendata.sz.gov.cn/data/dataSet/toDataDetails/29200_01903490, after registering at the platform.

Figure 2 Number of Transactions of Second-Handed Housing Properties in Shenzhen

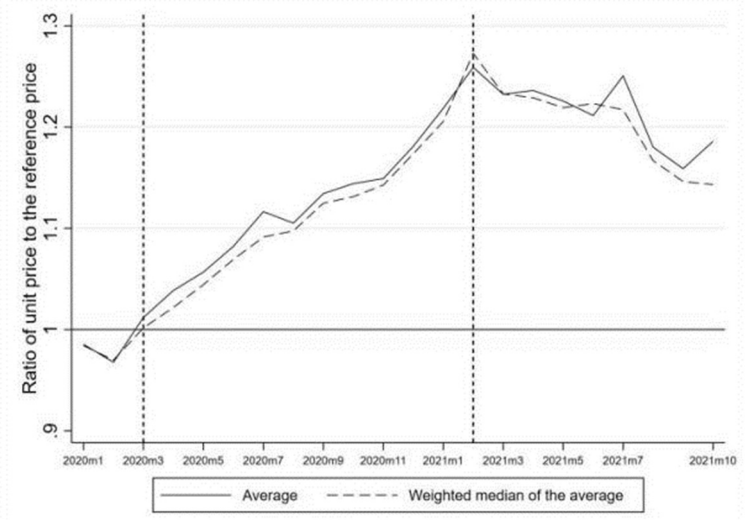
Alternatively, we may interpret the post-regulation market as a cooled down "trading" potential of the market which implies a more rational market based on fundamentals, if we believe that there more or less have been bubbles in previous years. This implies that the regulation effectively reduces transactions for arbitraging, thus, the regulation should be considered as effective. One other way of interpreting the decrease of trading volume is that the market has a larger proportion of more liquidity constrained buyers, so there is no bubble or depression involved in different years. The decrease in trading volume may be accompanied by a decrease in house prices through

the mechanism as illustrated in the model of Stein (1995). According to the model, house price and trading volume decrease at the same time in falling markets, because lower price decreases the liquidity of repeat buyers to pay the down payment for buying a new property. On the other hand, we have argued that Shenzhen second-hand housing market is mainly composed of repeat buyers. Thus, we may expect that house price, that can no longer be publicly observed, should have decreased or at least not increased, based on the Stein (1995) model. Consequently, more buyers are liquidity constrained to trade for another property.

3.2.2 The Monthly House Price Exhibits a Declining Trend since the Regulation Is Implemented

To capture the change in house price, we match the transaction data before and after the RP regulation with the reference pricing data by estate. We use transaction data covering March through September in 2020 and 2021 to ensure the price data over time is more comparable. Among 3,959 property developments with reference prices, 959 estates have transaction data both before and after the regulation. We then generate the average of unit price before and after the regulation at estate level. Figure A.2 in the sample shows that the matched 959 estates is a good representative of the sample of all estates with reference price, in terms of the distribution of unit price.

Figure 3 presents the monthly distribution of the average ratio of house price to reference price over time. As the reference price is constant for a given estate, the figure also exhibits the trend of house price based on the sample as described above.



Notes: The sample covers 959 estates which have transaction data both before and after the regulation for March through August in 2020 and 2021.

Source: Own construction.

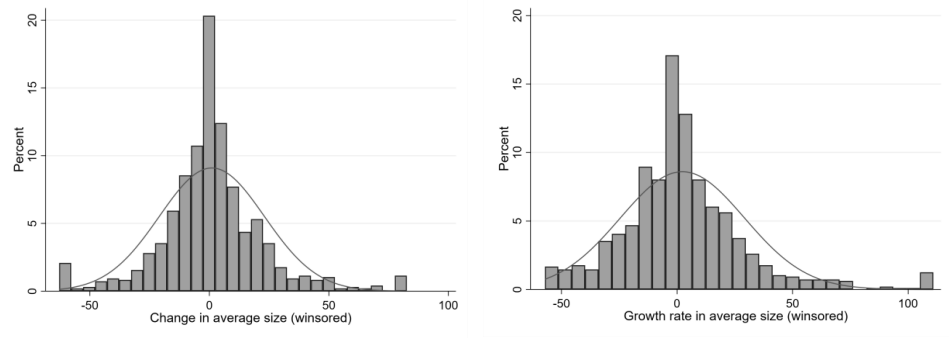
Figure 3 Average Ratio of House Price to Reference Price over Time: Balanced Sample

Since March 2020, the average house price has been larger than the average of reference prices. After the regulation is issued, there is an obvious declining trend in house price. Figure A.3 in the Appendix shows the ratio of house price to reference price over longer time period, based on the whole sample. The trend in the ratio for 2020-2021 is rather similar as in Figure 3. Figure A.4 in the Appendix displays the distribution of average unit price by property developments. A square and circle in the same vertical line imply that they correspond to the average unit price for the same development in 2020 and 2021.

This fact is consistent with our Hypothesis 2b, which predicts a decline in house price after the regulation is implemented.

3.2.3 The Average Size per Traded Development Does Not Change much

When inspecting the distribution of changes in average size of transactions in the balanced sample, Figure 4 shows that there is no apparent trend in the average size of traded estates. As seen, almost equal number of estates are exposed to an increase or decrease in the average size of traded estates after the RP regulation is implemented. This implies no apparent shift of preferences for estates with smaller or larger total values after the regulation.



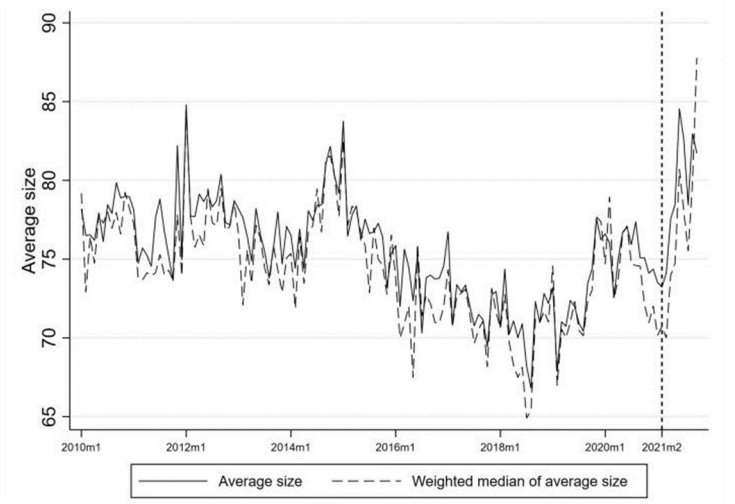
(a) Change in Values (b) Growth Rate

Notes: The left panel shows the changes in average size of traded apartments and the right panel shows the growth rate of the average size of traded apartments from 2020 to 2021. A normal density curve is included in each panel. The lowest 1% values and the highest 99% values of the two indicators are winsorized. The sample covers 959 estates which have transaction data both before and after the regulation for March through August in 2020 and 2021.

Source: Own construction.

Figure 4 Distribution of Changes in Average Size of Traded Estates (2020 vs. 2021)

The full sample tells a slightly different story. When we consider all transactions for estates that can be matched with those in the reference price dataset, we can see that traded estates on average have larger size after the regulation (Figure 5). If such a feature is not caused by the composition of our sample, then it reflects a shift of preference to larger apartments after the regulation, or at least a shift of "revealed" preference.

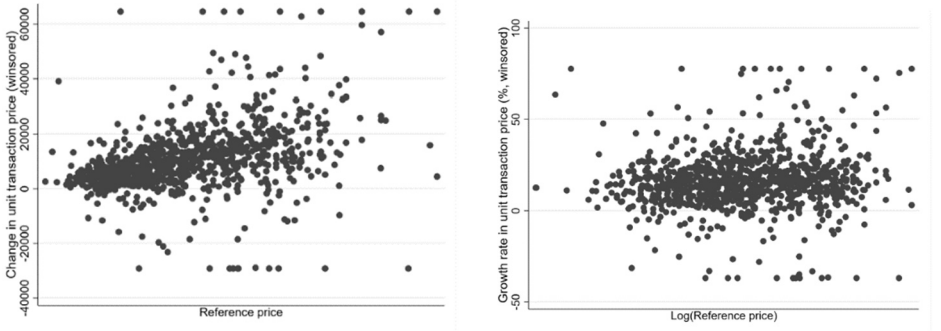


Notes: The figure is drawn on the full sample, which covers all transactions for estates that can be matched with those in the reference price dataset.

Source: Own construction.

Figure 5 Average Size per Transaction: Full Sample

The magnitudes of the increase and growth rate of house price appear to slightly increase with the reference price (Figure 6), while changes in average size per traded estate does not correlate with it (Figure 7).



(a) Change in Values (b) Growth Rate

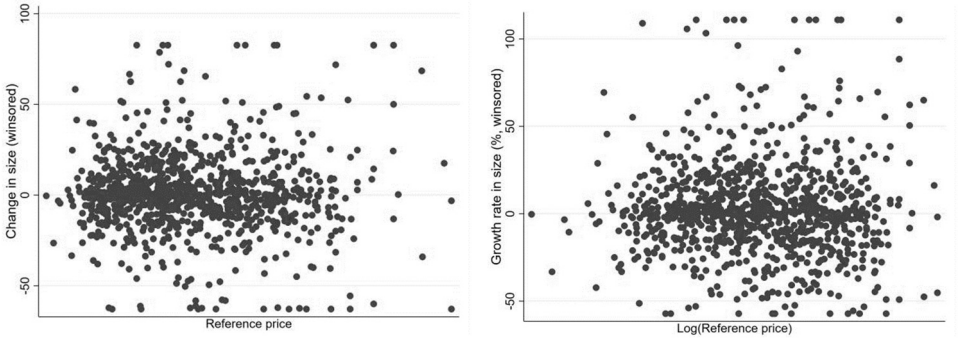
Notes: The left panel shows the changes in average house price from 2020 to 2021. The right panel shows the growth rate of the price for the same period. A normal density curve is included in each panel. The lowest 1% values and the highest 99% values of the two indicators are winsorized. The sample covers 959 estates which have transaction data both before and after the regulation for March through August in 2020 and 2021.

Source: Own construction.

Figure 6 Distribution of Changes in Average Unit Price Against Reference Price (2020 v.s. 2021)

Figure 6 presents the distribution of changes in average unit price against reference price at estate level. It shows that the higher the reference price, the larger the

increase in house price from 2020 to 2021. This is a result that is not predicted by our theoretical framework. The heterogeneity in the direction of changes in unit price across estates implies a more complicated impacts of the RP policy beyond what has been described by our theoretical framework. The increasingly larger house price as reference price increases may be caused by a signaling effect of the reference price for more valuable estates, such that buyers tend to buy apartments in these estates more likely after the regulation implemented, which consequently drives up the price more. On the other hand, higher reference price may indeed correspond to estates with higher fundamental values. The positive correlation shown in the figure then reflects a shift of preference for more valuable estates after the regulation. Figure 7 shows that there is no apparent change in growth rate in the size of traded apartments according to the reference price.



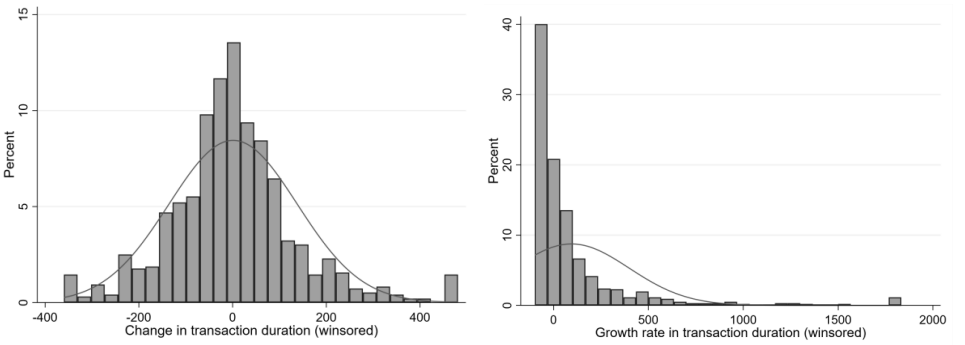
(a) Change in Values (b) Growth Rate

Notes: The left panel shows the changes in the average size from 2020 to 2021 and the right panel shows the growth rate of the average size for the same period. The lowest 1% values and the highest 99% values of the two indicators are winsorized. The sample covers 959 estates, which have transaction data both before and after the regulation for March through August in 2020 and 2021.

Source: Own construction.

Figure 7 Distribution of Changes in Average Size against Reference Price

Apart from the above-mentioned observations, we also notice that the turnover time does not increase significantly upon the implementation of the RP policy, as shown by Figure 8. Our hypothesis, based on the searching cost theory, is not validated by the data. It is not clear yet whether this implies insignificant effect of price in-transparency or there is a lag of the effect. Since it might take a while for the market to interpret the regulation, it is possible that market participants who have traded shortly after the implementation of the policy are those who are rather inelastic to prices. And they more urgently seek for a deal.



(a) Change in Values (b) Growth Rate

Notes: The left panel shows the changes in turnover time and the right panel shows the growth rate of the turnover time from 2020 to 2021. A normal density curve is included in each panel. The lowest 1% values and the highest 99% values of the two indicators are winsorized. The sample covers 959 developments which have transaction data both before and after the regulation for March through August in 2020 and 2021.

Source: Own construction.

Figure 8 Distribution of Changes in Turnover Time of Traded Estates (2020 v.s. 2021)

3.3 Empirics

As shown, the RP policy in Shenzhen coincides with a decrease in trading volume, heterogeneity in changes of the overall average unit price of March through August compared with the same period in 2020, and a declining trend in monthly house prices after the regulation was introduced. As mentioned before, Shenzhen RP regulation makes listing price and final transaction price not transparent and increase the *de facto* ratio of down-payment. They may further affect different aspects of the second-hand housing market, for example, the allocation of bargaining power among sellers and buyers, expectations of (potential) participants of the market, liquidity available to this particular market, and so on.

Due to limited exposure to exogeneity, we rely on the Ordinary Least Squares (OLS) analysis to exploit the cross-section variation in reference prices and house prices to study their correlation. Instead of using reference prices, we recover discount factor for each estate for the OLS analysis. Such a discount factor reflects the formula for policymakers to determine the reference prices. Thus, it is more general and straightforward. We thus first recover the discount factors and then apply them to the OLS analysis. Since the RP is based on past transaction price, both the RP, i.e., the discount factors, and the current transaction price are likely to be influenced by co-founders. Thus, we do not intend to find causal effect from RP to house price. Rather, we aim at documenting correlation between reference prices and house prices to investigate the pattern of house price that is related to RP.

3.3.1 To Recover the Discount Factors of the Reference Prices

The Shenzhen officials are rather vague on how they set the reference prices. In the text of the regulation, there is only one short paragraph describing the mechanism of

setting the reference prices, which states that they are set by the Shenzhen Real Estate and Urban Construction and Development Research Center, based on second-hand housing online price and referred to the surrounding first-hand house prices. We find two other pieces of information on the internet, which shed light on the mechanism. First, the director of Shenzhen Real Estate and Urban Construction and Development Research Center said that "reference prices for about 62 percent of the 3,595 residential communities were based on their transaction prices last year", as mentioned in one news report by China daily. Second, in an insight approved by a Chinese technology venture, the author mentions that 60-70% of the reference prices are based on transaction prices of the corresponding estates in the past two years. Three other factors related to the reference price setting process include trade frequency, land grant time and build time, and the overall "quality" of the estate. These factors are more difficult to be quantitatively incorporated to the reference price setting process. To recover an approximation of the formula, we mainly explore the ratios of reference prices to transaction prices of last year, i.e., the estate specific discount factors.

We explore transaction prices in the previous 12 months before the regulation was issued, i.e., 2020 February through 2021 January. Table 1 presents results of regressing reference prices on the average unit price in the past months, varying from the last month to the past 12 months. For example, results in column (6) imply that reference prices are regressed on the average unit price of transactions in the last 6 months before 2021 February, i.e., 2020 August-2021 January. Similarly, results in column (7) are based on the average unit price of transactions dated one more month earlier, i.e., 2020 July-2021 January.

Table 1 Regress Reference Price on Average Unit Price

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A: Only one regressor												
Past Price	0.644***	0.664***	0.675***	0.687***	0.689***	0.692***	0.707***	0.724***	0.737***	0.750***	0.760***	0.761***
	(46.810)	(67.455)	(75.708)	(83.083)	(86.429)	(81.215)	(83.848)	(86.935)	(86.929)	(83.916)	(82.217)	(82.162)
N	520	966	1204	1322	1402	1476	1603	1706	1775	1824	1845	1848
R^2	0.85	0.87	0.86	0.87	0.87	0.85	0.86	0.87	0.87	0.87	0.87	0.87
Adjusted R^2	0.85	0.87	0.86	0.87	0.87	0.85	0.86	0.87	0.87	0.87	0.87	0.87
Panel B: Region fixed effects included												
Past Price	0.527***	0.549***	0.558***	0.571***	0.579***	0.572***	0.593***	0.618***	0.630***	0.638***	0.647***	0.648***
	(19.735)	(27.266)	(31.665)	(35.623)	(36.525)	(28.646)	(31.611)	(34.823)	(37.860)	(38.480)	(38.420)	(38.334)
N	520	966	1204	1322	1402	1476	1603	1706	1775	1824	1845	1848
R^2	0.90	0.90	0.89	0.90	0.90	0.88	0.89	0.89	0.89	0.89	0.90	0.89
Adjusted R^2	0.89	0.89	0.89	0.89	0.89	0.88	0.88	0.89	0.89	0.89	0.89	0.89
Panel C: Growth rate of average unit price included												
Past Price	0.562***	0.567***	0.561***	0.574***	0.584***	0.592***	0.614***	0.637***	0.646***	0.658***	0.668***	0.669***
	(20.154)	(27.296)	(29.750)	(32.037)	(33.517)	(33.759)	(36.549)	(39.552)	(41.021)	(39.966)	(39.788)	(39.661)
N	501	910	1109	1211	1273	1323	1411	1454	1475	1480	1480	1480
R^2	0.92	0.91	0.90	0.90	0.90	0.90	0.90	0.91	0.91	0.91	0.92	0.91
Adjusted R^2	0.91	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.91	0.91	0.91	0.91

Notes: Reference prices are regressed on unit prices averaged on different month intervals in the past. For example, results in column (6) imply that reference prices are regressed on the average unit price of transactions in the last 6 months before 2021 February, i.e., 2020 August-2021 January.

Source: Own construction.

Panel A presents the results when there is only one regressor, i.e., the average of transactions price in the past. It shows that average unit price spreading different lengths has rather similar explanatory power in reference prices, since the values of R^2 and adjusted R^2 do not vary much across columns. As seen from the magnitude of these two indicators, the average unit price of transactions in the past year can only approximately explain 87% variation of the cross-section variation in reference prices. Thus, the average unit price based on past transactions is not the only predictor of the formulation of reference prices. This is, the claim by the government that "based on second-hand housing online price and referred to the surrounding first-hand house prices" (please see reference 13) is too vague and not complete.

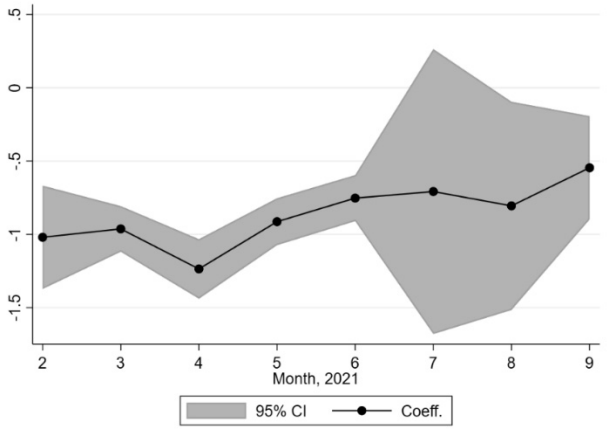
In panel B we include region fixed effects to the regression and in Panel C the growth rate of unit price averaged over the corresponding time intervals. To include district-level fixed effects helps to capture the impact of district-fixed factors that may have impacted the determination of reference prices, such as variation in bargaining power of district level government in setting reference prices for estates in different districts. The additional fixed effects have increased the explanatory power by around 2-3 percent. When we further include the growth rate of average unit price in the regression, the explanatory power is increased by 1-2 percent. This regressor is supposed to account for the impact of transactions on reference prices. Panel A through C show that 8-10% of reference prices are explained by other factors that are not illustrated in the table. There is space for the government to be more transparent in the formulation of reference prices, which may further affect the signaling effect or uncertainty of RP policy. The regression results are rather similar when we conduct the analysis using linearly interpolated unit transaction price. We also examine several other specifications of the regression models by using price weighted by the number of transactions given a development and time of the transaction. The explanatory power does not change much according to the time interval for averaging.

To recover the estate specific discount factors of reference prices, we use the average unit price in the last 12 months as the base due to the largest coverage of estates. Constructing the ratio of reference price to the corresponding unit price from the past, Figure A.6 presents the cumulative distribution probability of the discount factors, most of which lie in the range of 0.8-1. Approximately 10% of estates in the sample have reference prices larger than the average house price in the last 12 months. Several reasons might play a role: (1) house prices for these estates have only increased largely in February 2021, so that the officials set the RP higher than the average price over the last 12 months to take it into account; (2) there is selection bias of the sample or the price information of the transaction data before the regulation is inaccurate. Figure A.5 in the Appendix shows that the discount factor is smaller for estates with larger unit price. That is, estates with larger unit price are discounted more when the government sets the reference prices.

3.3.2 The Impact of the Reference Price (Discount Factor) on House Price

To investigate the dynamics of the response of unit price to reference price, we run regressions of monthly average unit price in 2021 on the discount factors recovered in the last section. Figure 9 displays the coefficient of the discount factor for each month

and the 95% confidence interval of the corresponding coefficient. Except for July, the discount factor has explanatory power to the average unit price at 95% confidence interval. The negative sign of the coefficients shows that a larger discount factor is correlated with a lower price after the regulation is issued. This is not too surprising since a larger discount factor is also set to be correlated with a lower unit price of transactions before the regulation (Figure A.5). A more interesting result is that the negative correlation becomes weaker as time passes. It may imply real effects of RP on unit price. Specifically, as time passes by, the unit price of estates with higher unit prices decreases so that the negative correlation between the discount factor and unit price turns weaker.



Notes: It presents the distribution of coefficient of the discount factor on transaction price for each month in 2021. The shaded area is the 95% confidence interval of the coefficient.

Source: Own construction.

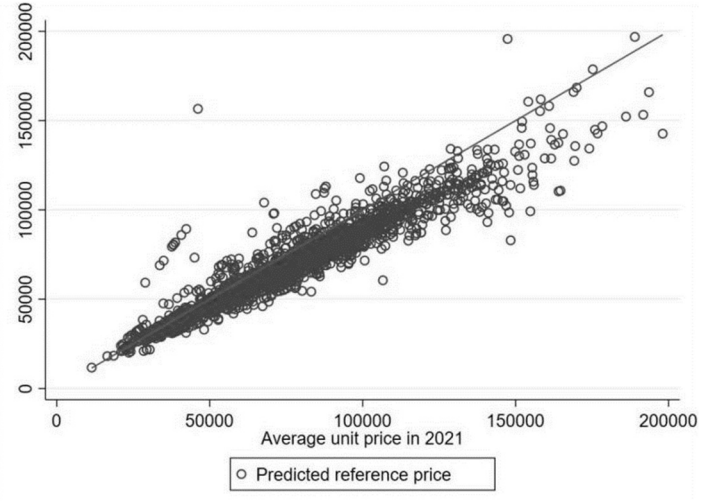
Figure 9 Correlation of Discount Factors and House Price over Months in 2021

3.4 Discussion

Figure 10 presents the predicted RP in 2022 based on the discount factor applied in 2021 and the average house price in our post-regulation sample. Estates with higher unit price are subject to smaller discount factors (more discounted) for RP in 2022.

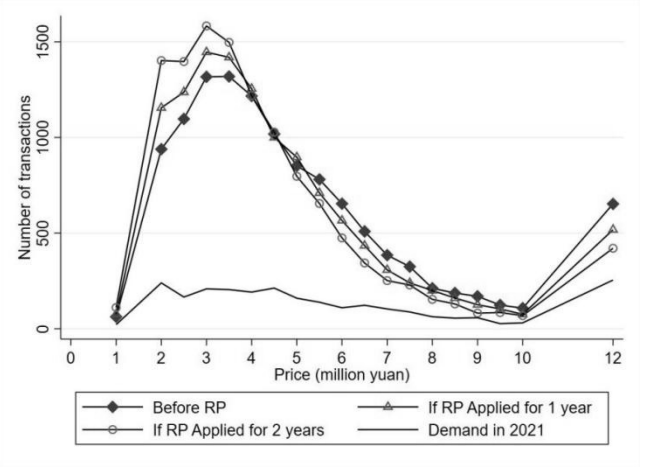
Given data solely on Shenzhen housing market, the effect of the regulation is more challenging to be disentangled. To illustrate potential effects of the policy on trading volume, we conduct a quantitative experiment as follows. We start with a second-hand housing market that is cleared so the market price is the equilibrium price. Then RP is applied to estates and the LTV is based on the RP. Given this, the households who are able to buy certain estates can only afford apartments with lower total values due to the decrease of loans that they can get from banks. Depending on how elastic of the housing supply to prices, some sellers who are more urgent to sell may decrease the price they charge. We use the transaction data in March-September, 2020 to proxy a clear market and use the discount factors we have recovered in last section

as the policy shock. The implied assumption is that Shenzhen housing market is not subject to bubbles, which should be relaxed in more elaborate analysis in the future.



Source: Own construction.

Figure 10 Predicted Reference Price Based on the Discount Factor Applied in 2021



Notes: Quantity before RP is based on the transaction data in 2020. If RP is applied, it displays the counterfactual distribution of demand; this is so, if RP was applied to these developments transacted in 2020.

Source: Own construction.

Figure 11 Shift of the Demand

Figure 11 shows the shift of demand given transaction data in 2020 and suppose the only impact of RP is on LTV ratios. As seen, the demand for apartments with value

above 5 million to 7 million yuan has decreased the most, while the demand for apartments with values lower to 2 to 3 million yuan has increased the most. Such a shift of demand is as expected, due to more credit constraints faced by buyers. If the effect of RP is solely bore by buyers, Figure 11 captures the effect, i.e., a shift of demand. However, if sellers also bare some of the impact, they may have offered lower unit price to sell their properties when they need liquidity more urgently. This requires an introduction of the supply curve to the figure. Depending on how these sellers are distributed along the value bands of the apartments, the supply curves are subject to different forms.

4. Summary and Conclusions

To investigate the effects of RP in Shenzhen, we start with hypotheses derived from a demand-supply analysis, which is complemented by other theoretical models. Taking advantage of a unique panel dataset, we are able to document details of the dynamics of estate level house price for periods before and after the RP regulation. The empirical evidence is consistent with the hypotheses that trading volume and house price decrease after the implementation of the RP. By using OLS analysis, we recover discount factors of reference prices as compared to past house prices. Based on these discount factors, we find a significant discouraging relation between reference price and house price. The negative correlation becomes weaker as time passes, which indicates that the RP policy has tamed house price gradually but successfully over time. In discussions, we predict an updated version of reference prices based on the recovered discount factors and conduct a simple experiment in illustrating the impact of RP on the shift in demand of the housing market.

Overall, our paper provides a rather complete picture of the features, theoretical framework and empirics of Shenzhen RP policy and its impact. As to our knowledge, this is the first contribution to study RP in housing market. Thus, it can be a reference for scholars and policy makers in evaluating the effectiveness of RP in regulating housing market.

More specifically, our study has important policy implications. After the 2008 financial crisis, the macro- prudential policy has become the main policy for countries to deal with systematic risks. As one of the commonly used policies of macro-prudential toolkit, restrictions on LTV are often applied to regulate housing markets. However, such restrictions are seldom applied to accompany reference prices. In this paper, we show that combining these policies may deliver significant effects on cooling down the housing market. The pilot experiment of RP in Shenzhen sheds light on other regions to implement similar policies.

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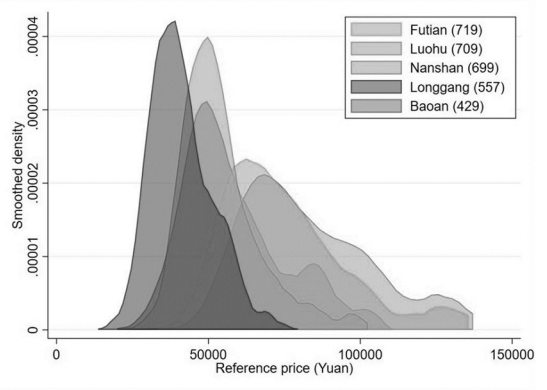
Appendix

Table A.1 A Thought Experiment on the Shift of Demand Given Stricter LTV

P	Q_1	LTV_1 (0.3)	LTV_2 (0.4)	Q_2
100	10	30	40	8
120	8	36	48	3
150	5	45	60	0
200	3	60	80	0

Notes: In the first two columns, we assume four combinations of price and demand. Assume the original LTV is 0.3, the third column shows how much initial savings each buyer in the corresponding group has. Upon a stricter LTV (0.4), the down-payment of estates at all price levels increases. Buyers can only afford estates with lower prices. Column 5 presents the new demand of estates at each price level. There is a shift of demand at each price level.

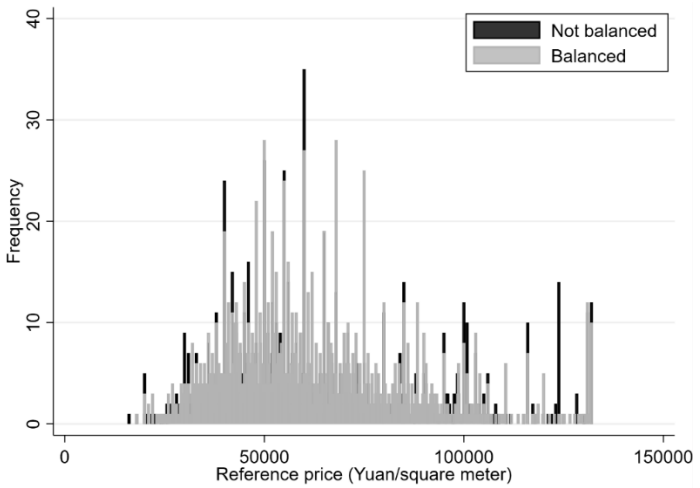
Source: Own construction.



Notes: Futian, Luohu, Nanshan, Longgang and Baoan are five of the 10 districts in Shenzhen. The number in the bracket indicates the number of developments in the corresponding district that are covered by the RP list. The number of estates covered by the list is lower for other districts.

Source: Own construction.

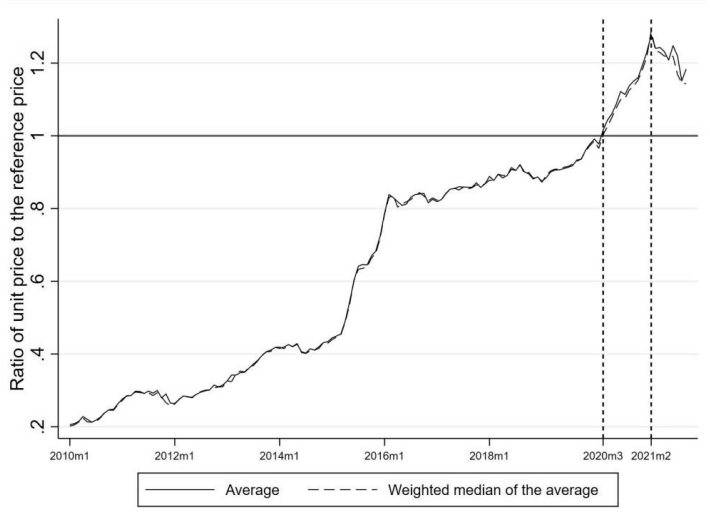
Figure A.1 Regional Distribution of Reference Prices



Notes: This figure presents the distribution of unit price for estates that transaction data for both before and after the regulation are available (black bars) and for estates that such transaction data is not available (grey bars). Only the former can be applied to analyze the impact of the reference pricing regulation. As can be seen, there is not systematical difference in the price distributions of estates for the two groups. Thus, the sample composed of estates with observations before and after the regulation should not be heavily selected in this regard.

Source: Own construction.

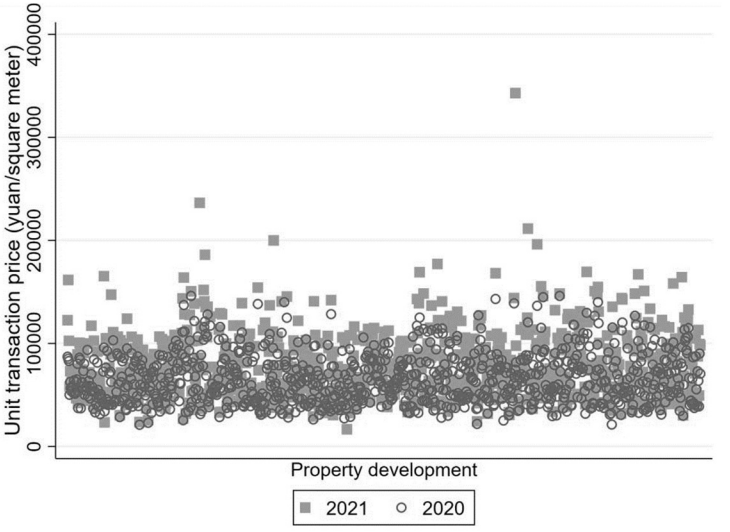
Figure A.2 Distribution of ZDJ for Balanced and Not Balanced Observations



Notes: The figure is drawn based on the sample as long as a given estates can be found in the reference price list.

Source: Own construction.

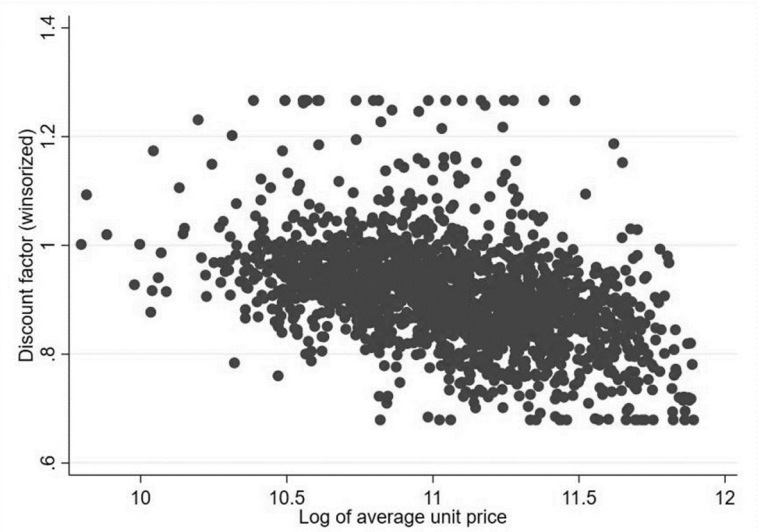
Figure A.3 Distribution of ZDJ for Balanced and Not Balanced Observations



Notes: This figure displays the distribution of average unit price across communities for year 2020 and 2021 (Mar.-Aug.). Observations lying on the same vertical line indicates that they correspond to the same community, as indicated by the axis. The figure shows that for several communities, the average price.

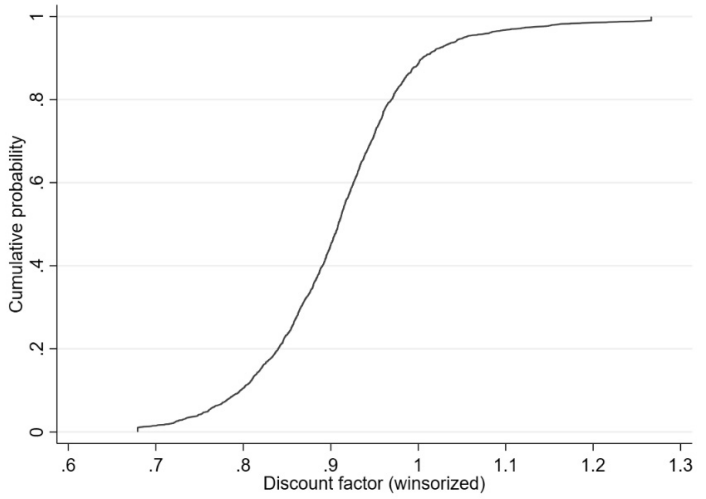
Source: Own construction.

Figure A.4 Distribution of Average Unit Price across Property Developments: 2020-2021



Source: Own construction.

Figure A.5 Distribution of the Discount Factor (Winsorized) against the Log of Average House Price in 2020



Source: Own construction.

Figure A.6 Cumulative Distribution Probability of the Discount Factor (Winsorized)

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