Understanding Misreporting: Responses to a Housing Transaction Tax Notch in China*

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Abstract

In China, for second-hand housing transactions, a business tax is levied on reported housing transaction prices once prices are above a certain threshold. Under an environment with weak enforcement, reported prices could deviate from true prices in response to the tax notch, creating an incentive for misreporting. We obtain from a large real estate broker company a unique dataset that includes both true and reported prices of second-hand housing transactions in Shanghai, which allows us to directly study the misreporting behavior. A simple tax evasion model predicts a novel three-segment misreporting pattern against true prices: no misreporting for houses with true prices below the notch; reported prices equal the notch value for true prices in a certain range above the notch; underreporting is largely constant for true prices well above the notch. The empirical misreporting pattern is remarkably consistent with theoretical predictions. In addition, we explore how various factors affect the misreporting pattern both theoretically and empirically. These factors include tax rate, housing loans, and a policy that imperfectly curbs evasion by setting a lower bound for misreporting. Potential alternative forms of the misreporting cost function are explicitly discussed and tested using data.

Keywords: misreporting, housing transaction tax, tax notch, China.

JEL Codes: H2, H26, R3.

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1 Introduction

How do people evade tax? How does the misreporting pattern depend on the tax schedule? How is the misreporting pattern affected by various factors? These questions are intriguing but are also notoriously hard to answer empirically, due to both data limitations and the mysterious nature of perceived misreporting costs. In this paper, we exploit a unique data set that allows us to measure misreporting directly, which helps us answer the above questions, under the setting of housing transation tax in China.

This paper studies reporting responses to a tax notch at housing transaction prices for second-hand housing transactions in Shanghai. In particular, if the price reported (P_R) to the Housing Management Bureau (HMB) is below a certain threshold $\overline{P}$, no business tax is due; if instead, $P_R > \overline{P}$, then a business tax with a rate $t = 5.6\%$ (a 5% tax plus a 0.6% surtax) needs to be paid. The policy thus creates a jump of business tax liability at the notch point (Blinder and Rosen (1985), Slemrod (2013)). The jump of tax liability equals $t\overline{P}$.

A special feature in our study environment is that for second-hand housing transactions, the reported transaction price P_R needs not to be the same as the true transaction price P_T. Second-hand housing transactions are dealt with by real estate broker companies, who keep record of both P_R and P_T. But only P_R is reported to the HMB, and only P_R matters for potential tax liability. The discrepancy between P_T and P_R for a same house thus provides a straightforward measure of misreporting.

Policy backgrounds vary across economies, which makes our focus on misreporting and previous papers' focus on real responses (e.g. Kopczuk and Munroe (2015), Best and Kleven (2018)) both appropriate. In the U.S., a broker company is required to publicize transaction prices by the government.[1] Since people can easily check their neighbors' housing prices online, it is much easier to check whether other people are misreporting. In addition, since a precisely estimated housing value is required to calculate the property tax due, there is a larger incentive for the local government to ensure a correctly reported housing price. By contrast, in China, brokers are not

[1] We are indebted to Ingrid Ellen for pointing this out.

required to publicize the transcation prices of each house online and property tax has not been implemented broadly. Due to these differences, it is reasonable to expect little misreporting in the U.S. second-hand housing transations and non-trivial misreporting in China.

Our major data source comes from a large real estate broker company, which includes about 15% of all second-hand housing transactions in Shanghai during our data period (April 2015-June 2017). This unique data set includes P_T and P_R for the houses transacted via the real estate company. This provides us a very rare opportunity to study misreporting directly. In addition, we obtain data on all housing transactions from Shanghai HMB. For these houses, we know P_R but not P_T. In many cases where there is tax distortion and misreporting might exist, only the reported value (e.g. price or taxable income) is known; researchers have to use the observed distribution to infer a counterfactual distribution and estimate the response to taxes or other distortions based on that (e.g. Saez (2010), Kleven and Waseem (2013), Rees-Jones (2018)). By contrast, our data allow us to directly observe the extent of misreporting for each observation. We are thus exempt from making potentially strong assumptions on the counterfactual and are able to study the misreporting phenomenon in the most straightforward way.

To start with, we derive predictions from a simple model of tax evasion. We follow the seminal work by Allingham and Sandmo (1972) and Yitzhaki (1974) to assume that true prices are given and people choose reported prices in response to a tax. Note that it is possible that P_T may have been affected by the notch compared to if the notch does not exist (Kopczuk and Munroe (2015), Slemrod et al. (2017), Best and Kleven (2018)). Yet this does not affect the analysis of underreporting. When deciding whether and how much to underreport, people trade off the saved taxes with perceived misreporting costs. Several predictions are derived from the simple model, which together depict a unique three-segment reporting pattern: for houses with true prices below the notch, there would be no misreporing; the reported prices would equal the notch value if true prices are in a certain range above the notch; the reported prices would be largely a constant value below the true prices if true prices are well above the notch. In addition, we expect to see a jump bewteen the second and the third segment.

In the empirical part, using the data obtained from a large real estate broker company, we first document a misreporting pattern that is remarkably consistent with the three-segment reporting pattern. This novel stylized fact precisely confirms the traditional understanding of tax evasion. Starting from this, we conduct a series of exercises on how various factors may affect the misreporting pattern both theoretically and empirically. In particular, we examine the impact of housing loans, the impact of a policy that imperfectly curbs evasion by setting a lower bound for misreporting (i.e. the government-guided price), and the impact of a tax rate change. In addition, we find that as tax rate increases by 1 percentage point, tax evasion amount increases by 1.4285 w RMB, which is 0.29 standard deviations of the evasion amount.

An important contribution of this paper is that we explicitly discuss potential alternative forms of the perceived misreporting cost function and test their implications using data. Understanding the perceived misreporting cost is key to understanding the misreporting behavior, yet previous literature has not examined it sufficiently. Although we cannot exhaust all alternatives, the empirical findings support our main model against major alternative assumptions of misreporting cost. In particular, we show that the empirical misreporting pattern is consistent with the assumption made by Yitzhaki (1974) rather than the alternative assumption of Allingham and Sandmo (1972). In addition, the emprical facts suggest the existence of a positive misreporting cost, and implies that the misreporting cost is not fixed, is not linear, and is not concave. The government-guided price alone cannot drive the empirical misreporting pattern without misreporting cost. Our detailed discussion helps us understand more about the perceived misreporting cost.

Finally, using data from the Shanghai HMB, we conduct placebo tests that confirm the responses of reported prices to notches are not fake. In particular, we show that there is bunching at the notches only for the second-hand housing transactions but not for the new houses sales, as the tax notch only applies to the former. In addition, as the notch places change over time occasionally, bunching traces the notch places over time.

Our paper mainly contributes to the literature of tax evasion.[2] One major contribution of this

[2]See Andreoni et al. (1998), Alm (1999), Slemrod and Yitzhaki (2002), Sandmo (2005), Slemrod (2007) for a more comprehensive review on the literature of tax evasion.

paper is to document the misreporting pattern at ***all*** levels of true tax base under a tax notch, rather than testing or estimating responses to tax at the average level or with limited heterogeneity (e.g. by subgroups). Documenting the whole pattern of misreporting also allows us to test against alternative forms of misreporting cost functions. The literature shows that theoretical predictions of the effect of tax rates on evasion are sensitive to modeling assumptions (Slemrod and Yitzhaki (2002)), yet few papers conduct serious tests against alternative assumptions. We show that the empirical misreporting pattern is remarkably consistent with a model that follows the assumption of misreporting function in Yitzhaki (1974) rather than the alternative assumption in Allingham and Sandmo (1972) or other alternative assumptions.

Studies on tax evasion mostly focus on income taxes, while we provide a case that studies evasion related to taxes levied on housing transaction prices. Since tax evasion is very hard to measure, even until now, papers providing direct evidence of evasion have been rare. Most papers indirectly study evasion using various approaches.[3] Papers providing direct evidence of evasion mostly use stratified random audits data (e.g. Clotfelter (1983), Kleven et al. (2011)), while some measure evasion by comparing self-reported value and third-party reports (e.g. Carrillo et al. (2017)) or using leaks from offshore financial institutions (e.g. Alstadsater et al. (2017)). Different from previous research, this paper uses a unique data set that contains true prices and reported prices of second-hand housing transactions recorded from a private real estate broker company, which provides an even more precise measure of misreporting than using audits data.[4] Different from Carrillo et al. (2017), in the unique data exploited in this paper, the true value is reported by the same source rather than from third-party reports or audits.

In addition, we also contribute to the literature on responses to housing related taxes. Previous papers in this literature mostly emphasize real responses rather than misreporting as the major

[3] For example, see Pissarides and Weber (1989), Fisman and Wei (2004), Marion and Muehlegger (2008), Gorodnichenko et al. (2009), Artavanis et al. (2016).

[4] Related to our study, Agarwal et al. (2018) also study tax evasion in the real estate market in China. While they also investigate the response of misreporting to tax changes, as they focus on a different policy change in a different period, they are unable to study the misreporting pattern under a tax notch and use it to test implications from alternative tax evasion models, which is the main contribution of our paper.

behavioral responses to taxes (e.g. Kopczuk and Munroe (2015), Best and Kleven (2018)).[5] Although their policy environments justify the focus on real responses rather than misreporting, they are unable to provide direct evidence excluding misreporting or evasion as a contributing factor to the behavioral responses they observe. By contrast, in this paper, we focus exclusively on misreporting, thus providing a complementary work to previous studies. This paper thus contributes to this literature by providing convincing evidence of misreporting and evading behaviors in response to housing related taxes. Related to our work, Tam (2016) studies tax avoidance reponses to time notches in housing transaction taxes in Hong Kong and Singapore. Slemrod et al. (2017) study behavioral responses to a price and time notch of residential real estate transfer taxes in Washington D.C.; they provide empirical evidence that there is manipulation of the sales price to evade tax.

The remaining sections are organized as follows. Section 2 introduces policy background of China's housing transaction taxes. Section 3 introduces data. Section 4 builds a simple tax evasion model under the tax notch setting and derives a three-segment misreporting pattern. Section 5 shows a direct test for the theoretical predictions and conduct various empirical analyses of misreporting. Section 6 concludes.

2 Policy Background

2.1 Housing Transactions in China

There are two kinds of housing sales: new houses and second-hand houses. In China, new houses are directly sold to customers by real estate developer companies, while second-hand houses are traded between individuals.[6] However, second-hand housing transactions rarely happen directly between individuals for two reasons: First, due to asymmetric information, sellers do not have enough channels to find potential buyers and buyers have a similar problem. This calls for a plat-

[5]Relatedly, Besley et al. (2014) study the incidence of a housing transaction tax in the U.K.

[6]In Chinese major cities, housing purchases are mostly second-hand houses. The supply of new houses is much smaller than second-hand houses (see Figure 7). This is particularly true for housing purchases in downtown area, where new houses are rare.

form to gather and publicize information and facilitate transactions. Second, the procedures related to second-hand housing transactions are very involved; individuals would find it too costly to deal with all issues themselves on housing evaluation, taxes, loans from banks, housing management, and others. Therefore, most individuals resort to real estate broker companies to handle second-hand housing transactions.

2.2 Major Housing Transaction Tax

Business income tax (BIT) is the major tax paid in the second-hand housing transactions. In China, once a buyer and a seller signs a contract on housing transaction with a true transaction price P_T, they need to report a price P_R to the Housing Management Bureau (HMB). Often, these two prices may differ. Since only P_R is observable to the HMB, it is the base for taxes. A business tax is levied on second-hand housing transactions if the reported sales prices P_R are above a certain threshold $\overline{P}$.[7] If $P_R \leq \overline{P}$, no business tax is due; if instead, $P_R > \overline{P}$, then a business tax with a rate $t = 5.6\%$ (a 5% tax plus a 0.6% surtax) needs to be paid. The policy thus creates a jump of business tax liability at the notch point. The jump of tax liability equals $t\overline{P}$. By contrast, new houses do not face such a tax notch.[8] By law, the business income tax should be remitted by sellers. But by tradition, all taxes and fees in the process of housing sales are paid by buyers.

Table 1 shows the tax notches in Shanghai from 2008 to now. The notch level is determined as 1.44 times the average housing price in a broad region and thus varies across regions and is subject to change occasionally over time. Since houses are more expensive in inner city than in the outer region, the notch thresholds are also higher in inner city. In particular, there are three locations for notch purposes: within the inner ring, between outer and inner ring, and outside the outer ring.[9]

[7] In addition to this constraint, the house area should not exceed 140 square meters to be exempted from the business tax. The fraction of houses exceeding 140 square meters is quite small (only 8% in our real estate broker company data). Thus, to focus on the incentive created by the notch, we restrict our analysis on houses below 140 square meters.

[8] It is not that new housing transactions do not need to pay any business taxes. They do. But the business taxes are levied as a fraction of all new housing sales revenue of a real estate developer company. There is no tax notch for individual new housing sales.

[9] Shanghai is geographically divided into several regions by overpasses, which are described as rings because they are like circles. Starting from the city center, three rings (inner ring, middle ring, and outer ring) divide Shanghai into three broad regions.

For period after November 20, 2014, the notch for housing transactions within the inner ring, between outer and inner ring, and outside the outer ring is 450w RMB, 310w RMB, and 230w RMB, respectively.[10] There are also several changes in the notches over time. Two changes happened in March 1, 2012 and November 20, 2014, when the notches for all locations increased discontinuously. These policy changes provide us opportunities to examine the behavioral responses to tax notch changes.

Table 1: Shanghai Housing Tax Notches (w RMB)

Location	Period 1 (2008-Feb 29, 2012)	Period 2 (Mar 1, 2012-Nov 19, 2014)	Period 3 （Nov 20, 2014-Now）
Within the Inner Ring	245	330	450
Between Outer and Inner Ring	140	200	310
Outside the Outer Ring	98	160	230

Note: 1w=10,000.

VAT-for-BIT reform. Since May 1, 2016, the business income tax (BIT) has been replaced by the value-added tax (VAT). This is a major tax reform in China, aiming at improving the taxation system. Prior to the reform, economic activities are subject to either BIT or VAT varying by industries. But the BIT is imposed on the value of sales, which may result in a double taxation problem (i.e. cascade tax). The VAT avoids this problem, as it is applied to the value added at each link in the production chain. Thus, the tax reform is designed to abolish the BIT entirely and have all industries subject to the VAT. Since the tax reform, industries like construction, real estate, financial and consumer services sectors have switched from the BIT to the VAT regime.

But for the second-hand housing transactions, this reform only changes the tax rate slightly, without changing the tax base or any other aspect. Both before and after the reform, the tax base is the reported price. The tax notch does not change; the standard for houses to enjoy the lower rate does not change. The only thing that has been changed is the effective tax rate: it decreases from t to $\frac{t}{1.05}$. We explore the implications of this reform in section 5.3 in detail.

[10]Here w denotes *wan* in Chinese, which is a very commonly used unit. 1w=10,000. The exchange rate is 1 USD=6.14 RMB (2014), 6.23 RMB (2015), 6.64 RMB (2016), 6.75 RMB (2017).

2.3 Government-Guided Price

Since the government cannot observe the true housing transaction prices, to combat tax evasion, it sets a so-called government-guided price P_G to prevent unreasonably low reported price. The government-guided price sets the lower bound for reported transaction prices.[11] P_G is determined based on the recent record of reported prices of second-hand housing transactions in a specific region and thus could vary across region (within a city) and over time. P_G is a restriction on price per area rather than the total reported price. Let A denote the area of a house, then it requires that $\frac{P_R}{A} \geq P_G$. In some sense, the government-guided price sets a lower bound for tax liability in a spirit like a presumptive tax, which is widely used when the exact tax base is hard to measure precisely. Normally, P_G is not publicly available, but the real estate broker companies might have a reasonable estimate of it based on previous transactions.

2.4 Other Taxes and Fees

There are several other taxes and fees involved in second-hand housing transactions. They are relatively small compared to the business income tax and thus do not play a major role in our analysis of the impact of the BIT notch on misreporting. But they may account for some side facts that cannot be solely explained by the BIT notch, which we will examine explicitly later.

Deed tax. The deed tax is proportional to P_R and the rate depends on the number of houses a buyer has and the area of the house. For the first house owned by a family, the tax rate is 1% if the house is below 90 m^2, 1.5% if above 90 m^2. If it is not the first house owned by a family, the tax rate is 3%, regardless of the area.

Personal income tax. By law, the personal income tax (PIT) involved in a second-hand housing transcation is levied on the seller. But in reality, it is mostly the buyer who pays it. The PIT is

[11] For new houses sales, the government normally sets an upper bound for housing sales prices, in order to curb the fast growth of new houses sales prices. For second-hand housing transactions, in rare cases, the government may also sets an upper bound for transaction prices.

exempt if the seller has owned the house for at least 5 years and it is the only house of the seller. If either condition is not satisfied, the PIT needs to be paid. There are two ways to calculate the PIT amount. First, it can be calculated as 20% times (sales price - original purchase price - taxes and fees paid in the transaction). To use this method, the seller must provide a complete and accurate certificate for the purchase price of the house. Second, it can be 1% times the reported price. In practice, whichever method generates a lower tax will be chosen. In practice, the latter method is adopted in most cases in Shanghai, since the HMB does not update the original purchase price to the tax bureau.

Commission fee. For houses transacted with the help of real estate brokers, a commission fee applies. The fee can be 1-3% of the true price varying across different agents. There are some other fees, though they are minor and negligible.

2.5 Housing Loans

If people tend to buy a house using loans from a bank, the bank will decide the loan amount L based on an evaluated price P_E. The bank would asks an evaluation company to evaluate the house, probably because the bank cannot observe P_T and does not believe P_R reflects the true price. An evaluation fee needs to be paid by the buyer, though the fee is small relative to taxes. Normally, the evaluated price P_E is lower than P_T; on average it is about 70-80% of P_T. The bank sets L to be equal to a loan multiplier ρ_L times $min\{P_R, P_E\}$.[12] Then the down payment paid by the buyer equals $P_T - L$. For buyers who face large down payment pressure, they may have an incentive to report a higher P_R or negotiate with the evaluation company or the bank to claim a higher evaluated price.

[12] Actually L not only depends on P_R, but also depends on the estimated wealth and income of the buyers. But we do not have information on wealth or income. Conditional on wealth and income, L is largely proportional to $min\{P_R, P_E\}$. Wealth and income may affect ρ_L.

3 Data

Data from a private real estate broker company. Our major data come from a large private real estate broker company in China. We obtain all second-hand residential housing transactions data dealt with by this company from April 2015 to June 2017 in Shanghai. It includes about 15% of all second-hand housing transactions in Shanghai during this period. The unique advantage of this dataset is that it includes both true sales prices and the prices reported to the Housing Management Bureau (HMB). The reported price rather than the true price (unknown to the HMB) is the basis for housing transaction taxes. Thus, the data provide us a unique opportunity to study potential misreporting behavior in the process of housing transactions. Other information provided by this dataset includes transaction date, house area, and location (within the inner ring, between outer and inner ring, or outside the outer ring). For about 75% of transactions, we have information of the housing loans.

Housing Management Bureau data. In addition, we obtain data from Shanghai HMB on all housing transactions in Shanghai. The data include not only second-hand housing transactions (February 2011- June 2017), but also all new houses transactions (January 2012-August 2015). Still, all the houses included in this dataset are for residential usage. The HMB only has information on reported prices but not true prices of all housing transactions. Other information provided by this dataset includes transaction date, house area, and location. Online Appendix Figure A6 shows the number of housing transactions and prices in the data used in this paper. In each month, there are thousands of second-hand houses transactions handled by the sample real estate broker company; there are tens of thousands of new houses sales and second-hand houses transactions recorded by Shanghai HMB. The number of transactions and prices fluctuate over time.

Comparing second-hand housing transactions in two data sets. Our major analysis is based mostly on the broker company data, as we focus on the relation between reported price and true price for a given housing transaction. The HMB data is mainly used to provide some placebo tests.

Since the private real estate broker company only covers 15% of all second-hand housing transactions in Shanghai during the sample period, it is not necessarily representative of the whole housing market in Shanghai. To see the potential difference, we examine summary statistics of key variables for second-hand housing transactions handled by this company versus all transactions recorded by the HMB during period April 2015-June 2017. Table 2 shows that while the distribution of areas of houses are comparable in two data sets, reported prices are generally larger for houses handled by the broker company. The location of houses handled by the broker company are more likely to be located within the inner ring or between outer and inner ring, where houses are more expensive. Even within each region, the housing prices are higher for houses handled by the broker company. This is not surprising as transactions of more expensive houses are more likely to be dealt with by a broker company.

Table 2: Summary Statistics: A Comparison of Two Datasets (April 2015-June 2017)

		Broker	HMB
Reported price (w RMB)			
	Mean	313.68	243.07
	S.D.	255.24	281.62
	Median	235	186
	90th Percentile	582	449
	10th Percentile	124	75
Area (square meter)			
	Mean	83.06	83.65
	S.D.	40.56	71.88
	Median	75.30	75.19
	90th Percentile	135.25	131.85
	10th Percentile	41.25	41.59
Location (fraction)			
	Within the Inner Ring	0.2	0.14
	Between Outer and Inner Ring	0.46	0.37
	Outside the Outer Ring	0.34	0.49
Observations		104812	681824

Note: 1w=10,000.

4 Theoretical Predictions From a Simple Model

Our model setting largely follows the seminal work on tax evasion by Allingham and Sandmo (1972) and Yitzhaki (1974), where true price P_T is taken as given and is known by the taxpayer but not by the tax bureau.[13] Tax is levied based on the reported price P_R, which is the taxpayer's decision variable. There is a tax notch at $\overline{P}$, below which no tax is due and above which the average tax rate is t.

We make two simplifying assumptions. First, misreporting $P_U \equiv P_T - P_R$ is associated with a cost $C(tP_U)$.[14] Assume $C > 0, C' > 0, C'' > 0$, and C is continuously differentiable. This assumption says misreporting cost will increase convexly with the scale of tax evasion. These assumptions are broadly consistent with the law, which specifies that the punishment on tax evasion is progressively more severe if a larger amount of tax is evaded.[15] [16] Second, all other taxes and fees are ignored.

[13]Note that P_T should not be regarded as the counterfactual price without a tax. In fact, a tax should well affect P_T in general, unless demand is completely inelastic or supply is completely elastic. Instead, P_T is the true price that have been affected by the tax. This paper focuses on the misreporting responses to tax, thus focusing on the difference between P_T and P_R is appropriate. Figure A5 shows the distributions of P_T around a tax rate change due to the VAT-for-BIT reform. In response to a tax rate decrease above the notch, we expect to see the more expensive houses to be traded more. Yet the pre-reform distribution might not work as a perfect counterfactual distribution for the post-reform period, as the transactions of second-hand houses fluctuate over time. Even focusing on the same months of pre-reform and post-reform periods, as we do in Figure A5, cannot address this issue cleanly. In addition, people owning more expensive houses may wait to sell their houses until after the tax rate falls. As a result, the evidence shown in Figure A5 is not clean enough to answer the potential impact of a tax rate change on P_T. Thus, in this paper, we do not examine this issue and focus only on misreporting.

[14]Note that while Allingham and Sandmo (1972) assumes the cost function to be $C(P_U)$, the famous response by Yitzhaki (1974) assumes the cost function to be $C(tP_U)$. Yitzhaki (1974) points out that the latter is more in line with tax laws in many countries. We adopt the Yitzhaki (1974) assumption and explicitly test it against the Allingham and Sandmo (1972) assumption in section 5.6.

[15]*The Criminal Law of the People's Republic of China* (as amended on November 4, 2017) clause 201 specifies the punishment for tax evasion. In particular, if the tax evasion amount is between 10,000 RMB and 100,000 RMB or is 10-30% of the tax due, the evader can be put in prison for less than 3 years and fined by 1-5 times the evaded tax amount. If the tax evasion amount is over 100,000 RMB or over 30% of the tax due, the evader can be put in prison for 3-7 years and fined by 1-5 times the evaded tax amount. If tax evasion is extremely severe, a life imprisonment or even a death penalty is possible.

[16]A traditional explanation of the misreporting cost is to interpret it as the expected fine due to misreporting, as people underreporting income faces investigation by tax authorities. The expected fine equals the probability of being caught times the punishment (e.g. fines or put into jail) conditional on being caught. If both the probability of being caught and the punishment conditional on being caught are linear (and positively related) to the tax evasion amount, then the expected fine would be convex with respect to tP_U. Note the probability and punishment here should be interpreted as the expected probablity and expected punishment as perceived by the taxpayers. It is possible that the expected probablity and expected fines are not the same as the objective probability and the actual fines. Moral costs of misreporting should well be included in the perceived misreporting cost. In Allingham and Sandmo (1972) and Yitzhaki (1974), for ease of solution, the probability of being audited is assumed as a constant.

The first assumption will be explicitly tested against alternative assumptions using our data in section 5.6. The empirical facts are consistent with our benchmark model and are against alternative assumptions. Other taxes and fees will also be discussed explictly later. Although they help explain some side facts, thet do not drive the major misreporting pattern.

A person chooses P_R to minimize the total cost (tax liability plus misreporting cost):

$$min_{P_R} t \cdot P_R \cdot \mathbf{1}[P_R > \overline{P}] + C(t(P_T - P_R)), \tag{1}$$

where $\mathbf{1}[P_R > \overline{P}]$ is a dummy indicating whether $P_R > \overline{P}$ holds.[17]

If $P_T \leq \overline{P}$, given these simplifying assumptions, we expect to see $P_R = P_T$. Since misreporting is assumed to be associated with a positive cost, there is no gain to misreport for those with $P_T \leq \overline{P}$, whose business tax due is already zero.

If $P_T > \overline{P}$, due to the jump of tax liability, there would be a strong incentive to underreport. Since $C' > 0$, the solution P_R can only be either $\overline{P}$ or some value larger than $\overline{P}$. If $P_R = \overline{P}$, then the total cost is $C(t(P_T - \overline{P}))$. If $P_R > \overline{P}$, then total cost is $t \cdot P_R + C(t(P_T - P_R))$; in this case, P_R would be the solution to $t - tC'(t(P_T - P_R)) = 0$. Since $C'' > 0$, we have a unique solution:

$$P_R = P_T - \frac{C'^{-1}(1)}{t}.$$

It implies that underreporting $P_U = \frac{C'^{-1}(1)}{t}$ will decrease with the tax rate t, same as the prediction in Yitzhaki (1974). Note that we need $P_T - \frac{C'^{-1}(1)}{t} > \overline{P}$ to ensure an interior solution (here we mean $P_R > \overline{P}$). This requires the true price P_T to above the notch $\overline{P}$ with at least $\frac{C'^{-1}(1)}{t}$.

With this solution, the total cost when $P_R > \overline{P}$ would be

[17] Allingham and Sandmo (1972) framed the problem as a utility maximization problem from the perspective of the buyer. However, in our case, the reported housing transaction price is potentially determined collectively by buyer, seller, and the broker. Then the problem would be more like a Nash bargaining setting (Besley et al. (2014), Kopczuk and Munroe (2015), Slemrod et al. (2017)). To avoid making assumptions about the utility function and the bargaining power parameter of each person, we focus on the cost minimization problem, which is a necessary condition for solving the Nash bargaining game. Cost minimization is not only a necessary condition for Nash bargaining but also a necessary condition for any form of utility maximization. Thus, it may be the weakest condition that should be satisfied under this setting. In our setting, the misreporting cost should be interpreted as a cost faced collectively by all sides (buyer, seller, and the broker) who together make the underreporting decision.

$$C_{Interior} = t \cdot P_T - C'^{-1}(1) + C(C'^{-1}(1)),$$

where $P_T > \frac{C'^{-1}(1)}{t} + \overline{P}$.

Comparing it with

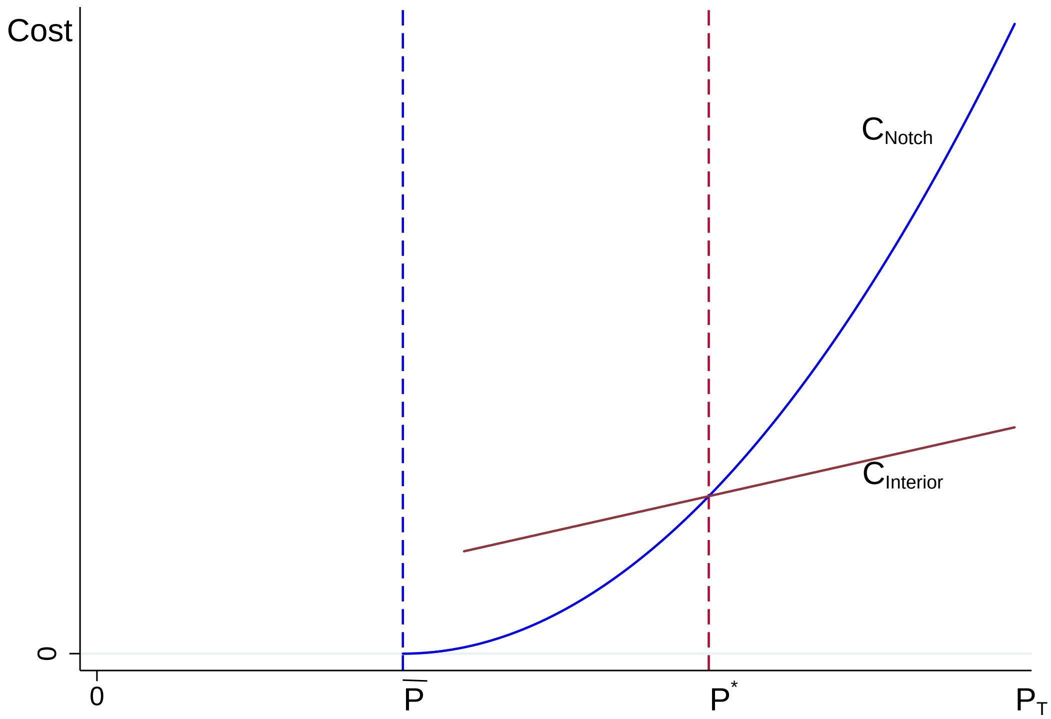
$$C_{Notch} = C(t(P_T - \overline{P})),$$

which is the total cost when misreporting to the notch point, i.e. $P_R = \overline{P}$, we can see how people would choose.

Figure 1 illustrates the choice based on the total cost for reporting housing prices. Since $C'' > 0$, C_{Notch} convexly increases starting from $\overline{P}$. By contrast, $C_{Interior}$ is a linear cost line with a slope t. Without making additional assumption, the two cost curves do not necessarily cross. In that case, the only possibility is that C_{Notch} is always above $C_{Interior}$, which implies no bunching at the notch at all. Our data show clear bunching of P_R at $\overline{P}$, refuting this possibility. Therefore, the two curves must cross. A linear line can only cross once with the right half of a convex curve, thus we have a unique solution to $C_{Interior} = C_{Notch}$. Denote the solution as P^*. Since $C_{Interior}$ starts from $P_T > \frac{C'^{-1}(1)}{t} + \overline{P}$, we know $P^* > \frac{C'^{-1}(1)}{t} + \overline{P}$. For houses with true prices close enough to the notch, i.e. $P_T \in (\overline{P}, P^*)$, the optimal choice is $P_R = \overline{P}$. This would create a bunching at the notch point $\overline{P}$. For houses with true prices well above the notch, i.e. $P_T > P^*$, the optimal choice is $P_R = P_T - \frac{C'^{-1}(1)}{t}$. If people share a similar misreporting function, or, much more weakly, if the curvature of the misreporting cost function $C(P_U)$ is largely the same for all individuals at $t = 100\%$, then the underreported amount $\frac{C'^{-1}(1)}{t}$ would be largely the same for all $P_T > P^*$, which can be examined directly using our data.

Key prediction: three-segment reporting pattern. The simple tax evasion model predicts a novel three-segment reporting pattern

Figure 1: Total Cost for Reporting Housing Prices



Notes: Total cost includes tax liability plus misreporting cost when choosing P_R for a given P_T. $C_{Interior}$ is the optimal total cost when $P_R > \overline{P}$, and C_{Notch} is the total cost when $P_R = \overline{P}$.

$$P_R = \begin{cases} P_T & if\, P_T \leq \overline{P}, \\ \overline{P} & if\, P_T \in (\overline{P}, P^*) \\ P_T - \frac{C'^{-1}(1)}{t} & if\, P_T > P^*, \end{cases} \tag{2}$$

where P^* is the solution to $C_{Interior} = C_{Notch}$.

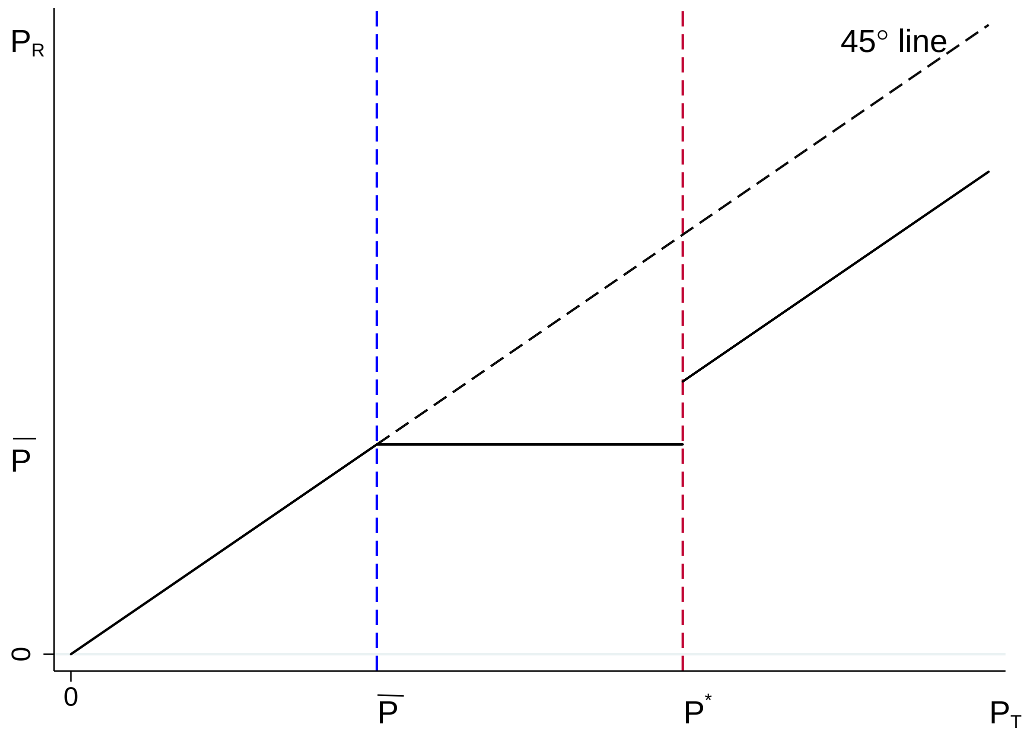
Figure 2 illustrates the pattern graphically. In the first segment ($P_T \leq \overline{P}$), there is no misreporting; the reporting price is a 45° line against the true price. In the second segment, i.e. $P_T \in (\overline{P}, P^*)$, $P_R = \overline{P}$. We expect to see a bunching for the distribution of transactions at $\overline{P}$. In the third segment ($P_T > P^*$), we expect to see a largely constant underreporting, given that people share a similar misreporting cost function $C(.)$. In addition, it is worth noting that there is a jump between the second and the third segment. For $P_T > P^*$, we have $P_R = P_T - \frac{C'^{-1}(1)}{t}$; when $P_T \to P^{*+}$, $P_R \to P^* - \frac{C'^{-1}(1)}{t}$. Since we already know $P^* > \frac{C'^{-1}(1)}{t} + \overline{P}$, we have $P_R \to P^* - \frac{C'^{-1}(1)}{t} > \overline{P}$ when $P_T \to P^{*+}$. This shows a clear jump of P_R as a function of P_T at P^*, though without assuming a functional form of $C(.)$, we can say nothing about the extent of the jump, which becomes an empirical question.

5 Empirical Facts of Misreporting

5.1 Distribution of True Prices and Reported Prices

Are these predictions supported by empirical regularities of our data? The three-segment price reporting pattern suggested in Figure 2 is quite sharp and we are motivated to see if it is consistent with data. But before doing that, let's first examine the distribution of true prices P_T and reported prices P_R, respectively. Since the business tax is based only on P_R rather than P_T, we expect to see a smooth distribution of P_T and a bunching of P_R at the notch. Since the notches are different for houses in different regions, we show them separately. We cluster observations in bins with a width=10w RMB.

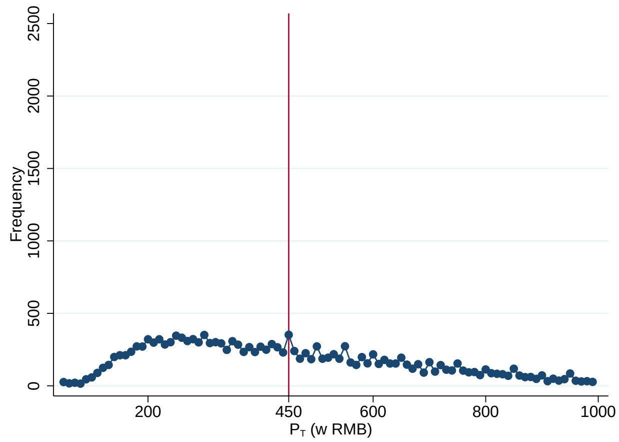
Figure 2: Predicted Pattern of Housing Price Reporting



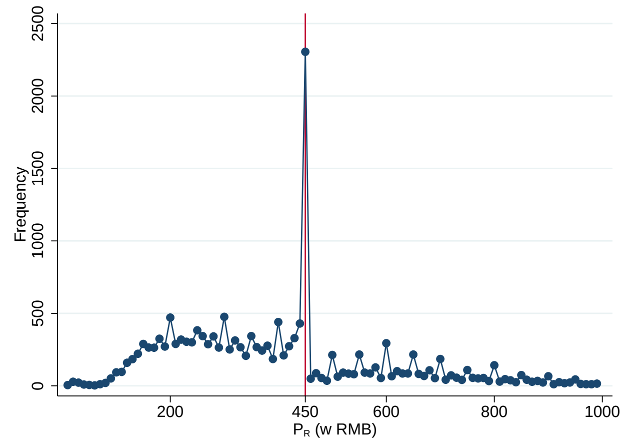
Using the broker company data, Figure 3 shows the distribution of P_T and P_R for the same transactions in each region separately. As expected, we see a smooth distribution of P_T and a clear bunching of P_R at the notch for all three regions. This provides a first support of our model. Importantly, the sharp difference between distributions of P_R and P_T shows clear evidence for misreporting in response to the tax notch. By contrast, previous papers studying behavioral responses to housing transaction tax notches generally emphasize real responses rather than misreporting as the major behavioral responses to taxes (e.g. Kopczuk and Munroe (2015), Best and Kleven (2018)). It is possible that under the specific policy environment in their studies, the opportunities to misreport price or evade tax are rare or do not exist. However, due to data limitations, they are unable to provide direct evidence excluding misreporting or evasion as a contributing factor to the behavioral responses they observe. Using data with both true prices and reported prices, we provide convincing evidence for misreporting under our setting.

Figure 3: Distribution of True Prices and Reported Prices

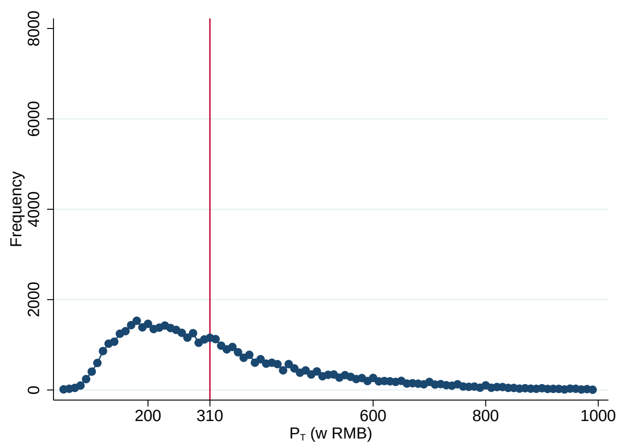
(a) True Prices: Within the Inner Ring



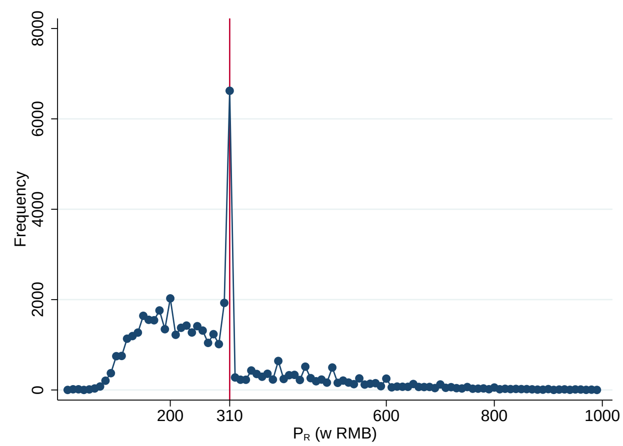
(b) Reported Prices: Within the Inner Ring



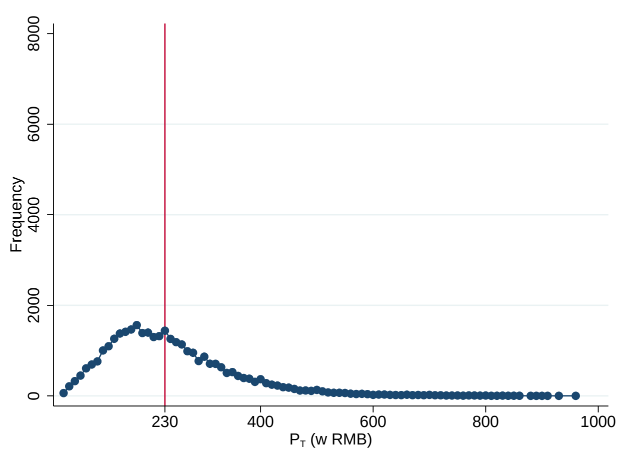
(c) True Prices: Between Outer and Inner Ring



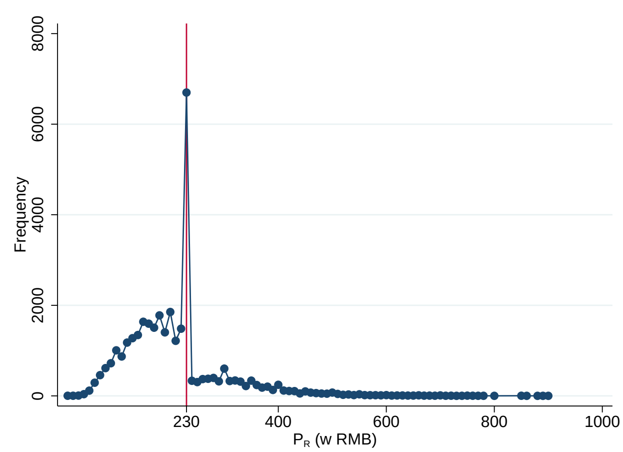
(d) Reported Prices: Between Outer and Inner Ring



(e) True Prices: Outside the Outer Ring



(f) Reported Prices: Outside the Outer Ring



Notes: bin size=10w RMB. To facilitate comparison between the distributions of reported prices and true prices, we use the same y-scale for the same area.

5.2 Novel Stylized Fact: Three-Segment Reporting Pattern

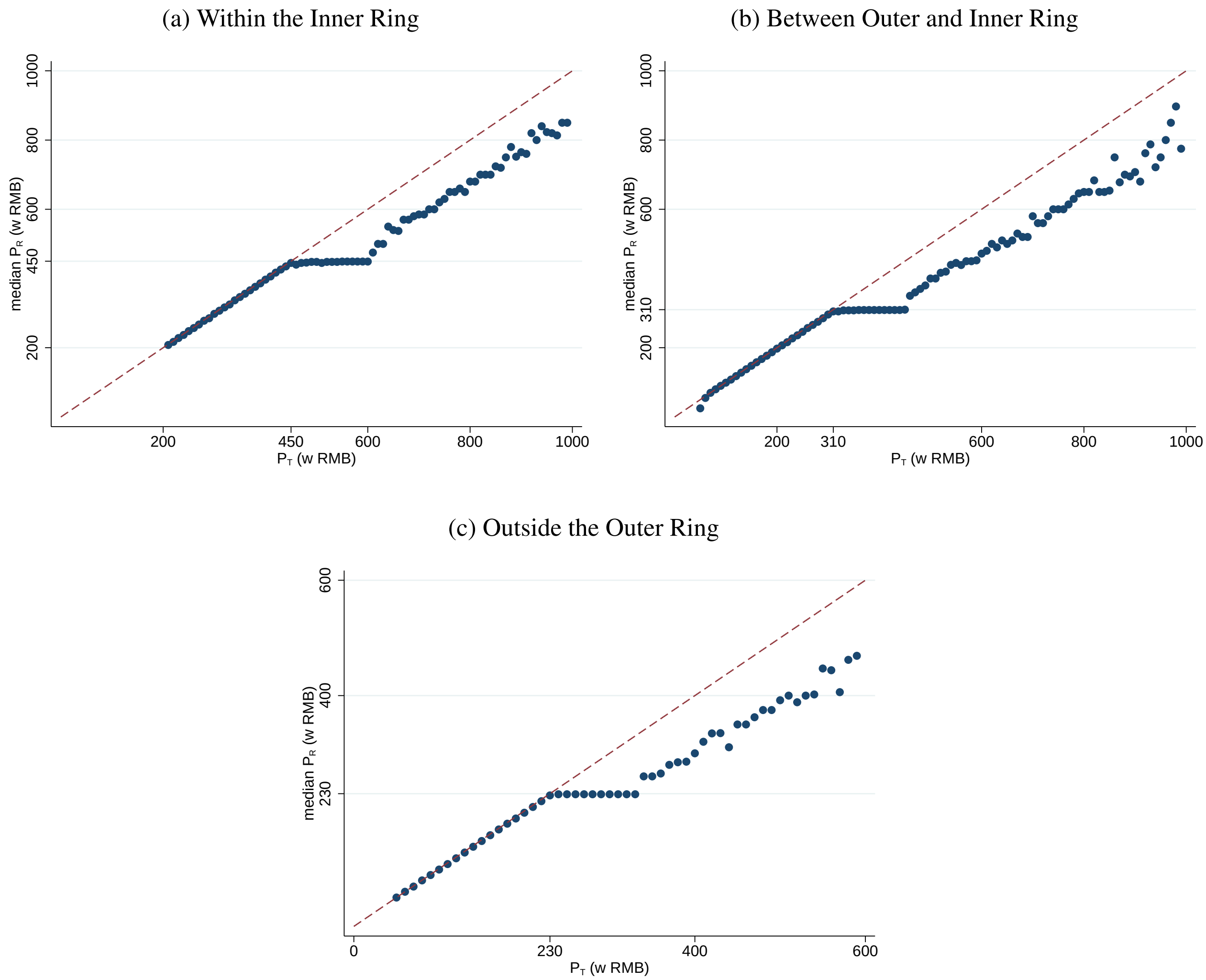
Now we examine the main prediction of our model, the three-segment reporting pattern as illustrated in Figure 2. Figure 4 shows the empirical pattern of housing price reporting against true transaction prices. To examine the representative individual behavior, we focus on the median reported price for each true price bin. Using the mean reported price would show a slightly different pattern, as implied by our discussion of heterogeneity in Online Appendix A. Figure 4 shows that for each notch, the empirical pattern of reported prices against true prices is exactly the same as the predicted pattern suggested in Figure 2. In particular, in the first segment, for $P_T \leq \overline{P}$, we do see $P_R = P_T$; in the second segment, for P_T in a certain range above $\overline{P}$, we do see $P_R = \overline{P}$; the third segment does imply a largely constant underreporting for P_R well above $\overline{P}$. Furthermore, we do observe a small jump between the second and the third segment. The jump is not remarkable, yet does exist; note that the model only predicts such a jump but does not predict its extent. Overall, the empirical reporting pattern confirms our model predictions in a remarkable way. It implies that the representative individuals do behave exactly as the model predicts.

Some people might feel this misreporting pattern to be surprising and implausible. After all, why should the multi-million RMB apartments underreport the same amount as the apartments with P_T just above the notch? This is because for a given tax rate, on the one hand, the benefit of underreporting (i.e. tax saving) depends only on the price underreporting amount, on the other hand, the cost of underreporting depends only on the tax evasion amount, which is proportional to the price underreporting amount. Since P_T does not play any role in either benefit or cost side, at least in our simple model, it is not surprising that the underreporting amount has nothing to do with P_T in the interior solution segment (i.e. the third segment).[18]

While Figure 4 shows that the representative individual behaves exactly as the theory predicts, heterogeneous reporting behaviors could well exist. In Online Appendix A, we examine potential heterogeneity of misreporting on two margins. On the extensive margin, we explore the heterogene-

[18]To see this more clearly, note that assuming an interior solution, equation 1 can be rewritten as $min_{P_U}\, tP_T - tP_U + C(tP_U)$. It is clear that P_T should have no impact on P_U.

Figure 4: Empirical Pattern of Reported Housing Prices Against True Prices



Notes: bin size=10w RMB. The dashed line is a 45-degree line.

ity of whether people underreport or not. On the intensive margin, we examine the heterogeneous misreporting patterns among those who underreport. Overall, while our simple model is able to capture the main misreporting pattern, omitted factors (e.g. other taxes and fees, housing loans, idiosyncratic misreporting costs) may be helpful explaining the heterogeneous misreporting patterns.

5.3 Responses of Misreporting Pattern to a Tax Rate Change

Since May 1, 2016, the business tax has been replaced by the value-added tax. The notch does not change; the standard for houses to enjoy the lower rate does not change. The only thing that has been changed is the effective tax rate: it decreases from t to $\frac{t}{1.05}$. How would the three-segment reporting pattern be affected? There should be no change for the first segment; we still have $P_R = P_T$ if $P_T \leq \overline{P}$. The general patterns for the second and third segments also do not change: the second segment is a flat line starting from $\overline{P}$ to P^*; the third segment is a parallel downward shifting of the 45° line that crosses the origin point; there is a discontinuous jump from the second segment to the third segment. The only changes are the place of P^* and the extent of the downward shifting.

First, we examine how P^* would be affected theoretically. Note that P^* is the solution to $C_{Interior} = C_{Notch}$, where $C_{Interior} = t \cdot P_T - C'^{-1}(1) + C(C'^{-1}(1))$ and $C_{Notch} = C(t(P_T - \overline{P}))$. Taking derivative of the equation with respect to t and simplifying it, we have

$$\frac{dP^*}{dt} = \frac{P^* - C' \cdot (P^* - \overline{P})}{(C' - 1)t},$$

where C' is evaluated at $t(P^* - \overline{P})$. Since $C' - 1$ has an ambiguous sign, the overall expression has an unclear sign. Thus, how P^* would be affected is unclear.

Second, we examine how the extent of the downward shifting would change. For the third segment, $P_R = P_T - \frac{C'^{-1}(1)}{t}$. It is clear that $\frac{C'^{-1}(1)}{t}$ would increase when t decreases. Thus, we predict that the downward shifting would be more for the post-reform period than for the pre-reform period.

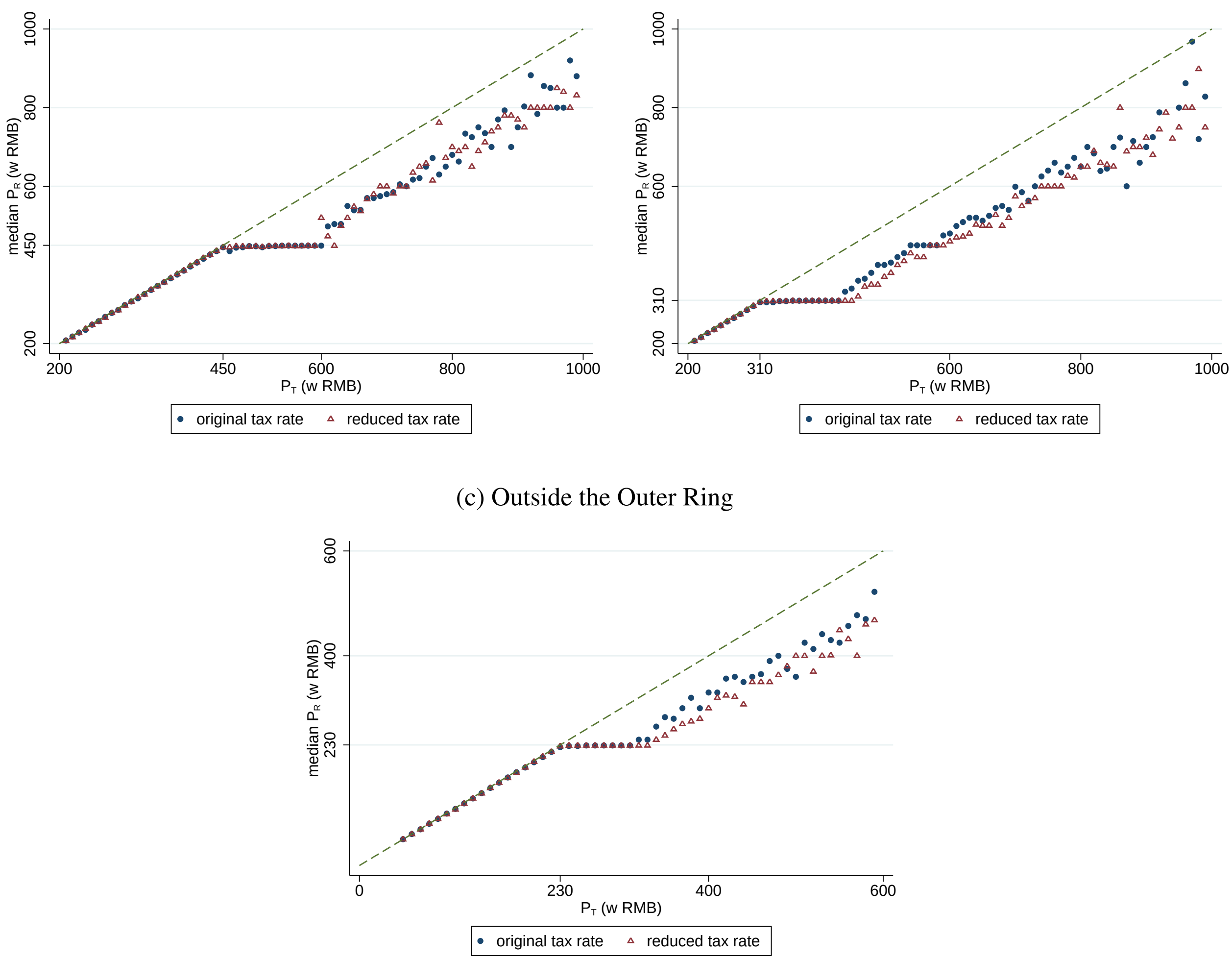
In Figure 5, we show the empirical misreporting pattern for pre-reform months (April 2015-April 2016) in period 3 and that for post-reform months (May 2016-June 2017), when the tax rate decreases. Although the change in reporting patterns for houses within the inner ring is less salient, changes for reporting patterns of houses bewteen outer and inner ring and houses outside the outer ring are just as predicted by theory. We do see the third segment shifts downwards to a larger extent after the tax rate dercrease, though the extent is quite small.

Figure 5: Empirical Reporting Responses to Reduced Tax Rate

(a) Within the Inner Ring

(b) Between Outer and Inner Ring

(c) Outside the Outer Ring



Notes: bin size=10w RMB. The dashed line is a 45-degree line.

Given the relatively small change of reporting patterns due to the small tax rate change in period 3, for ease of analysis, it is reassuring for us to merge all observations in period 3 together in the rest of this paper. While we investigate the qualitative predictions of how reporting patterns respond to a tax rate change here, we conduct a quantitative analysis on the relation between tax rate and tax evasion in section 5.7.

5.4 The Impact of Government-Guided Price on Misreporting

5.4.1 Government-Guided Price

The government-guided price P_G is set to curb underreporting. Let A denote the area of a house, then it requires $\frac{P_R}{A} \geq P_G$. How would the government-guided price affect reporting? The most straightforward implication is that houses with a smaller $\frac{P_T}{A}$ are more likely to be binded by P_G and thus are less likely to underreport.[19] Thus, a testable implication is: **Underreporting is positively associated with $\frac{P_T}{A}$, for a given P_G.**

For a house with a true price P_T and facing a given P_G, the larger area A it has, the smaller $\frac{P_T}{A}$ it would have, and the more likely its unconstrained optimal reported price would be binded by P_G. Thus, we have a second testable implication: **Conditional on P_T and P_G, underreporting is negatively associated with A.** The variation of A conditional on P_T and P_G would then generate a heterogeneous pattern of misreporting.

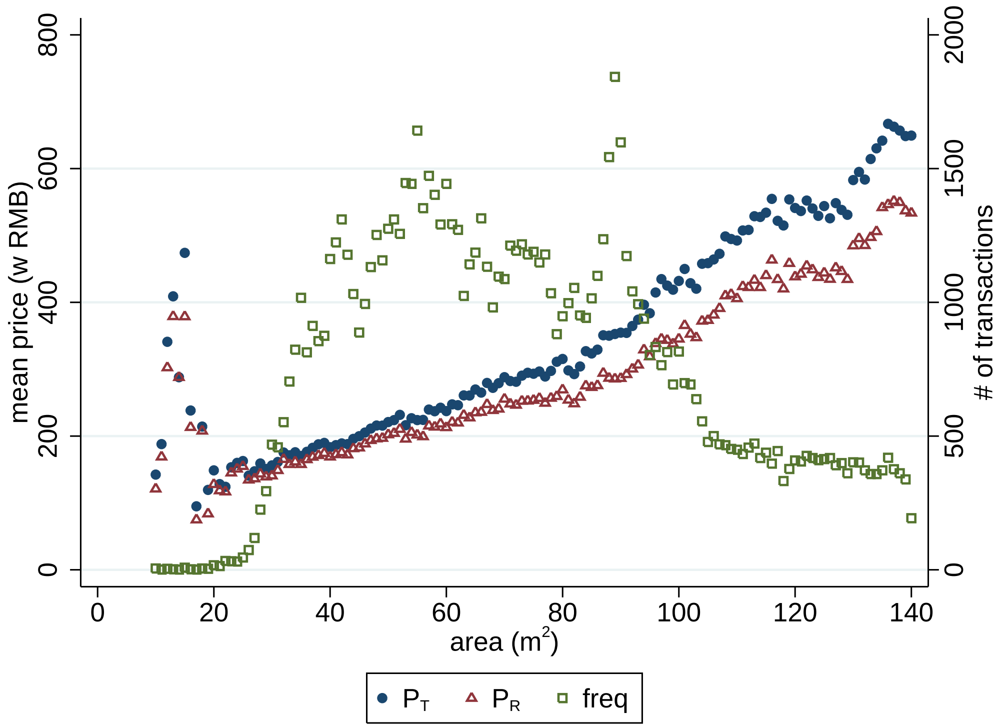
5.4.2 House Prices, Area, and Underreporting

Before testing these predictions, let's have a look at the relation between house prices and area of houses. Figure 6 gives us a sense of the distribution of second-hand housing transactions handled by the broker company by area of houses. In China, area is normally measured by square meter (m^2) . Overall, we see a general trend of increasing price, either for true price or for reported price, with area. An exception is that for houses smaller than 20 m^2, the mean prices are abnormally high. This is probably due to the unique "school district housing" phenomenon in China. In China, to get access to the outstanding public primary or middle schools, it is necessary to own houses in the region where the schools are located. Sometimes, the school district housing is not for living purpose and thus its area can be quite small. But the demand for excellent education resource is

[19]Note that since the unconstrained optimal reported price P_R weakly increases with P_T, houses with a smaller $\frac{P_T}{A}$ would have a smaller unconstrained $\frac{P_R}{A}$.

so high that a few very rich families can bid up the prices of these houses to a very high level. Yet the supply of such houses in the second-hand housing market is very limited, as shown in Figure 6. Therefore, in the later analysis, we exclude houses smaller than 20 m^2.[20] The bunching at 90 m^2 is due to a small deed tax rate increase (0.5%) there for the first house owned by a family. The area of most houses ranges from 40 to 100 m^2.

Figure 6: Prices of Houses by Area



Notes: We use data from the real estate broker company (April 2015-June 2017) to produce this figure.

First, we test the prediction that underreporting is positively associated with $\frac{P_T}{A}$, for a given P_G. We use two measures for underreporting. At the extensive margin, we examine whether there is any price underreporting in a transaction. At the intensive margin, we examine to what extent the price is underreported conditional on underreporting. The regression is as follows

[20]Online Appendix Figure A8 shows the distribution of all second-hand housing transactions in Shanghai as recorded by the HMB during the same period. The distribution of area is similar. The transaction prices are lower than houses handled by the broker company, as shown earlier. But for houses smaller than 20 m^2 there is no abnormally high prices. Thus, the abnormally high prices as handled by the broker company presents the self-selection of high-value school district housing into the broker company data as compared to the universe.

$$UR_{irm} = \beta \frac{P_{T,irm}}{A_{irm}} + \eta_m + \eta_r + \eta_{rm} + \varepsilon_{irm},$$

where UR_{irm} is a measure for price underreporting in a transaction i in region r of month m. For extensive margin regressions, UR_{irm} is an indicator for underreporting. For intensive margin regressions, UR_{irm} is $\frac{P_{U,irm}}{P_{T,irm}}$, the evasion ratio. The interested coefficient is β. In addition, we include month fixed effects η_m and region fixed effects η_r to account for region-invariant time-specific factors (e.g. inflation and time-specific policy changes) and time-invariant region-specific factors (e.g. differential economic levels and population density across regions). Although P_G is unobservable to us, we know it varies across region and over time. Thus, including region-month fixed effects η_{rm} would help control for the impacts of government-guided prices and other factors varying with both region and time (e.g. differential development of the housing market across regions over time). ε_{irm} is the error term.

Table 3 column 1 shows the extensive margin regression result. It shows that when the price per area increases by 1w RMB/m^2, the probability of underreporting would on average increase by 0.093. Column 2 shows the intensive margin regression result. It shows that focusing on those underreporting observations, when the price per area increases by 1w RMB/m^2, the evasion ratio increases by 0.007, i.e. 0.7 percentage points. All associations in Table 3 are statistically significant at 1% level. Thus, the evidence is consistent with our prediction.

Second, we test the prediction that conditional on P_T and P_G, there would be a negative relation between A and underreporting. The regression is as follows

$$UR_{irm} = \gamma A_{irm} + f_{rm}(P_{T,irm}) + \eta_m + \eta_r + \eta_{rm} + \varepsilon_{irm},$$

where γ is the interested coefficient, which measures the conditional association between area of houses and underreporting. Since our model and empirical results show a highly nonlinear relation between P_T and the misreporting pattern, we control for P_T in a highly non-parametrical way. We take two forms of $f_{rm}(P_{T,irm})$: decile-by-month-by-region fixed effects and percentile-by-month-by-region fixed effects.

Table 3 columns 3 and 4 show results when $f_{rm}(P_{T,irm})$ takes the form of decile-by-month-by-region fixed effects. We see a significantly negative association between area of houses and underreporting, both at the extensive margin and at the intensive margin, consistent with our prediction. Columns 5 and 6 show results when $f_{rm}(P_{T,irm})$ takes the form of percencile-by-month-by-region fixed effects. The results are very similar.

Table 3: Underreporting and Area of Houses

	[1]	[2]	[3]	[4]	[5]	[6]
Dep. Var.	Underreport	Evasion Ratio	Underreport	Evasion Ratio	Underreport	Evasion Ratio
P_T/Area	0.093***	0.007***				
	(0.001)	(0.001)				
Area			-0.0004***	-0.0003***	-0.0005***	-0.0003***
			(0.000)	(0.000)	(0.000)	(0.000)
Control of P_T			decile-by-month-by-region FE		percencile-by-month-by-region FE	
Observations	96,077	49,356	96,077	49,356	96,077	49,356
Adjusted R-squared	0.065	0.118	0.209	0.152	0.211	0.157

Notes: In all regressions, we have controlled for region fixed effects, month fixed effects, and region-by-month fixed effects. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

5.4.3 An Imperfect Solution to Underreporting

The government-guided price sets a lower bound for underreporting and thus cannot entirely prevent it. A partial reason for this imperfect solution to underreporting is technical: it is impossible or would incur unreasonably high cost to precisely estimate the true price of each second-hand housing transaction. Although it might be possible to set the government-guided price in a way to make the average misreporting close to zero, it must also have a fraction of people pay more than they ought to, and thus is undersirable. Why does not the government directly ask the broker company to hand in the true prices data? Since evasion is illegal, the broker company is unlikely to have incentive to do so. Given the high housing prices in China, this imperfect way to curb underreporting might alleviate households' fiscal burden, and thus could be understood as an equilubrium result in some sense. But why not set a lower tax rate with a strict enforcement? We do not know, maybe due to the high cost associated with a perfect enforcement. Misreporting is expected to be reduced if similar policies of the U.S. are adopted – requiring brokers to publicize the housing transaction prices online and implementing a property tax. Reform may just take time. At least for now, the imperfect solution to underreporting provides an opportunity to study the misreporting behavior.

5.5 How do Housing Loans Affect Misreporting?

Although housing loans are not driving the three-segment misreporting pattern, they could still affect misreporing. Those who want to get loans would have a lower tendency to underreport, since loans positively depend on $min\{P_R, P_E\}$. To examine this conjecture, we use the following regression

$$UR_{irm} = \gamma Loan_{irm} + f_{rm}(P_{T,irm}) + \eta_m + \eta_r + \eta_{rm} + \varepsilon_{irm},$$

where γ is the interested coefficient, which measures the conditional association between housing loans and underreporting. To account for the highly nonlinear relation between P_T and the misreporting pattern, we include $f_{rm}(P_{T,irm})$ as percentile-by-month-by-region fixed effects. As before, we take two measures of UR_{irm}: an indicator for any underreporting, and the unreported price as a fraction of the true price. We also take two measures for $Loan_{irm}$: an indicator for any positive housing loans, and housing loans as a fraction of the true price.

Table 4 shows the result. Column 1 shows that having housing loans would significantly reduce the possibility of underreporting, by about 0.2. Column 3 shows that conditional on those having housing loans, the more one relies on housing loans, the less one would underreport. Since the area of houses would affect underreporting, we control for area in columns 2 and 4. The coefficients of area are remarkably consistent with Table 3 and the coefficients of housing loans are almost unchanged, suggesting area and housing loans affect underreporting largely independently.

Table 4: Underreporting and Housing Loans

Dep. Var.	[1] Underreport	[2] Underreport	[3] Evasion Ratio	[4] Evasion Ratio
Have Housing Loans	-0.2165***	-0.2163***		
	(0.003)	(0.003)		
Area		-0.0004***		-0.0004***
		(0.000)		(0.000)
Loans/P_T			-0.2088***	-0.2092***
			(0.002)	(0.002)
Control of P_T	percencile-by-month-by-region FE			
Sample	All		Have housing loans	
Observations	96,077	96,077	73,767	73,767
Adjusted R-squared	0.244	0.244	0.37	0.372

Notes: In all regressions, we have controlled for region fixed effects, month fixed effects, and region-by-month fixed effects. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

5.6 Testing Against Alternative Forms of the Misreporting Cost Function

In this section, we discuss potential alternative forms of the misreporting cost function and their implications. Although we cannot exhaust all alternatives, the empirical findings support our main model against major alternative assumptions of misreporting cost. In the end, we discuss the cost function in more detail.

5.6.1 Yitzhaki (1974) vs Allingham and Sandmo (1972)

A major response to the Allingham and Sandmo (1972) model is by Yitzhaki (1974), who points out that if the reporting cost (i.e. a penalty conditional on detecting underreporting) is a function of the evaded tax rather than the undeclared income, then the original result about the tax effect on underreporting changes. In our model, replacing the cost function by $C(P_T - P_R)$ will also generate a three-segment reporting pattern. However, the prediction about the response to a tax rate change is just the opposite.

To see this, note that with a cost function $C(P_T - P_R)$, the first-order condition would be $t - C'(P_T - P_R) = 0$, which renders $P_U \equiv P_T - P_R = C'^{-1}(t)$. Since $C' > 0$, this implies that underreporting increases with t in the third segment. This is in sharp contrast with the implication obtained by assuming a cost function $C(t(P_T - P_R))$. The reason for the contrast lies in how the marginal cost (MC) of underreporting depends on t: When the cost function is $C(P_T - P_R)$, the MC of underreporting is independent of t; when the cost function is $C(t(P_T - P_R))$, the MC of underreporting is $tC'(t(P_T - P_R))$, clealy a function of t. The way t enters the margianl cost-benefit tradeoff determines the contrast between the two models. Previous literature largely remains silent about a serious test between these two assumptions. Fortunately, our data allow us to conduct a direct test between the two contrasting predictions.

Section 5.3 shows how a small tax rate change due to a tax reform affects the misreporting pattern. When the cost function is $C(t(P_T - P_R))$, the third segment of the reporting pattern is $P_R = P_T - \frac{C'^{-1}(1)}{t}$, which will shift downwards as t decreases. By contrast, when the cost function is $C(P_T - P_R)$, the third segment is $P_R = P_T - C'^{-1}(t)$, which will shift upwards as t decreases. The empirical evidence in section 5.3 supports the Yitzhaki (1974) assumption against the Allingham and Sandmo (1972) assumption, at least under our policy environment.

5.6.2 Refuting Many Other Alternative Assumptions

The empirical reporting pattern documented in Figure 4 rules out many alternative assumptions of misreporting cost. First of all, it suggests there exists a positive misreporting cost. If there is no misreporting cost, P_R can be any value below $\overline{P}$ for $P_T \leq \overline{P}$, and we should also observe $P_R \leq P_T$ for all $P_T > \overline{P}$. Since we do not see these, some positive misreporting cost must exist. Second, it suggests the misreporting cost is not fixed, is not linear, and is not concave. If the misreporting cost is ϕ, i.e. fixed and common to all individuals, people will simply choose P_R to be either P_T or zero, whichever giving the smaller total cost. Then we would expect to see people with $P_T > \frac{\phi}{t}$ choose $P_R = 0$. Since we do not see this, this cannot be true. If the misreporting cost is linear, i.e. $C(tP_U) = \alpha + \beta(tP_U)$, with $\alpha > 0$, $\beta > 0$, we should expect to observe all people choose$P_R = \overline{P}$ (if $\beta < 1$) or $P_R = \infty$ (if $\beta > 1$). Since we do not see this, this also cannot be true. Furthermore, if the cost function is concave, a graph similar to Figure 1 implies that we should see $P_R = \overline{P}$ for all transactions with P_T larger than a certain value. But we do not see this in Figure 4. Thus, the misreporting cost cannot be concave.

Another potential form of the misreporting cost function is $P_T \cdot f(\frac{P_T - P_R}{P_T})$, i.e. the cost depends on the true price times a function f of the evasion ratio. In this case, the interior solution is $P_R = (1 - C'^{-1}(t))P_T$, i.e. reported price is a proportional fall from the true price. But this is inconsistent with the third segment (the interior solution part), which suggests this possibility does not hold. In addition, in practice, since P_T is unknown to the government, this cost function may be inconsistent with a plausible government auditing and enforcement regime.

5.6.3 No Misreporting Cost, Only Government-Guided Price?

Absent direct evidence of actual fines on the misreporting of housing transaction prices, there is a concern that factors other than misreporting costs might generate the reporting pattern we observe. The only potential factor that may directly affect the reporting pattern in this setting is the government-guided price P_G. But can P_G alone drive the empirical patterns we have documented? Without misreporting cost, given the tax saving benefit from underreporting, people will choose $P_R = A \cdot P_G$. For a given P_G in a region, it is unlikely for the heterogeneous distribution of A to generate the reporting pattern as documented in Figure 4.[21] Therefore, P_G alone cannot drive the empirical patterns we see and there must exist some misreporting costs.

5.6.4 How to Understand the Misreporting Cost?

It is well recognized that it is the perceived or expected costs rather than the objective or actual costs that matter for decision making. Thus, in our case, the misreporting cost should also be interpreted as the perceived cost instead of the actual punishment. But what is in the perceived cost? The law clearly states the punishment for tax evasion. Individuals may have a vague impression of the potential punishment but may not know the details of the law clauses. Yet the real estate broker company, with the help of professional lawyers in their team, must know it well. Given the

[21] Since P_G cannot be predicted when constructing houses, and notch $\overline{P}$ is subject to change over time, it is impossible to adjust A when constructing houses in order to make $A \cdot P_G$ just below the notch.

law clauses, even if currently there were no fines or punishment for misreporting in housing transactions, the taxpayers see the possibility that the tax authority may trace back their underreporting in the future and punish them, as has been recently experienced by top earners and enterprices that have evaded or avoided taxes in China. Thus, the perceived cost of misreporting reasonably exists.

Given the lack of evidence on auditing and punishment on misreporting in second-hand housing transactions, the objective costs seem to be much lower than the perceived costs. Yet this is just what has been documented by the literature. In a comprehensive review of the literature on tax compliance, Andreoni et al. (1998) find that people comply much more than is predicted by theory. The discrepancy between a standard model and actual tax compliance reflects the difference between the actual noncompliance cost and the perceived noncompliance cost. While the fundamental reason for this discrepancy still waits for further research, an immediate implication is that policymakers can achieve a high compliance target by paying much lower costs.

5.7 Tax Rate and Tax Evasion

What is the relation between tax rate and tax evasion? This is an empirical question of great interest to researchers, government and the general public. In general, this question is hard to answer due to both measurement and identification issues. Yet in this paper we have an appropriate setting to study this question in a simple and straightforward way.

In genenal, the impact of tax rate on tax evasion is theoretically ambiguous and is largely an empirical question, which depends on the elasticity of the underreporting tax base with respect to the tax rate $\frac{dlnP_U}{dlnt}$. If the elasticity (absolute value) is larger than 1, then tax evasion decreases with tax rate, and vice versa. Among papers that study the response of tax evasion to marginal tax rate changes, some find $\frac{dE}{dt} > 0$ (e.g. Clotfelter (1983), personal income tax in the U.S.; Marion and Muehlegger (2008), diesel fuel tax in the U.S.; Fisman and Wei (2004), import tariff in China; Kleven et al. (2011), individual income tax in Denmark), some find $\frac{dE}{dt} < 0$ (e.g. Feinstein (1991), personal income tax in the U.S.). The differential responses depend on specific policy environments of each study. Thus, the relation between tax rate and tax evasion obtained in a specific setting is normally hard to have external validity.

Our theoretical model predicts that $P_R = \overline{P}$ if $P_T \in (\overline{P}, P^*)$ and $P_R = P_T - \frac{C'^{-1}(1)}{t}$ if $P_T > P^*$, which is consistent with the empirical pattern. For those with $P_T \in (\overline{P}, P^*)$, their extent to evade tax is constrained by the notch. Therefore, we focus on the unconstrained people, i.e. those with $P_T > P^*$. The tax evasion amount is $E \equiv t \cdot (P_T - P_R)$. For $P_T > P^*$, the simple model predicts that $E = C'^{-1}(1)$, which implies a zero effect of tax rate on evasion. That is, any change in the tax rate would be entirely offset by the adjustment of underreporting amount P_U. This is because in equation 1, t and P_U are inseparable.[22] But if the misreporting cost take some other form such as $C(tP_U, P_R)$, i.e. if it not only depends on the tax evasion amount, but also depends on the reported house value (plausible if the probability of auditing depends on the house value), then this zero effect result will not hold.

In the following, we examine the impact of a tax rate change (due to the VAT-for-BIT reform) on the evasion amount. Note that this should not be regarded as a fail-proof test of our simple model. Instead, it suggests to what extent our parsimonious model deviates from the empirical pattern. Any deviation thus implies the necessity to consider other factors for specific purposes.

To estimate the impact of tax rate on tax evasion formally, we use the following regression

$$E_{irm} = \alpha_1 t_{irm} + \alpha_2 \frac{P_{T,irm}}{A_{irm}} + \alpha_3 Loan_{irm} + \eta_r + \varepsilon_{irm},$$

where the evasion amount E_{irm} equals the prevailing tax rate times $(P_{T,irm} - P_{R,irm})$ and t_{irm} denotes the tax rate (in percentage points). α_1 measures the impact of tax rate on tax evasion. Since the tax rate changes only once and varies only with time, we cannot control for the tax rate and the time fixed effects simultaneously. However, as the government-guided price P_G changes over time (and across region), this could cause omitted variable bias if P_G is correlated with both E_{irm} and other independent variables (e.g. η_r). To address this issue, we restrict our sample to houses with large enough $\frac{P_{T,irm}}{A_{irm}}$. The idea is that houses with a large enough true price per area are less

[22] Tax rate and undeclared tax base (i.e. income) are also inseparable in the expected utility maximization problem of the seminal paper Yitzhaki (1974). But Yitzhaki (1974) does not predict an explicit relation between underreporting and the true value, since the form of utility function is unknown.

likely to be constrained by P_G. For houses unconstrained by P_G, we would expect to see that $\frac{P_{T,irm}}{A_{irm}}$ has no impact on E_{irm}. Admittedly, as we are unable to control for the time fixed effects, we have to assume that evasion does not change over time systematically. As we focus on a relatively short period, this assumption might be reasonable. Yet given such concern, we admit that the coefficient should be interpreted with caveats.

Regressions are restricted to observations in the third segments of Figure 4 to focus on the transactions unconstrained by the tax notch. Table 5 shows estimation results. Column 1 shows the result without restricting $\frac{P_{T,irm}}{A_{irm}}$. Tax rate is positively related with tax evasion. $\frac{P_T}{A}$ is positively and loan ratio is negatively related with evasion, consistent with earlier findings. Columns 2-4 restrict sample to houses with the top 50%, top 25%, and top 10% $\frac{P_{T,irm}}{A_{irm}}$ within each region by month, respectively. As sample is restricted to a higher percentile $\frac{P_{T,irm}}{A_{irm}}$, the coefficient α_2 converges to zero, consistent with our expectation. In column 4, α_2 becomes very close to zero, which implies that P_G has no impact on evasion for these houses. Our preferred specification column 4 suggests that as the tax rate increases by 1 percentage point, tax evasion will increase by 1.4285 w RMB, which is 29% of the standard deviation of the evasion amount in the regression sample. To address the concern that the mean estimates might be driven by some extreme evasion amounts, column 5 runs a quantile regression at median using the same sample as column 4. The estimates are consistent with column 4, which shows a slightly larger positive relation between tax rate and evasion amount.

Given this result, should the government thus decrease the tax rate to constrain tax evasion? From a social welfare perspective, a tax change should be evaluated not only by its impact on evasion, but also its real impact (e.g. on true prices and trading volumns), as well as the resource costs of tax evasion and social weights of people with different housing values. With relevant parameters estimated, a welfare analysis could be done, following Gorodnichenko et al. (2009). As the focus of this paper is only on misreporting, these considerations are well beyond the scope of this paper.

Table 5: Response of Tax Evasion to Tax Rate

DV: Tax Evasion	[1] OLS	[2] OLS	[3] OLS	[4] OLS	[5] Quantile (median)
Tax Rate (pct. points)	3.21***	2.42***	1.81***	1.43***	2.02***
	(0.28)	(0.32)	(0.38)	(0.52)	(0.69)
P_T/Area	0.25***	0.16***	0.09***	0.030	0.010
	(0.02)	(0.03)	(0.03)	(0.04)	(0.05)
Loans/P_T	-12.51***	-12.74***	-12.78***	-12.41***	-19.15***
	(0.17)	(0.19)	(0.22)	(0.31)	(0.41)
Sample: P_T/Area	All	Top 50%	Top 25%	Top 10%	Top 10%
Observations	13,928	11,950	8,455	4,544	4,544
Adjusted R-squared	0.302	0.309	0.307	0.291	
mean(DV)	5.4	5.505	5.634	5.856	5.856
std(DV)	4.565	4.648	4.765	4.886	4.886

Notes: In all regressions, we have controlled for region fixed effects. Regressions are restricted to observations in the third segments of Figure 4 to focus on the transactions unconstrained by the tax notch. Columns 2-4 restrict sample to houses with the top 50%, top 25%, and top 10% $\frac{P_{T,irm}}{A_{irm}}$ within each region by month, respectively. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

5.8 Placebo Tests

5.8.1 New Houses Sales vs. Second-Hand Housing Transactions

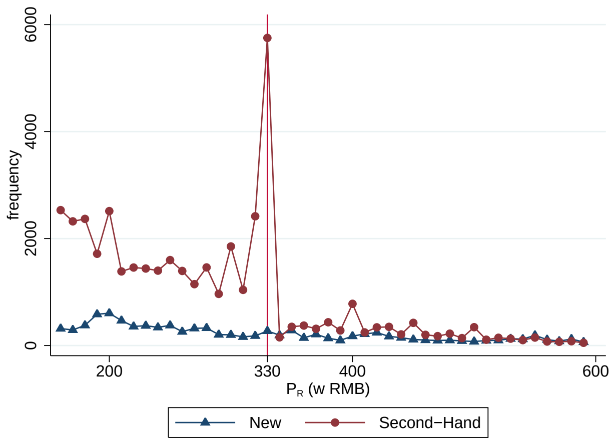
Since only second-hand transactions face tax notches while new houses sales do not, the reported prices for new houses sales are expected not to respond to the business tax notches. To examine this, we use data from Shanghai Housing Management Bureau. Figure 7 shows the distributions of reported prices from March 1, 2012 to Novermber 19, 2014.[23] As expected, while there is a clear bunching at the business tax notches for second-hand housing transaction prices, the distribution of new houses sales prices is entirely smooth around the notch. The number of new houses sales within the outer ring is much less than that of second-hand housing transactions, due to a restricted supply of new houses there. By contrast, there is little restriction of new housing sales outside the outer ring. In that region, the distribution of new houses sales is similar to that of second-hand

[23]We focus on this period because over 70% of our data from Shanghai HMB fall into this period. Using data after Novermber 19, 2014 shows a similar pattern.

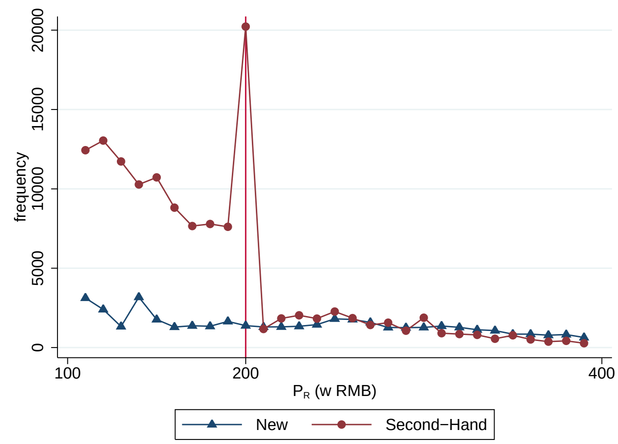
housing transactions in places other than close to the notch, while the sharp contrast is clear around the notch. Relative to the distribution of new houses sales, the distribution of second-hand housing transactions has a bunching at the notch and a hole above the notch, as predicted by the standard bunching theory (Kleven and Waseem (2013)).

Figure 7: Reported Prices of New Houses Sales vs. Second-Hand Housing Transactions

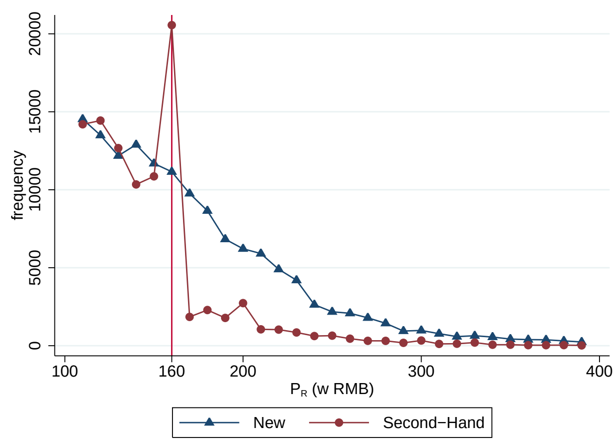
(a) Within the Inner Ring



(b) Between Outer and Inner Ring



(c) Outside the Outer Ring



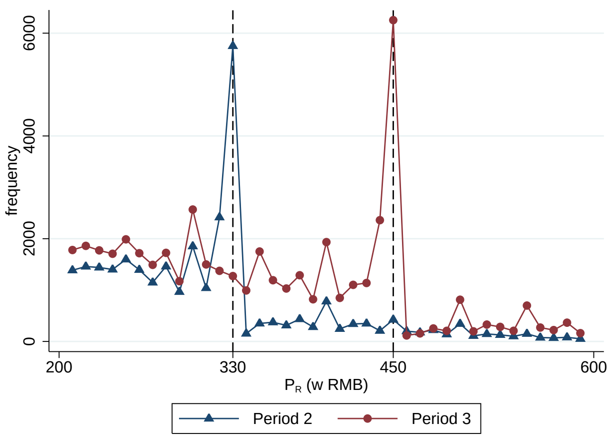
Notes: bin size=10w RMB. Sample period: March 1, 2012 – Novermber 19, 2014.

5.8.2 Dynamic Responses of Bunching to Notch Changes

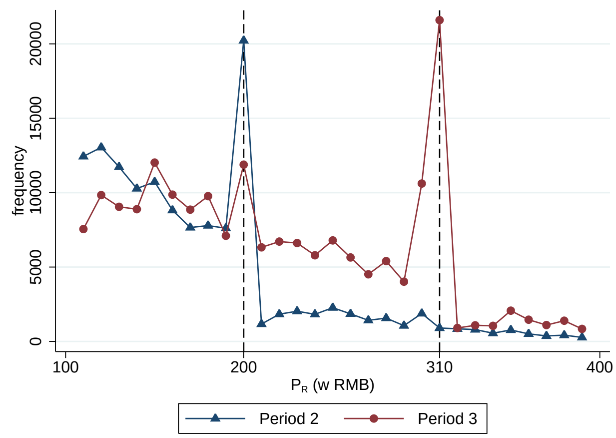
Another standard placebo test under the notch setting is to examine whether there is no bunching when a notch is not implemented and there is bunching when it is implemented. To examine this, we use the HMB data to see the dynamic bunching responses of P_R to notch changes. We show evidence in period 2 (March 1, 2012-Nov 19, 2014) vs period 3 (Nov 20, 2014-June 30, 2017). Observations of period 1 in our data are relatively few (7.94%), while those of period 2 (40.16%) and period 3 (51.9%) are more comparable. Figure 8 shows that in all locations, there is no bunching at a notch when it is not implemented[24], and that bunching disappears in old notches and forms in new notches clearly.

Figure 8: Dynamic Responses of Bunching to Notch Changes

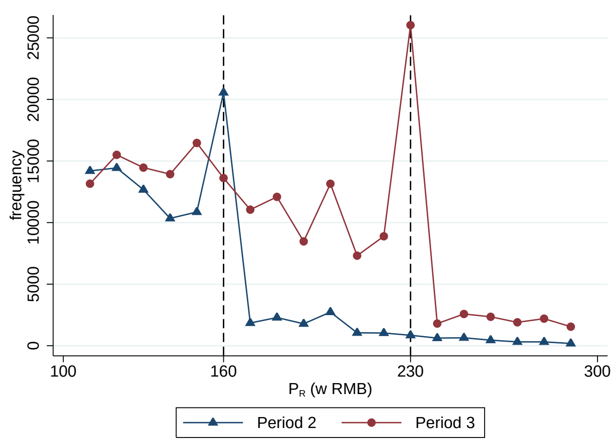
(a) Within the Inner Ring



(b) Between Outer and Inner Ring



(c) Outside the Outer Ring



Notes: bin size=10w RMB. Period 2: March 1, 2012-November 19, 2014. Period 3: November 20, 2014-June 30, 2017.

[24]One exception is that there is some bunching at 200w RMB even when there is no notch there. This is the well-known bunching at rounder numbers because of behavioral reasons (Kleven and Waseem (2013), Kleven (2016)).

6 Conclusion

Using a unique data set from a large real estate broker company that includes both true prices and reported prices of second-hand housing transactions in Shanghai, we study how people misreport facing a housing transaction tax notch. We document a novel three-segment misreporting pattern that is remarkably consistent with a simple tax evasion model. We delve into details of the misreporting pattern, analyzing potential factors that may have affected it and testing alternative forms of the perceived misreporting cost function. The understanding of the misreporting behavior is greatly enhanced in this process.

Tax notch usually works as a way to impose a higher tax burden for wealthier entities. Yet given that tax notches may create major incentives to evade tax, at least under a policy environment with weak enforcement, it is tempting to ask whether other types of tax design would be better. While there has been some discussion on cases for a tax notch (Blinder and Rosen (1985), Slemrod (2013)), there has been no concensus on when a notch is desirable. This could be a fruitful topic for further research.

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Online Appendix

(Not For Publication)

A Heterogeneity of Misreporting

A.1 Extensive Margin

The benchmark model predicts that no one with $P_T \leq \overline{P}$ will misreport and everyone with $P_T > \overline{P}$ will underreport. Is this true in the data? Figure A1 shows that even for $P_T \leq \overline{P}$, about 20-40% people underreport the transaction prices. For $P_T > \overline{P}$, not all people underreport. The underreporting fraction is close to 1 for P_T above but close enough to $\overline{P}$, but decreases as P_T further increases. This pattern implies that there are other costs impeding people from making the response as our simple model predicts. One omitted factor is the existence of other taxes. For houses with $P_T \leq \overline{P}$, even if they are not subject to the business tax, they are still subject to the deed tax, which is proportional to P_R and the rate depends on the number of houses a buyer has (1-1.5% if there is only one house, 3% for more than one house). We do not have such information to calculate the deed tax due for each buyer. Yet this is sufficient to create an incentive for those with $P_T \leq \overline{P}$ to underreport prices. For people with $P_T > \overline{P}$, there will always be some people not responding to the tax incentive, due to large perceived costs or simple ignorance.

Figure A7 shows the fraction of honest reporting. It shows a complementary picture of Figure A1 but is worth showing explicitly.[25] It is especially worth noting that honest reporting is least when P_T is barely above $\overline{P}$, and gradually increases and becomes stable beyond certain point.

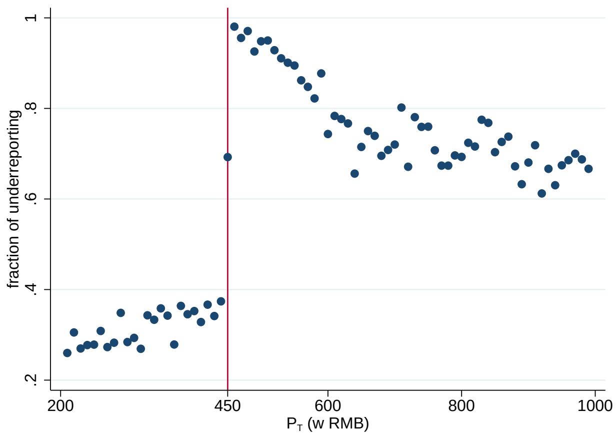
A.2 Intensive Margin

Figure A1 and Figure A7 show that there is non-trivial heterogeneity among individuals choosing whether to misreport or not. It is possible that, even among those who misreport, there exists some

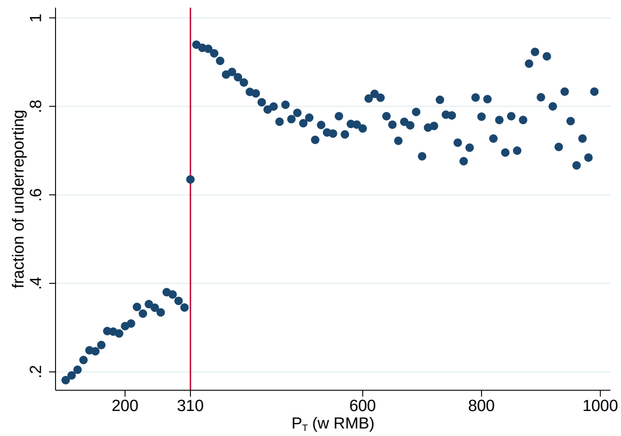
[25] Overreporting is very rare and negligible in our data.

Figure A1: Fraction of Housing Price Underreporting

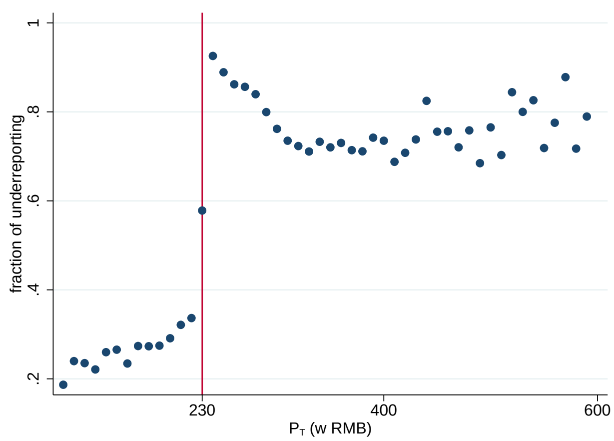
(a) Within the Inner Ring



(b) Between Outer and Inner Ring



(c) Outside the Outer Ring



Notes: bin size=10w RMB. The solid line denotes the notch.

heterogeneity in their misreporting patterns. How differently can people behave from the representative ones? We find it informative to examine the misreporting pattern of people in different percentiles relative to the median. Figure A2 overlaps 10th percentile, median, and 90th percentile of P_R against each 10w RMB bin of P_T. First of all, it is clear that the 10th and 90th percentiles P_R differ from the median. In fact, the 90th percentile of P_R is largely the same as P_T; this simply says that for almost all levels of P_T, there are some people honestly reporting, which has been suggested in Figure A7. The 10th percentile pattern is much more interesting, which exhibits a proportional downward shifting (rather than a parallel downward shifting) of the median pattern.

When we further look at finer divided percentiles, more heterogeneity emerges. Figure A3 uses housing transactions between outer and inner ring as an illustration. Using the other two regions yields the same results. Panel (a) shows the distribution of P_R that is above the median for each bin of P_T and panel (b) shows the distribution of P_R that is below the median for each bin of P_T. In both panels, there is clear heterogeneity. One notable distinction is that, above the median, houses with $P_T < \overline{P}$ do not misreport, while below the median, houses with $P_T < \overline{P}$ would even underreport. How to reconcile these facts?

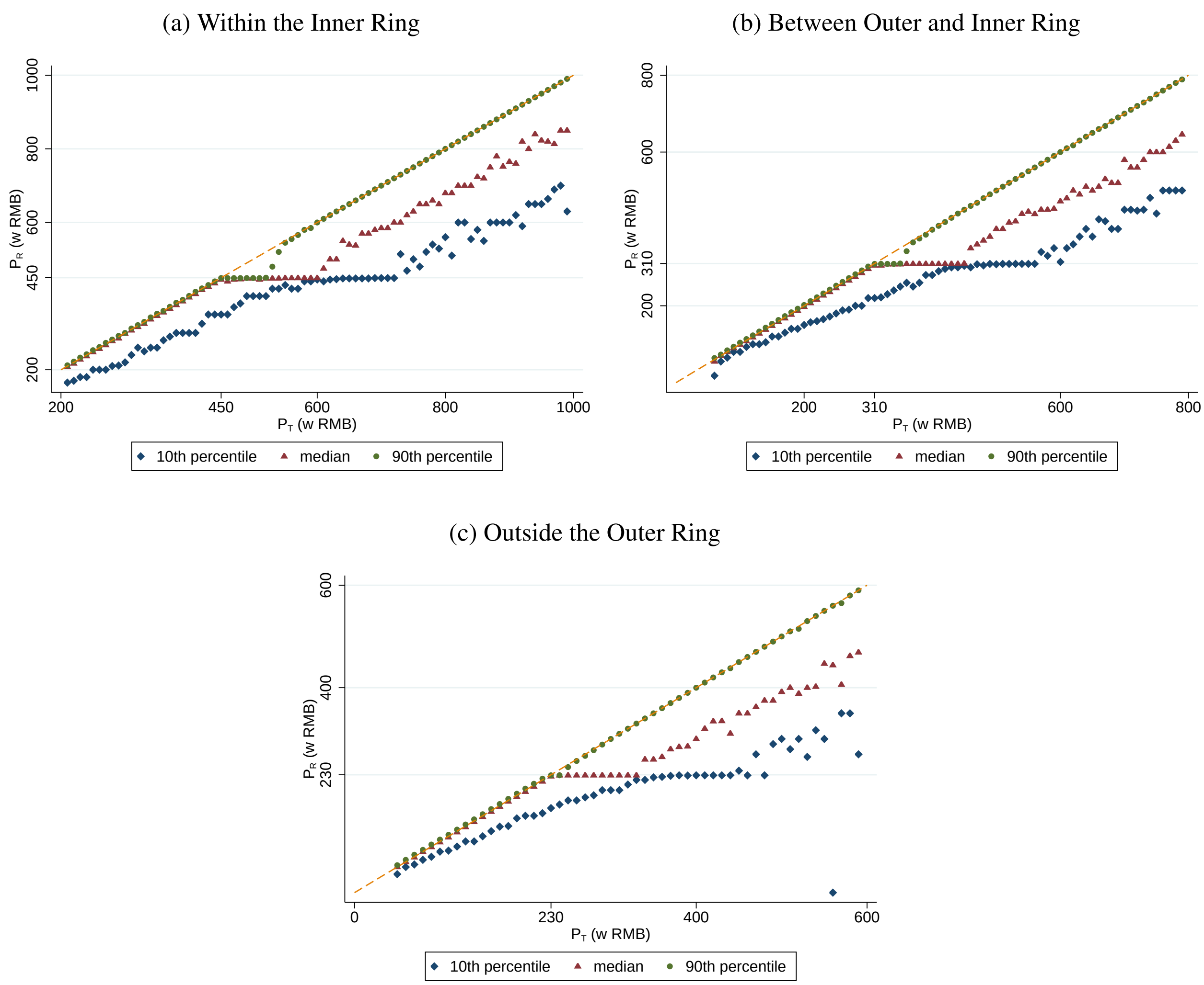
A.3 Possible Explanations for the Heterogeneity

In the following, we explore whether the heterogeneity of misreporting could be explained by some possible factors, including other taxes and fees, housing loans, and idiosyncratic misreporting costs. We find that they (even taking togther) cannot explain the whole observed misreporting pattern, though idiosyncratic misreporting costs per se can explain much of the heterogeneity.

Other taxes and fees. Can the existence of other taxes and commission fees explain this observation? No. These taxes and fees are proportional to P_R even if P_R is less than $\overline{P}$. Denote the aggregate tax rate for other taxes and fees as τ, then the problem becomes

$$min_{P_R} t \cdot P_R \cdot \mathbf{1}[P_R > \overline{P}] + \tau \cdot P_R + C(t(P_T - P_R)).$$

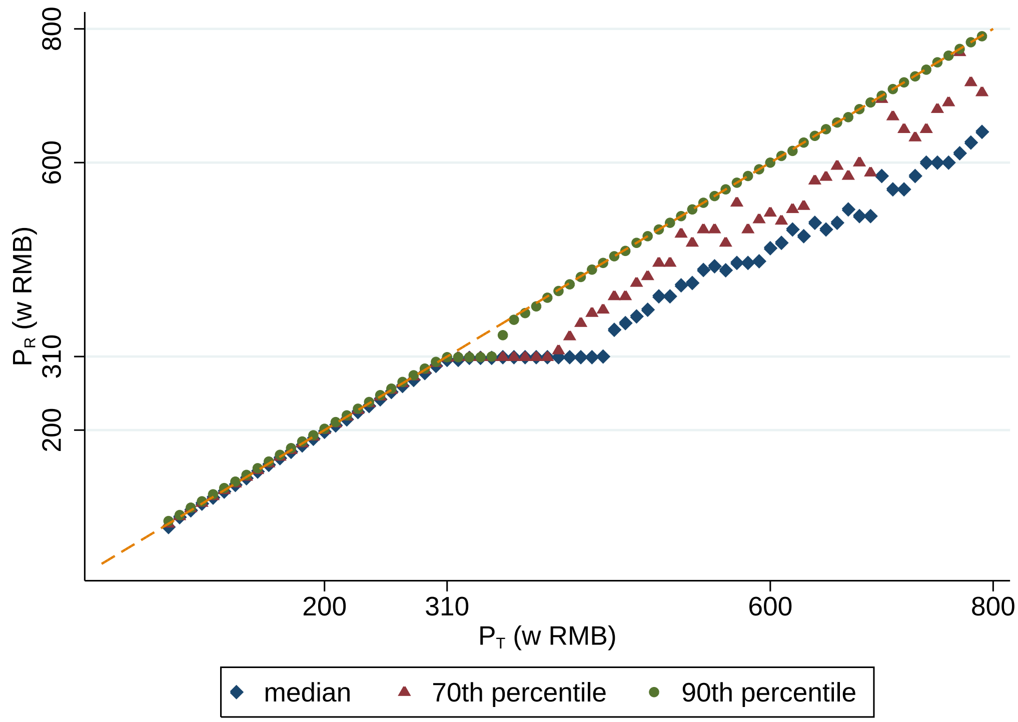
Figure A2: Heterogeneity of Misreporting Patterns



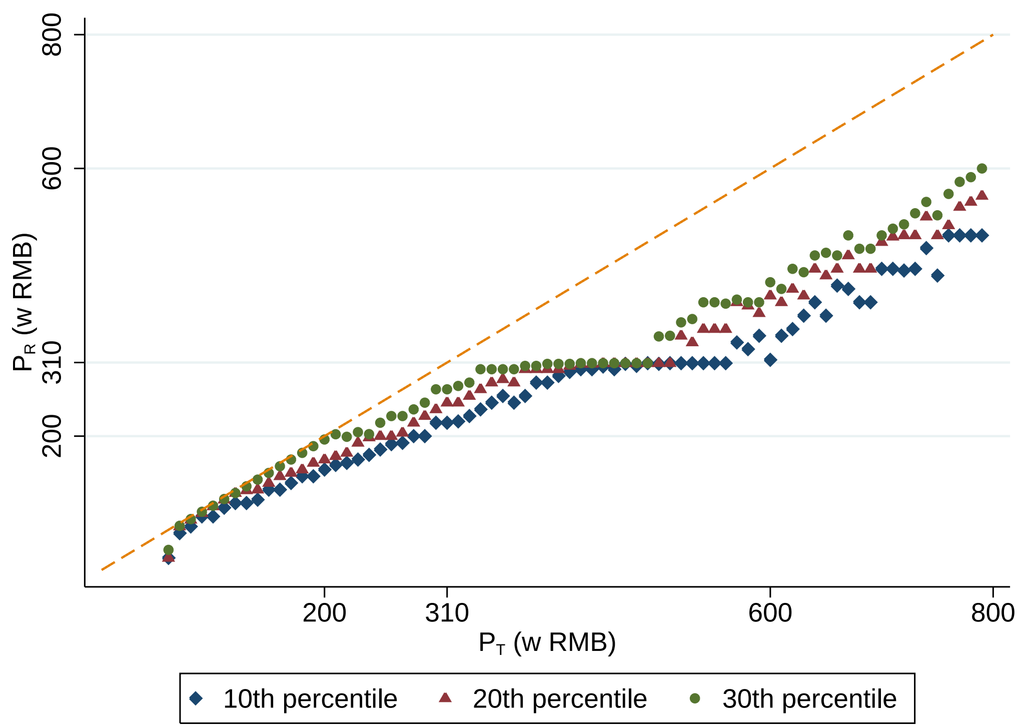
Notes: bin size=10w RMB. The dashed line is a 45-degree line.

Figure A3: Heterogeneity of Misreporting Patterns: Between Outer and Inner Ring

(a) Above Median



(b) Below Median



Notes: bin size=10w RMB. The dashed line is a 45-degree line.

It is clear that for houses with price less than $\overline{P}$, the solution is $P_R = P_T - \frac{C'^{-1}(\tau/t)}{t}$, which implies a constant underreporting even for $P_T < \overline{P}$. This is inconsistent with Figure A2. The empirical pattern we observe also implies that potential impacts of other taxes are dwarfed by the business income tax when analyzing the misreporting responses to the tax notch. This is reasonable since the amount of other taxes are small relative to the business tax involved in housing transactions.

Housing loans. Can housing loans explain the heterogeneous misreporting patterns we observe? As introduced earlier, available loans are $L = \rho_L \cdot min\{P_R, P_E\}$, and the down payment is $P_T - L$. For loans to make a difference in accounting for the heterogeneous misreporting patterns, there must be $P_R < P_E$. Then we focus on the binding cases, i.e. $L = \rho_L \cdot P_R$. In China, given that people generally expect a much higher growth rate (above 10% per year in most of the past 20 years) for housnig price than interest rate (annual norminal rate around 2%), people would prefer as higher loans as possible. For a given wealth, a larger loan for a house implies a smaller down payment, which leaves a larger remaining wealth for buying another house or investing in other profitable projects with a return higher than the interest rate. Suppose the benefit from loans can be represented by $g(L)$, with $g' > 0$. Then the individual's problem becomes

$$min_{P_R} t \cdot P_R \cdot \mathbf{1}[P_R > \overline{P}] + C(t(P_T - P_R)) - g(L).$$

Let's focus on the houses with P_T well below $\overline{P}$ so that they are unlikely to choose P_R above $\overline{P}$. Without considering loans, there will be no misreporting. Considering loans will give them an incentive to overreport. However, this is not observed in the data. Taking both other taxes and housing loans into account, we would have $P_R = P_T - \frac{C'^{-1}((\tau+\rho_L)/t)}{t}$ for houses with price less than $\overline{P}$, which is inconsistent with Figure A2. Thus, housing loans are unlikely to be the driving force for the observed misreporting pattern.

Idiosyncratic misreporting costs. It is possible that different people may face different misreporting costs. This is particularly true since the cost should be interpreted as a perceived cost. Even facing the same objective cost, different people might perceive it differently, let alone the potential diverse objective misreporting costs, due to the diverse knowledge and available help from lawyers and brokers. Suppose the cost function now takes the form of $\lambda \cdot C(t(P_T - P_R))$, where $\lambda > 0$ and may differ across people.[26] λ could represent various factors that affect misreporting costs, such as the perceived probability to be caught for evasion, or the moral cost of underreporting. Then we would obtain the following reporting patterm:

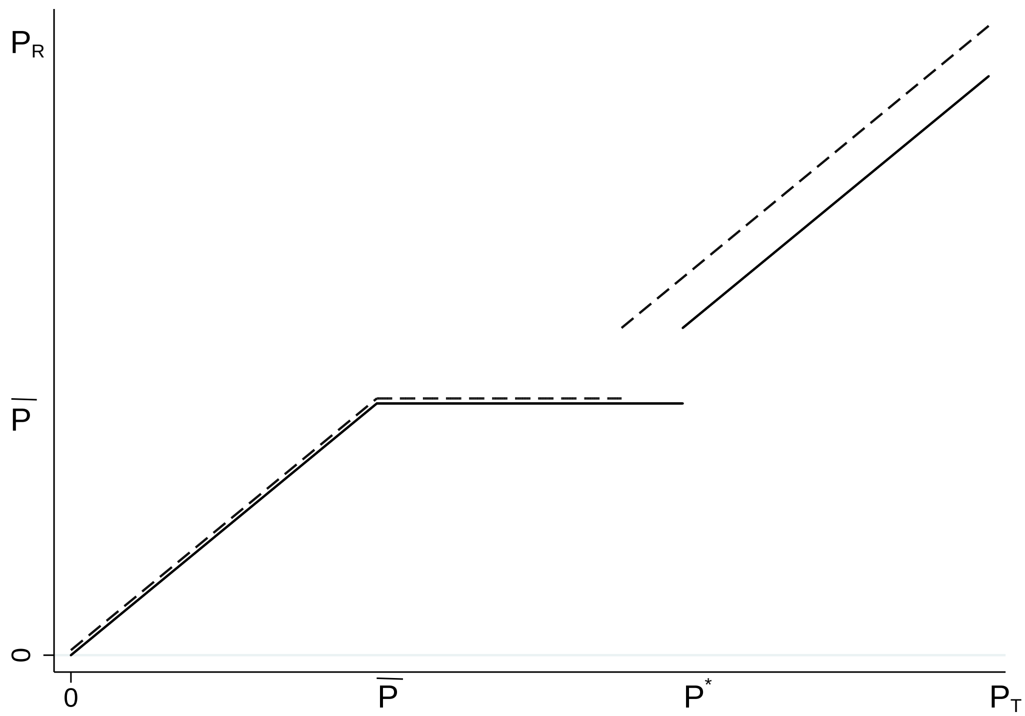
$$P_R = \begin{cases} P_T & if\, P_T \leq \overline{P}; \\ \overline{P} & if\, P_T \in (\overline{P}, P^*) \\ P_T - \frac{C'^{-1}(\frac{1}{\lambda})}{t} & if\, P_T > P^*. \end{cases};$$

P^* is the solution to $C_{Interior} = C_{Notch}$, where $C_{Notch} = C(t(P_T - \overline{P}))$ and $C_{Interior} = t \cdot P_T - C'^{-1}(\frac{1}{\lambda}) + \lambda \cdot C(C'^{-1}(\frac{1}{\lambda}))$. How would λ affect the above reporting pattern? Since $C'' > 0$, $\frac{C'^{-1}(\frac{1}{\lambda})}{t}$ would decrease with λ. This is intuitive, as a higher cost would make people underreport less. How would P^* depend on λ? Obviously, C_{Notch} does not depend on λ. Using envelop theorem, we know $\frac{dC_{Interior}}{d\lambda} = C(C'^{-1}(\frac{1}{\lambda})) > 0$. Thus, from Figure 1, we know that P^* decreases with λ.

Figure A4 illustrates the impact of an increasing λ on the misreporting pattern. This can explain much of the heterogeneous reporting patterns as shown in Figure A2. In particular, it predicts that for people with a high enough λ, e.g. those having no knowledge on underreporting price or having very high moral cost of misreporting, they would honestly report. For those with a λ smaller than the median people, they will underreport more than the median. It also predicts that, for people with $P_T < \overline{P}$, none of them would misreport. These predictions are all consistent with the misreporting pattern in Figure A3 panel (a). But a heterogeneous λ per se still cannot explain the misreporting pattern in Figure A3 panel (b). It cannot explain why people with a P_T below a certain inflation of $\overline{P}$ would underreport a fraction of their true income.

[26] If we consider an alternative form of misreporting cost $C(\lambda \cdot t(P_T - P_R))$ rather than $\lambda \cdot C(t(P_T - P_R))$, it is easy to show that the same results hold.

Figure A4: Responses of Misreporting Pattern to Heterogeneous Misreporting Costs



Notes: The solid lines show the original reporting pattern, while the dashed lines show the reporting pattern for people with a higher misreporting cost λ.

A.4 Misperception as a Possible Explanation

All these heterogeneous misreporting patterns can be reconciled by simply introducing misperception. Suppose people could perceive true price with some deviation. Denote the perceived price as $P_T^{Perceived} = \delta P_T$ with $\delta > 0$. The heterogeneity of δ would then reconcile all these heterogeneous misreporting patterns. For the representative people who do not misperceive the true price, we have $\delta = 1$. Their misreporting is described by the three-segment pattern as shown in Figure 2. For people who underperceive the true price (e.g. they misperceive the down payment as the true price), i.e. $\delta \in (0,1)$, they choose P_R as if their true price is $\delta P_T < P_T$, thus their reporting pattern is a proportional downward shifting of the median people, as shown in panel (b) of Figure A3. Likewise, for people who overperceive the true price (e.g. they misperceive the after-tax price as the true price), i.e. $\delta > 1$, they choose P_R as if their true price is $\delta P_T > P_T$, thus their reporting pattern is a proportional upward shifting of the median people, as shown in panel (a) of Figure A3.

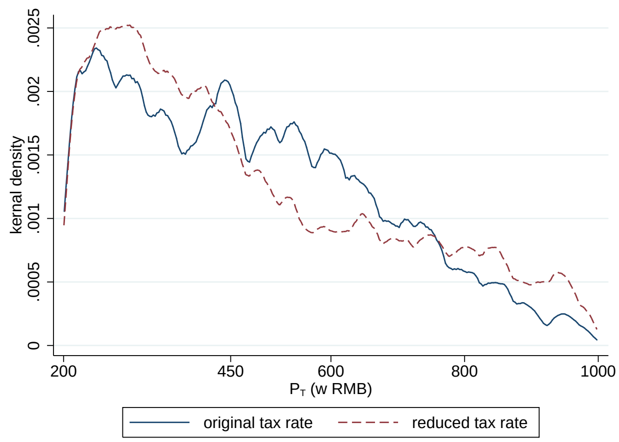
In reality, other factors considered above could drive the heterogeneous misreporting patterns. Yet since misperception of true price alone is sufficient to reconcile the most important heterogeneity observed here, we should think more on it. Instead of regarding it as a final explanation, we maintain that it should be more appropriately regarded as a descriptive explanation or an intermediate step to a more fundamental explanation. Any successful explanation should at least be able to reconcile it. But how to interpret this misperception? It is certainly not because people do not know the exact value of P_T. Instead, it is possibly because choosing the optimal P_R based on a given P_T requires weighing the tax saving against the misreporting cost in a precise way. Since the optimal solution is not simple and obvious, it is not surprising that people would make a decision that deviates from the optimal choice, which makes they behave as if they misperceived the true price, like making optimization errors. After all, it is well known that people may make mistakes even in some simplest decision making situations. Since people are not thinking machines, it is quite reasonable that some people overperceive while some underperceive the true price when facing a complicated decision making.[27]

[27]A growing literature examines various misperceptions under tax and related settings. A widely documented fact

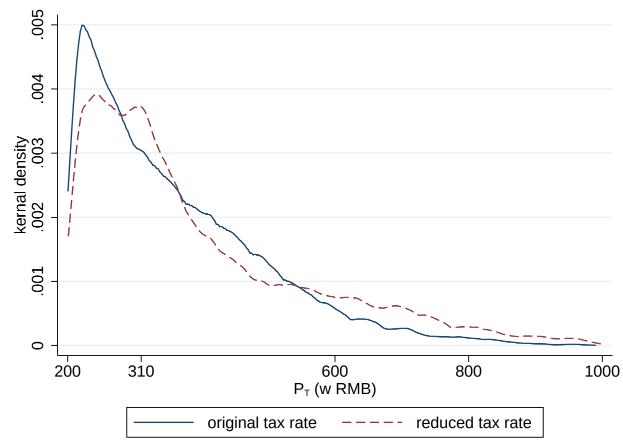
B Appendix Figures

Figure A5: Distributions of True Prices Around a Tax Rate Change

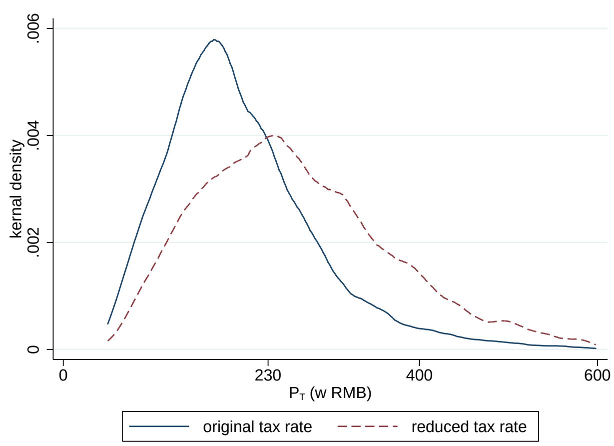
(a) Within the Inner Ring



(b) Between Outer and Inner Ring



(c) Outside the Outer Ring

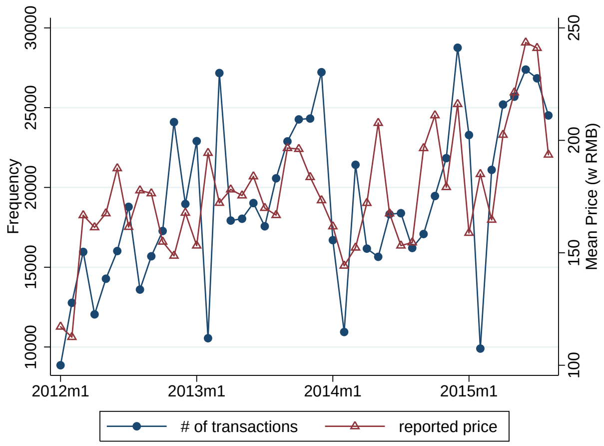


Notes: The figures show the Epanechnikov kernel density curves fitted with a bin size equal to 10w RMB. To make the distributions more comparable, we focus on same months for the pre-reform period (May 2015-April 2016) and the post-reform period (May 2016-April 2017).

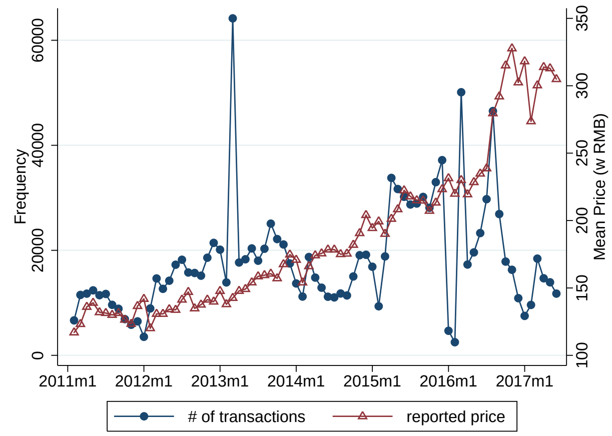
is the misperception between marginal tax (price) rate and average tax (price) rate (e.g. de Bartolome (1995), Liebman and Zeckhauser (2004), Ito (2014), Rees-Jones and Taubinsky (2018)). Feldman et al. (2016) find evidence that people misperceive the tax liability change due to a lump-sum Child Tax Credit change as an increase in their marginal tax rate. Therefore, it is not surprising that some people behave as if they misperceive the true price. Importantly, the misperception is centered around a correct perception of the true price, which makes the misperceptions like standard errors around the mean value (correct perception).

Figure A6: Number of Housing Transactions and Prices in Shanghai

(a) New Houses from HMB: Jan 2012-Aug 2015



(b) Second-Hand Houses from HMB: Feb 2011-June 2017



(c) Second-Hand Houses from a Real Estate Broker: April 2015-June 2017

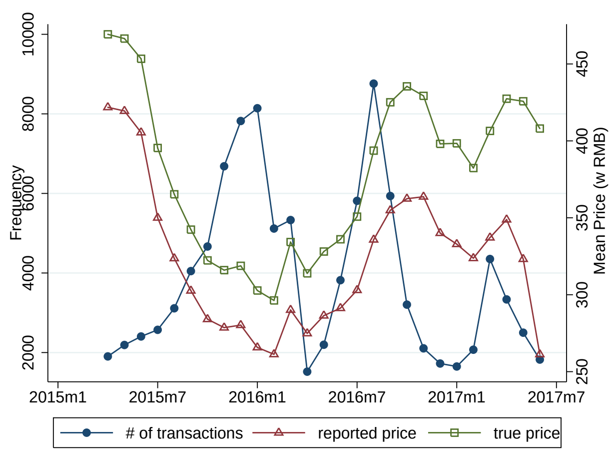
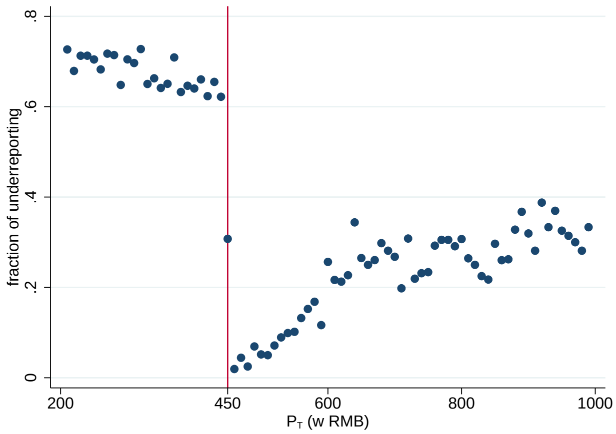
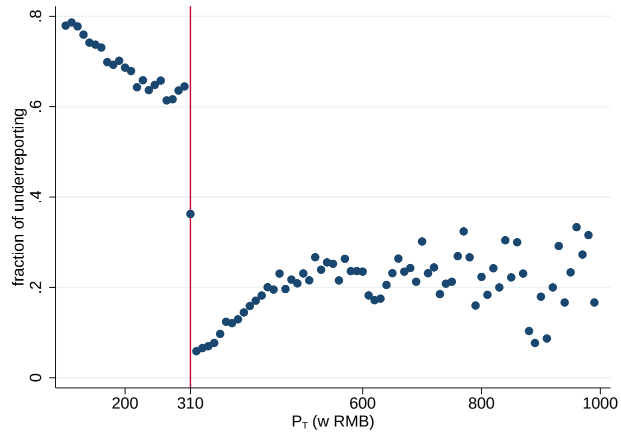


Figure A7: Fraction of Honest Reporting

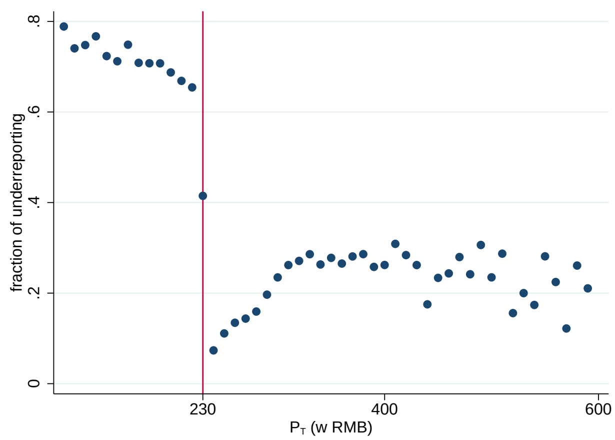
(a) Within the Inner Ring



(b) Between Outer and Inner Ring

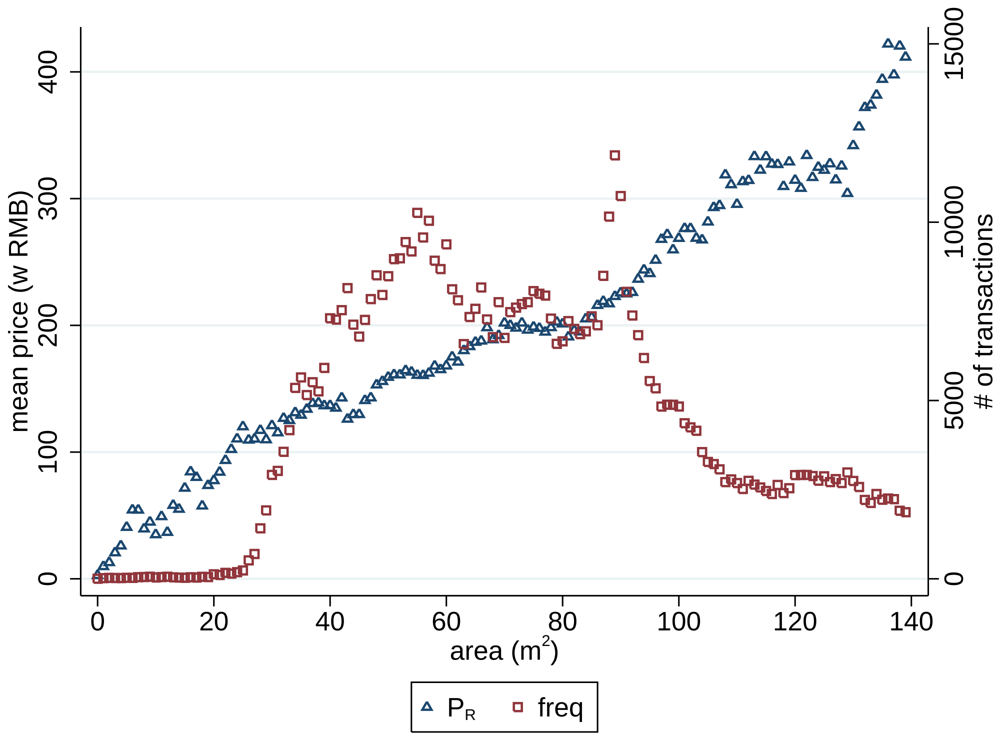


(c) Outside the Outer Ring



Notes: bin size=10w RMB. The solid line denotes the notch.

Figure A8: Prices of Houses by Area: All Second-Hand Housing Transactions in Shanghai



Notes: We use data from Shanghai HMB (April 2015-June 2017) to produce this figure.