Mortgage Prepayment in China and Counter-Productive Monetary Policy*

Zhenyu Gao, Wenxi Jiang, Haohan Ren, Kemin Wang, Yuezhi Wu

August 20, 2024

Abstract

Despite of restrictions on mortgage refinancing, Chinese households prepaid an unprecedented amount of mortgage loans between 2021 and 2023, when the government cut interest rates to combat economic slowdown. Using loan-level data from a leading commercial bank in China, we find that households are likely to prepay when the gap between their own mortgage rate and the benchmark rate becomes positive and increases. Evidence further suggests that households prepay with their savings (rather than through refinancing), and the prepayment is associated with household deleverage and consumption reduction. Combining with the data of UnionPay card spending, we find macro-level evidence that as the national lending rate decreases, cities with more mortgage borrowers having a positive rate gap tend to experience greater prepayment, consumption reduction, and lending contraction, suggesting counter-productive monetary policy transmission.

*We thank Zhiguo He and seminar participants at CUHK, Fudan University, 2nd HKU Summer Finance Workshop for helpful comments. Zhenyu Gao and Wenxi Jiang are at the Department of Finance, CUHK Business School, The Chinese University of Hong Kong, Shatin, Hong Kong; and Haohan Ren, Kemin Wang, and Yuezhi Wu are at the Department of Finance, School of Management, Fudan University, Shanghai, China. Authors' contact information: Gao: gaozhenyu@baf.cuhk.edu.hk; Jiang: wenxijiang@baf.cuhk.edu.hk; Ren: haohanren@fudan.edu.cn; Wang: wangkm@fudan.edu.cn; and Wu: wuyz23@m.fudan.edu.cn.

1. Introduction

In response to the economic slowdown, China's central bank started to cut interest rates in 2021 to boost lending and the real estate market. With the lowered loan rate, Chinese households rushed to prepay their mortgage loans. Unlike the case in other countries, mortgage refinancing is prohibited in China. Anecdotes report that the prepayment is financed by households' saving or liquid investment, implying household deleverage—as opposed to the objective of the expansionary monetary policy.[1] Market observers estimated that the total mortgage repayment in 2022 was 4.7 trillion RMB (700 billion USD), or 12% of China's total outstanding mortgage loans.[2] The trend continued in the first half of 2023: based on our loan-level data from a leading commercial bank, the ratio of mortgage prepayments to newly issued mortgage loans increased to 86%.

Such an unprecedented amount of mortgage prepayment in China not only concerned commercial banks for profitability but also the central bank for the effectiveness of monetary policy. Over the period between 2021 and 2023, to combat economic downturn, PBC injected money supply and reduced borrowing cost for multiple times. The 5-year loan prime rate (LPR)—the reference rate for home loans—was adjusted to 4.20% in June 2023 from 4.85% in mid-2019. However, households hardly benefit from the lowered borrowing cost. The interest rate of most mortgage loans in China is set as LPR plus a local margin. The local margin as a fixed component is determined based on city-level home purchase policies at mortgage issuance and can vary substantially cross cities and over time; LPR is the floating component but subject to a delay in adjustment.[3] Furthermore, as a unique institutional setting in China, the regulation strictly forbids mortgage refinancing by obtaining a new loan at a lower rate. At the same time, households' deposit rate or return from wealth management products (WMP) is immediately adjusted to the new benchmark rate.

[1] Cao, "Chinese Consumers' Lack of Confidence Is Causing a Rush of Mortgage Prepayments," Wall Street Journal, April 2023.

[2] Liu and Zhang, "Five Things to Know About Early Mortgage Repayments in China," Caixin Global, April 2023; According to the quarterly report from People's Bank of China (PBC), the outstanding mortgage loans was 38.8 trillion RMB at the end of 2022; see https://www.gov.cn/xinwen/2023-02/03/content_5739947.htm.

[3] Mortgage rate can be only adjusted once a year to the most recent LPR relative to the pre-determined adjustment date. For example, if the adjustment date is January 1st and PBC decreases LPR to 4.2% in June 2023, then the mortgage rate would not benchmark to 4.2% LPR until January 2024.

Therefore, the gap between financing cost (mortgage rate) and return rate on savings can turn positive and increase for many households when LPR is reduced, motivating borrowers to prepay mortgage with their own savings. The unique regulatory setting makes the phenomenon in China distinct from the mortgage repayments in other countries, where mortgage prepayments are typically refinanced with a new loan and prepaying households are financially constrained (e.g., Berger, Milbradt, Tourre, and Vavra 2021; Eichenbaum, Rebelo, and Wong 2022). More importantly, the implications to monetary policy transmission can be vastly different: following rate cuts, Chinese households prepay loans with their savings and deleverage, whereas US borrowers refinance leading to more borrowing and consumption.

In this paper, we use loan-level data from one of the major banks in China to study households' motives for prepaying mortgages and the implications for the consequence of monetary policies. This paper not only provides a systematic analysis on the unprecedented episode in the second-largest economy, but also offers important insights into how China's unique regulatory setting and market frictions could lead to unintended policy consequences.

The loan-level data is provided by one of the nationwide banks in China from October 2019 to June 2023. This bank has branches all over the country with about a 25% share of the mortgage market. In the sample period, the bank has over 10 million mortgage loan borrowers; we randomly select 100,000 mortgage loans at the beginning of the sample period for our loan-level analysis. 30.4% of the borrowers have made at least one prepayment before June 2023. The majority of prepayments are partial: the average prepayment amount equals 78,429 RMB, whereas the mortgage balance at the time of prepayment is 410,848 RMB. This is consistent with the anecdotal evidence that Chinese households are prepaying with their saving rather than mortgage refinancing.

We start by exploring the motivate to prepay. Chinese households tend to hold some savings while taking mortgage loans. According to the survey of PBC, more than 80% of Chinese households' financial wealth is invested in bank deposits and WMPs. The return of bank deposit and WMPs are closely benchmarked to LPR. On the financing side, the mortgage loan rate contains a fixed component and does not immediately adjust to LPR. As LPR is reduced, the financing cost (the mortgage rate) becomes significantly higher

than the expected investment return of savings for many households, motivating mortgage prepayment to save interest expenditure.

To test this conjecture, we first regress a prepay dummy over the next six months at the loan level onto interest rate gap (denoted as *RateGap*), which equals the borrower's current mortgage rate minus LPR. We hypothesize that borrowers are more likely to prepay when *RateGap* turns positive and increases. Importantly, we control for year-month fixed effects to rule out the potential macroeconomic confounding effects. For example, it could be the case that both the central bank and households expect an economic downturn in the future, then the central bank cuts the rate and households decide to reduce borrowing by prepaying. Our identification tries to separate such effect by exploiting the cross-sectional variations in the fixed component (that is, local margin) of the mortgage rate. The local margin depends on factors at mortgage issuance, such as local cities' mortgage policies and borrowers' home portfolio.[4] Our assumption is that the variation in the fixed component is orthogonal to households' current expectation of future economy.

We find that households are more likely to prepay as the rate gap between their current mortgage interest and LPR increases. Also, such effect is non-linear and only significant when *RateGap* turns positive. That is, households would not react if their existing mortgage rate is lower than the benchmark loan rate. This pattern seems to be similar to the finding in the US; Berger et al. (2021), for example, show that the gap between existing and new mortgage rates can trigger a significant amount of prepayment, and the effect takes place as a step-like function around zero.

The patterns in China, however, has several important differences, suggesting a distinct underlying mechanism. First, the propensity to prepayment keeps increases as *RateGap* becomes larger, whereas in the US the effect mostly concentrates right above zero (i.e., a step-like function). Second, a necessary condition of our hypothesis is that the household has the saving to make the prepayment, since refinancing is not allowed. In this sense, our effects should be stronger for more affluent borrowers. Indeed, we find that households with more liquid investments, better education, and higher credit scores are more reactive to *RateGap* changes and make the prepayment. By comparison, US evidence shows it is

[4]See more details in Section 2.

mostly low-income households prepay as they are more financially constrained and eager to reduce interest expense. In addition, consistent with our hypothesis, the long-term level of savings for prepaying households is significantly reduced for about 61% after the payment.

Next, to link the micro-data evidence to macro-level effects, we aggregate individual prepayment behavior to the city level. We calculate the *PrepayCount*, which is the fraction of mortgage borrowers that prepay during month t+1 to t+6 in a city. Similarly, our key explanatory variable is the city-level *RateGap_City*, which equals the average *RateGap* of all existing mortgage loans at month t. We control for local economic variables, including PMI, CPI GDP growth rate, GDP per capita, level and growth rate of housing prices, and year-month fixed effects. Similarly, the identification is based on the cross-regional variations in the average interest of existing mortgages, which is largely driven by the heterogeneity in local margin at mortgage issuance. Results are consistent with the analysis at the loan level: as *RateGap_City* turns positive and rises, the fraction of homeowners prepaying mortgage significantly increases. To better capture the non-linear effect of *RateGap*, we follow Berger et al. (2021) and calculate the $Frac > 0$, the fraction of borrowers in the city whose mortgage rates are greater than the current LPR, as the explanatory variable; the results are robust.

In the second part of the paper, we examine how the prepayment channel affects the monetary policy transmission, in particular, household consumption. In a market such as the US, cutting interest rates will lead to mortgage prepayment/refinance (which likely means more leverage) and a reduction in household interest expenses, resulting in higher consumption after prepayment. This highlights an effective monetary policy transmission. However, we observe the opposite in China, decreases in interest rates caused households to prepay with their own savings, which led to household deleveraging and less borrowing. For the effect on consumption, as we illustrated with a stylized model in Appendix B, Chinese households could even reduce their short-term consumption under certain circumstances, rather than increasing consumption. This is to accelerate the prepayment of their mortgages and avoid future interest expense, as the *RateGap* becomes sizeable. If this is indeed the case in China, it suggests a counter-productive monetary policy, at least through the mortgage prepayment channel: cutting interest rates for new loans led to less household borrowing and consumption.

The challenge to test this conjecture is to identify the causal effect of rate cuts on household consumption through the mortgage prepayment channel. Other confounding effects could potentially drive the correlation among rate cuts, mortgage prepayment, and consumption reduction. For example, it could be driven by an expectation channel. That is, both the central bank and households expect an economic downturn in the future, then the central bank cuts the rate and households choose to reduce borrowing (via prepayment) and consumption. We acknowledge that this expectation channel is compelling during this period in China, but it is not exclusive to our repayment channel. We are interested in the causal effect of LPR adjustments on household consumption.

Our identification strategy relies on the cross-regional variation in $Frac > 0$. While the adjustment of LPR is national, the induced policy impact can vary substantially cross cities. It depends on the average rates of existing mortgage loans, which are heterogeneous and path-dependent on local factors such as the composition of mortgage loans' issuance time and the local margin policies at that time in the borrower's city. Since the fixed component of existing mortgage rate, local margin, is set at issuance, it is plausibly orthogonal to households' current expectation on local economy. Specifically, we use $Frac > 0$ at the city-level as an instrument variable (IV) for *PrepayCount*, and in the second-stage regression, we use the instrumented *PrepayCount* to predict the subsequent growth in total consumption. City-level aggregate consumption is measured with the total spending through UnionPay bank cards.[5]

Our IV regression results find a significantly negative correlation between *PrepayCount* and the subsequent consumption growth. The economic magnitude is also meaningful: a one-standard-deviation increase in the fraction of prepayments is associated with a 19.6% decrease in aggregate consumption. Moreover, such an effect is more pronounced for discretionary spending.

Finally, we discuss the policy implications based on our findings. First, one can think of $Frac > 0$ as a predictor of monetary policies' effectiveness. That is, we show that in the cities where more borrowers paying mortgage rates higher than LPR, reductions in LPR are

[5]The data covers transactions directly via bank cards through POS system and through digital wallets such as Alipay and WeChat Pay, provided that the bank cards are linked to the digital wallet.

likely to be counterproductive in boosting household borrowing and consumption. Second, our finding highlights the friction of the lack of refinancing channel prevents an effective transmission of monetary policy among households. It is worth noting the work by Agarwal, Deng, Gu, He, Qian, and Ren (2022), who find that in 2008 as the Chinese regulator cut the benchmark lending rate and applied the new rate immediately to all existing mortgages, it increased household consumption. Taken together of their study and ours, one can see that it is crucial to allow household mortgage rates to float with the central bank's benchmark rate to make the monetary policy transmission effective. Third, we examine other macroeconomic consequences beyond the household sector. Specifically, we investigate whether mortgage prepayment affects the total lending by all banks and financial institutions. Our IV regression results show that total lending also decreases as mortgage prepayments rise, consistent with the notion of counter-productive monetary policy.

Literature Review Our paper is related to the literature on several fronts. First, our paper contributes to the literature on the effect of interest rate changes on mortgage prepayment and refinancing (e.g., Dunn and McConnell (1981), Green and Shoven (1986), Schwartz and Torous (1989), and Deng, Quigley, and Van Order (2000)). More recently, scholars have explored the heterogeneity in responses to interest rate changes and the obstacles faced in making prepayment decisions, such as financial frictions and inattention (Agarwal, Rosen, and Yao (2016); Bhutta and Keys (2016); Keys, Pope, and Pope (2016); Andersen, Campbell, Nielsen, and Ramadorai (2020)). Our paper is primarily connected to two studies that investigate the distribution of mortgage rates to generate state-dependent prepayment decisions (Berger et al. (2021); Eichenbaum et al. (2022)). However, the lack of refinancing options in China introduces a distinctive element, which alters the consequences of prepayment and affects the effectiveness of monetary policy in this context.

Second, we contribute to the literature on the role of mortgages in the transmission of monetary policy. Previous studies, such as Iacoviello (2005), Rubio (2011), Garriga, Kydland, and Šustek (2017), and Greenwald (2018), examine how changes in monetary policy are transmitted through the mortgage market within a representative framework. Recent studies, utilizing more detailed cross-sectional data, such as Agarwal, Green, Rosenblatt, and

Yao (2015), Di Maggio, Kermani, and Palmer (2016), Di Maggio, Kermani, Keys, Piskorski, Ramcharan, Seru, and Yao (2017), Auclert (2019), Beraja, Fuster, Hurst, and Vavra (2019), and Cloyne, Ferreira, and Surico (2020), have explored the heterogeneity effect of monetary policy transmission through mortgage markets. While our study also confirms that households' decision to prepay their mortgages is influenced by the historical pattern of interest rates and the distribution of mortgage rates and is thus path- and state-dependent, as noted by Berger et al. (2021) and Eichenbaum et al. (2022), the outcome of monetary policy through the prepayment channel in China diverges entirely from the findings documented in the literature for the US. Specifically, households in China reduce their borrowing and consumption rather than increase them after mortgage prepayment induced by interest rate cuts.

Third, our paper makes a substantial contribution to the extensive literature on household borrowing and consumption, with a particular focus on the relationship between consumption, household leverage, and savings. Notable studies, such as Mian, Rao, and Sufi (2013) and Chen, Michaux, and Roussanov (2020a), investigate the influence of household debt and housing-related assets on consumer spending during the housing boom. In our study, we empirically document a compelling deleveraging effect on household consumption through their savings during the economic downturn. We therefore also contribute to the empirical literature on savings and consumption such as Caballero (1990), Gourinchas and Parker (2001), Parker and Preston (2005), and Christelis, Georgarakos, Jappelli, and Van Rooij (2020).

Fourth, our study presents novel empirical evidence on mortgage prepayment in the context of China. Previous research on mortgage prepayment has predominantly focused on the US market. However, scholars such as Badarinza, Campbell, and Ramadorai (2016) have emphasized the importance of adopting an international comparative approach to studying household finance. While there are a few exceptions, such as Miles (2004) examining the UK, Bajo and Barbi (2018) investigating Italy, and Andersen et al. (2020) exploring Denmark, the literature on mortgage prepayment in non-US markets remains relatively limited and has little coverage on emerging markets. In line with findings from other markets, our study reveals that reductions in interest rates serve as an incentive for households in China

to engage in mortgage prepayment. However, a distinctive characteristic of an emerging market like China is market frictions such as the lack of refinancing options. Consequently, prepayment in response to rate cuts in China leads to a reduction rather than an increase in household borrowing and consumption, highlighting an unintended consequence of mortgage prepayment.

Lastly, our study makes a valuable contribution to the literature on understanding monetary policy in China. China's monetary policy exerts a significant influence on both the domestic economy and global financial markets, yet it remains an area that is not thoroughly comprehended (Huang, Ge, and Chu (2019)). An emerging body of literature, including works by Chen, Ren, and Zha (2018), Chen, He, and Liu (2020b), and Chen et al. (2023), has examined monetary stimulus with a specific focus on the banking system, particularly the rise of shadow banking in China. In our paper, we shift the focus to the transmission of monetary policy through the housing market in China. Real estate holds substantial importance not only in the country's economy but also as a vital component of its financial system (Liu and Xiong, 2023; Xiong (2023)). Surprisingly, the mortgage channel of monetary policy transmission in the Chinese context has received limited attention, despite the significant role played by real estate markets in driving China's economic growth. One exception is the study by Agarwal et al. (2022), which examines how "wealthy hand-to-mouth" consumers increase their credit card spending in response to a decrease in their mortgage interest expenses due to interest rate cuts. This finding aligns with existing studies conducted in the United States and other developed countries (e.g., Kaplan and Violante (2014); Kaplan, Violante, and Weidner (2014)). In contrast, our paper focuses on the prepayment channel and uncovers a novel phenomenon, to the best of our knowledge, in the literature. We find that households who engage in early mortgage prepayment due to interest rate cuts for the newly issued mortgages experience a decrease in their consumption, shedding light on a previously undocumented aspect of the relationship between mortgage prepayment and consumption behavior.

2. Institutional Background and Hypothesis

In this section, we introduce institutional details about the Chinese mortgage market. Specifically, we focus on the rules regarding how mortgage rates are determined and adjusted, procedures of mortgage prepayments, and the restrictions on mortgage refinancing. Then, we develop our hypothesis.

2.1. Interest Rate of Mortgage Loans

The BLIR-Based Mortgage Rates Before October 8, 2019, the People's Bank of China (PBC) used the RMB Benchmark Loan Interest Rates for Financial Institutions (BLIR) as the reference rate for loans to individuals and corporations issued by financial institutions (e.g., commercial banks). During this period, the mortgage rates were calculated as the product of BLIR times a local multiplier of the city. For example, the mortgage rate in Beijing in June 2018 was "110% of the benchmark rate," where 110% is the local multiplier. The local multiplier is at the discretion of the prefecture-level cities and may change over time, as it is used as a tool to control local home prices and demand. For example, the Beijing government increased the local multiplier from 85% in October 2016 to 110% in June 2017 to cool down the real estate market.

The benchmark rate, BLIR, is often adjusted by PBC as a tool of the central bank's monetary policy. The adjustments to BLIR were applied to both existing and new mortgages. Local governments may also change the local multiplier to control local home prices, but the adjustments to local multipliers are only applied to new mortgages but do not affect the existing mortgages. That is, the local multiplier for a mortgage remains fixed for the life of the mortgage, thus mortgages issued at different time periods in the same city can use different multipliers.

The LPR-Based Mortgage Rates On October 8, 2019, PBC adopted a new reference rate, Loan Prime Rate (LPR), and a new pricing scheme for mortgage loans. LPR refers to the average of lending rates for prime customers submitted by 20 quoting banks and is published by the National Interbank Funding Center (NIFC) on the 20th day of every

month.The interest rate of a mortgage issued after October 8, 2019, is calculated as LPR plus a local margin. For instance, the interest rate of a mortgage issued by banks in Beijing on October 10, 2019, was "LPR+55 bps," where the local margin equals 55 bps. Similar to the local multiplier in the BLIR-based system, the local margin is set by the prefecture-level city as a policy tool for real estate price controls. Local margin can depend on whether it is the household's first home and be higher for investment homes. Policy changes on local margin by the local government are only applied to the subsequent new mortgages, not to existing mortgages. Changes to LPR will be immediately applied to new mortgage loans, but for existing loans, the mortgage rate is adjusted to the most recent LPR only at an annual frequency.[6]

Conversion from BLIR- to LPR-based Rate Mortgage loans issued with BLIR-based rates were required to convert to either an LPR-based rate or a fixed rate. For either choice, the conversion formula is designed in such a way that the interest rates do not change right after the conversion. For example, suppose a mortgage with an interest rate of 5.25% in March 2020 and the LPR in December 2019 was 4.85%.[7] If the borrower chooses an LPR-based rate in March 2020, then the interest rate specified in the new contract (effective on January 1, 2021) would be "LPR + (5.25% − 4.85%)," that is, the local margin is set to be 40 bps for the rest life of the loan. If the borrower opts in a fixed rate, then she would pay a fixed rate of 5.25% till maturity. In both cases, the borrower continues to pay the pre-conversion rate of 5.25% immediately following the conversion. This ensures that the differences in interest rates, which are mostly from the differences in local multipliers, among existing mortgages under the old BLIR-based system are inherited by the differences in the local margins under the new LPR-based system. Over 94% existing mortgages chose the LPR-based pricing scheme.

In sum, the mortgage rate in China features both fixed and floating components. Over our sample period from October 2019 to June 2023, the interest rate of mortgage loans

[6]Specifically, the interest rate of an existing mortgage is adjusted once per year based on the latest LPR right before the adjustment date. Borrowers may select either January 1 or the issuance date of the mortgage as the adjustment date. Once chosen, the adjustment date is fixed.

[7]All the conversions are required to use the LPR in December 2019 to determine the new local margin.

(denoted as m) can be written as, for individual i at month t,

$$\mathrm{m}_{i,t} = \mathrm{LPR}_{t-\tau} + \mathrm{Local\_Margin}_{i,0} \tag{1}$$

where $LPR_{t-\tau}$ refers to the most recent LPR related to i's adjustment date, which is floating with the current LPR but with a delay. $Local\_Margin_{i,0}$ is the fixed component and determined at the issuance of the mortgage. The heterogeneity in local margins among households can come from (1) the timing of i's home purchase, (2) whether it is i's first home or not, and (3) the cross-city and time-series variations in policies that determine local margin.

2.2. Mortgage Prepayment and Restrictions on Refinancing

The Chinese regulators do not provide any official channels for mortgage borrowers to refinance their mortgages. Rather, the regulatory rules explicitly prohibit banks or households from issuing new loans to prepay mortgages.[8] While anecdotes suggest that some households may take short-term loans (such as consumer loans) to prepay their mortgages during this episode, such behavior is rare due to the risks and costs. First, taking new loans to prepay mortgages is explicitly prohibited by commercial banks in China; banks can terminate the loan contract if they find it is used for prepaying mortgages. Second, these loans are likely to be short-term, so borrowers must roll over the loans to repay the long-term mortgage, which is costly and can be cut off by the bank. Indeed, according to an internal report of the bank, fewer than 1% of their clients may have used other types of loans to finance mortgage prepayments.

It is very common for households to use their own saving to make mortgage prepayments. However, making mortgage prepayments is subject to some frictions in China. For instance, commercial banks usually only allow a household to have one mortgage prepayment within a calendar year. Also, it may take a few months to finish the whole procedure from application submission to making the final payment. These frictions can have nontrivial impacts on households' saving and consumption behavior. For example, households tend to accumulate more cash right before the once-a-year prepayment.

[8] See https://www.gov.cn/zhengce/zhengceku/2021-03/26/content_5596070.htm.

2.3. Hypothesis

In Appendix B, we develop a stylized model to motivate the hypotheses presented in this paper. The key intuition of the model is that mortgage prepayment can be viewed as a form of savings for households, where the "return" on prepayment is the mortgage rate. When the household's savings/investment rate exceeds the mortgage rate, they will choose to save/invest rather than prepay the mortgage. Conversely, when the savings/investment rate is lower than the mortgage rate, prepayment becomes the more optimal choice. Given that mortgage rates can vary across households and time periods when mortgages originated, we expect to observe mortgage prepayment when the gap between a household's current mortgage rate and their savings rate becomes positive. Moreover, the wider this positive gap, the stronger the incentive for households to prepay their mortgages to reduce their financing costs. Our first hypothesis is therefore developed as follows:

Hypothesis 1: Mortgage prepayment has a nonlinear relationship with the gap between the mortgage rate and the household's savings rate. When the gap is negative, households will not choose to prepay. When the gap is positive, prepayment will increase as the gap widens.

Additionally, when interest rates decline, richer households (those with higher income and total assets) who face a positive rate gap between mortgage and savings will have a stronger tendency to prepay their mortgages, as they have more savings and income available to make the prepayments. The model then suggests the second hypothesis:

Hypothesis 2: If the gap between the mortgage rate and savings rate is positive, households with higher income and AUM will prepay their mortgages to a greater extent.

Given the restrictions on mortgage refinancing in China, households are not allowed to obtain new loans to pay off their existing mortgages. As a result, when Chinese households choose to prepay their mortgages, they must utilize their own savings and personal financial resources to do so. This need to tap into their savings accounts or other liquid assets in order to accelerate mortgage payments can lead to a reduction in household deposit balances.

Furthermore, the diversion of funds away from savings and towards mortgage prepayments may also compel some households to cut back on their overall consumption spending. We summarize these mechanisms in Hypothesis 3 as follows:

Hypothesis 3: After the interest rate cuts, in order to prepay their mortgages, households with a positive gap between the mortgage rate and saving rate will deleverage by reducing their deposits and may decrease their consumption.

The predictions about mortgage prepayment behavior in China differ from the dynamics seen in the US market, where mortgage refinancing is a common practice. In the US, when interest rates are cut and new mortgage rates decline, households often choose to refinance their mortgages to secure a lower interest rate. This can be particularly beneficial for households with low incomes or tight financial constraints, as the reduced monthly mortgage payments can free up disposable funds that can then be allocated towards consumption. As a result, US households tend to exhibit a pattern of increased consumption following mortgage prepayment. The lower monthly obligations allow them to devote a greater portion of their disposable income towards discretionary spending.

In contrast, the hypotheses about mortgage prepayment behavior in China do not assume the availability of a mortgage refinancing channel. Consequently, even though both U.S. and Chinese households' prepayment behaviors demonstrate a nonlinear relationship with the gap between the mortgage rate and savings rate, as described in Hypothesis 1, the predictions diverge in other key aspects.

Specifically, the hypothesis for the Chinese market suggests that Chinese households with stronger financial positions are more inclined to prepay their mortgages more aggressively (Hypothesis 2). Furthermore, it is predicted that Chinese households would actually reduce their consumption levels in order to accelerate the prepayment of their mortgages when interest rates decline, rather than increasing consumption (Hypothesis 3).

These distinctions are attributed to the lack of a mortgage refinancing market in China. Without the ability to easily refinance to a lower rate, Chinese households may feel compelled to use savings to pay down their mortgage more quickly, rather than increasing spending, leading to counter-productive monetary polices.

3. Data

3.1. Mortgage Data

Our mortgage data is from one of the largest commercial banks in China, with a market share of more than 25% in the mortgage market. In 2023, this bank issued mortgage loans over 900 billion RMB and had a total outstanding mortgage balance surpassing 6 trillion RMB at the end of the year. The sample period is from October 2019 to June 2023. We choose October 2019 as the starting point because the LPR-based mortgage rate was implemented in that month.

We first construct a loan-level dataset by randomly selecting 100,000 loans from the population of 12.9 million outstanding mortgages as of October 2019. The dataset contains basic information of the mortgage such as a unique ID of the borrower, mortgage location, issuance date, and mortgage maturity; monthly variables including interest rate, remaining mortgage balance, regular monthly payment, the actual payment in a month, and a dummy variable of prepayment; and information about the collateralized real estate property including its purchase price and size. The bank also provides demographic information for the borrower, including age, gender, education level, marriage status, credit score, total deposits, and assets under management (AUM, which includes deposits, wealth management products, and insurance products on the borrower's bank account). The key variable of interest at the loan level is $Prepay_{i,t}$, a dummy variable that equals one if mortgage i is fully or partially prepaid in month t, and zero otherwise. We also calculate $RateGap_{i,t}$ as the difference between an individual's current mortgage interest rate $m_{i,t}$ and LPR_t.

We also construct a city-level dataset, which is compiled from the bank's all outstanding mortgages over our sample period (October 2019 to June 2023) across 267 cities. Specifically, for each city c in a given month t, we compute the ratio of the number of mortgage prepayments to the total number of mortgage payments ($PrepayCount_{c,t}$), the average interest rate of existing mortgages ($M_{c,t}$), the average interest rate of newly-issued mortgages ($LocalNewRate_{c,t}$), and the average house price ($HousingPrice_{c,t}$). We also follow Berger et al. (2021) and compute the fraction of existing mortgages with $RateGap$ greater than zero in a given month ($Frac > 0_{c,t}$).

3.2. Consumption and Macroeconomic Data

We obtain monthly city-level consumption data from UnionPay, which is a state-owned payment card company that manages the largest interbank card transaction settlement network in China. UnionPay was founded through a government initiative to build a unified, effective, and secure bank card network to connect all commercial banks in its association and process interbank settlement and clearing transaction information. As of 2022, UnionPay has more than one billion cardholders and is accepted in 181 countries and regions. A series of papers use the data from UnionPay cards to study household consumption behaviors, e.g., Agarwal, Qian, Seru, and Zhang (2020); Chen, Qian, and Wen (2021); Chen, Qian, and Wen (2023).

Most interbank card transactions in China are recorded in UnionPay's clearing system. One major category of these transactions is credit/debit card spending through point-of-sale (POS) systems. These spendings include not only transactions conducted directly via bank cards but also those executed through digital wallets such as Alipay and WeChat Pay, provided that consumers use the bank cards linked to their digital wallet accounts to make payments. Each transaction record includes the date, amount in RMB, location, and the merchant's industry classification. The dataset does not contain any information about the cardholders. UnionPay provides us with city-day-level aggregation of individuals' transaction records. We measure the total consumption, discretionary consumption, and essential consumption made through UnionPay bank cards.

We also obtain macroeconomic variables at the city-level and country-level from iFind and CSMAR. These variables include total lending provided by local financial institutions, GDP per capita, GDP growth rate, the Purchasing Managers' Index (PMI), and the Consumer Price Index (CPI).

4. Mortgage Prepayment Behavior: Loan-level Analysis

In this section, we analyze Chinese individuals' mortgage prepayment behavior with the loan-level data. We document the aggregate trend and summary statistics before testing the main hypothesis.

4.1. The Aggregate Trend and Summary Statistics

We start by documenting the aggregate trend of the prepayment waves using our randomly selected sample of 100,000 mortgage loans from the bank. In Figure 1, we plot the level of the 5-year LPR over the sample period (in blue). PBC reduced LPR from 4.85% in September 2019 to 4.65% in April 2020. As the economy further slowed down, PBC started another round of LPR reductions at the end of 2021 and adjusted to 4.20% in June 2023. Along with the LPR rate, we calculate the average ratio of yuan-value mortgage prepayments to total mortgage repayments, including both regular repayments and prepayments, over the subsequent 12 months. The figure shows that as the PBC started to gradually reduce LPR in 2022, the subsequent prepayments sharply increased and reached the highest 35% in 2022.[9] The time-series correlation is consistent with our hypothesis that LPR reductions motivated Chinese households to prepay and deleverage, and we provide further evidence for causal interpretation in the following sections. In terms of headcounts, among our randomly selected sample of 100,000 individuals who have mortgages in October 2019, 30.4% have made at least one full or partial prepayment before June 2023.

[Insert Figure 1 near here]

Table 1 Panel A presents the summary statistics of the main variables at the loan level. The mean of *Prepay* dummy equals 1.1% per month, which suggests that 13.2% of mortgage borrowers prepay their mortgage per year (remind that one can only prepay once per year). The average *RateGap* is positive (0.34%) with the 25th and 75th percentiles of 0.005% and

[9]The sharp reduction in the 12-month forward moving average of prepayments ratio around the beginning of 2023 is due to the nationwide COVID-19 lockdown in China in 2022.

0.79%, respectively. This means that despite some cross-sectional heterogeneity, the majority of mortgage borrowers are paying higher interest rates than the current LPR. As introduced earlier, this is because the local margin is fixed and there is a delay in adjusting the mortgage rate to the latest LPR. This pattern also reflects the fact that the Chinese economy has been growing fast and it is until recent years that borrowing costs started to decrease.

In Panel B, we compare the characteristics of borrowers who made at least one mortgage prepayment with those who did not prepay at all during the sample period. For the 30.4% who have made at least one prepayment, their average prepayment amount is 78,429 RMB, which constitutes 19% of the mortgage balance of 410,848 RMB at the time of prepayment. This suggests that the majority of prepayments are partial, consistent with the observations that Chinese households are prepaying with their saving rather than refinancing. Also, their prepayment of 78,429 RMB is a significant expenditure compared to their regular repayment of 5,232 RMB.

Mortgage prepayment is a choice, not a randomized treatment; as we discuss in the next subsection, our identification does not rely on a direct comparison between the prepaying and non-prepaying groups. Nonetheless, it is still meaningful to understand their characteristics. The two groups exhibit similar levels of credit score, age, LTV ratio, and home size. *RateGap* at the time of prepayment equals 0.29 for the non-prepaying but is slightly higher 0.33 for the households who prepaid. Prepaying households tend to have more net wealth, better education, more expensive homes, and higher mortgage borrowing and monthly repayments, than non-prepaying ones.

[Insert Table 1 near here]

4.2. Interest Rate Gap and Mortgage Prepayment

In the following, we test our main hypothesis that Chinese households tend to prepay their mortgage when their mortgage rate (m) becomes greater than the current interest rate of loans (r, proxied by LPR). As we discussed in Section 2.3, since Chinese households tend to keep precautionary savings, when their saving returns, which are closely linked to

r, decrease below m, households will, due to refinancing restrictions, repay mortgages with their savings to lower their interest expenditure.

To test this mechanism, we conduct the following individual-month-level panel regression as specified,

$$\text{Prepay}_{i,t+1\to t+6} = \alpha + \beta \cdot \text{RateGap}_{i,t} + \text{Controls} + \mu_c + \gamma_t + \varepsilon_{i,t} \tag{2}$$

where $Prepay_{i,t+1\to t+6}$ is a dummy variable which equals one if borrower i makes a prepayment between month $t+1$ to month $t+6$, and zero otherwise. We set a 6-month window to identify prepayment behavior because the application for mortgage prepayment typically takes a few months to process and approve (as we discussed in Section 2). $RateGap_{i,t}$ equals the interest rate of mortgage ($m_{i,t}$) minus the LPR in month t.

Our identification relies on the heterogeneity in each mortgage's fixed component, $Local\_Margin_{i,0}$. Local margin is determined at the time when the mortgage was issued and depending on the local policy and borrowers' home portfolio. Further, we control for year-month (γ_t) and city (μ_c) fixed effects. This is to rule out any possible effects at the city and/or year-month level that can be correlated with *RateGap* and households' prepayment decisions. For example, it could be an expectation channel driving the observed effects. That is, both PBC and households are pessimistic about the future economy, thus PBC reduced LPR, and households prepaid mortgage to cut borrowing. While this channel is compiling, it is ruled out by the time-fixed effects. In short, the assumption of our identification strategy is that the local margin at issuance is not correlated with the borrower's current expectation of the economy.

We follow Berger et al. (2021) and control for the borrower's gender, education status, age, credit score, total assets in the bank, the quadratic term of the loan-to-value ratio, the remaining mortgage balance, and indicators for mortgage age in month t. We also include a set of macroeconomic variables such as the average housing price in borrower i's city, the growth rate of housing prices, and the lagged housing prices. Standard errors are clustered by year-month.

[Insert Table 2 near here]

Table 2 presents the results. In Column (1), we include city fixed effects and year-month

fixed effects. In Column (2), we add city times year-month fixed effects, which rule out any city-time level economic conditions or factors that could impact prepayment behavior.

The coefficients before *RateGap* are both positive and statistically significant (t-stats above 12). In terms of economic magnitude, the coefficient 0.0091 in Column (1) indicates that a one-standard-deviation increase in *RateGap* corresponds to a 9.9% increase in the prepayment indicator relative to its sample mean (9.9% = 0.643 × 0.0091 / 0.059). In Panel B, we replace the dependent variable *Prepay* over the 6-month window with monthly dummies, $Prepay_{t+1}, ..., Prepay_{t+6}$ to show the dynamics of the effects. We find that prepayment behavior is evenly distributed over the six month period with all t-stats around 6.

[Insert Figure 2 near here]

An important implication from our hypothesis is that the effect of *RateGap* should be non-linear; that is, households' propensity to prepay decreases in LPR only if *RateGap* is positive, and no reaction when the mortgage rate remains lower than LPR. We illustrate this pattern in Figure 2, following the methodology of Berger et al. (2021). We estimate a regression of the prepayment dummy ($Prepay_{i,t+1\to t+6}$) on a series of 30-basis-point *RateGap* bins, ranging from −120 bps to +180 bps. We then calculate the fraction of prepayments in each gap bin based on the coefficients obtained from the regression. One can find that the positive correlation between prepayment and *RateGap* only shows up in the positive region of *RateGap*, while no correlation is observed with negative gaps. In addition, the "kink" around the zero rate gap motivates the use of $Frac > 0$ as the key instrumental variable to identify the effectiveness of monetary policies (LPR adjustment) in the next section.

This non-linear pattern is similar to the findings of Berger et al. (2021), who show that US households also appear to prepay mortgage when the rate gap between their own and a new mortgage loan becomes positive. However, note that while the empirical patterns seem to be similar, the underlying economic mechanism can be distinct in China and the US. The key difference comes from the institutional settings of whether mortgage refinancing is allowed or not.

As shown in Berger et al. (2021), in the presence of mortgage refinance, low-income or financially constrained households are more reactive to positive rate gap to repay and

refinance their mortgage, as they are more incentivized to lower the interest expenditure. By comparison, since refinancing is disallowed in China, prepaying households should be the ones who have better financial conditions and have savings or liquid investments.

To verify this intuition, we construct three dummy variables for high AUM, high credit score, and high education, respectively, based on the 70th percentile of the sample. Then, we interact these dummy variables with *RateGap* in the baseline regression of Equation (2). Results are reported in Table 3: the coefficients before the interaction terms are all positive and significant at the 1% level. The economic magnitude is also meaningful; for example, in Column (1), the coefficient before $RateGap \times HighAUM$ is 0.0127 (t-stat=11.96), whereas the coefficient before *RateGap* is 0.0051 (t-stat=7.72). This suggests that the top 30% high AUM households are more than twice as responsive to the rate gap to prepay than other borrowers. The coefficients before the dummies themselves (high AUM, high credit score, and high education) are positive, which is expected as households with better financial conditions are more likely to prepay mortgage on average. We visualize such effects in Figure 3 by repeating the analysis in Figure 2 for subsamples of high versus low AUM in Panel A, credit score in Panel B, and education in Panel C.

[Insert Table 3 and Figure 3 near here]

4.3. Saving Behavior Around Prepayment

Next, we examine how prepaying households adjust their saving and consumption behavior before and after making the prepayment. As discussed in Section 2.3, our mechanism implies that prepaying borrowers should significantly reduce their total savings and consumption after making the prepayment. The prediction, again, contradicts to implication of mortgage refinancing, which predicts more consumption afterwards due to lowered interest expenditure. Furthermore, our mechanism also suggests the monetary policy (reducing LPR here) could be counterproductive in boosting borrowing and consumption from the household side.

In this subsection, we test the prediction on prepaying households' savings, as the consumption at the individual level is not available. In the next section, we test the implication

on consumption at the city level with the spending data from UnionPay. Specifically, we focus on households' total deposits in the bank account 12 months before and after the prepayment month (labeled as 0). We also measure households' total liquid assets (AUM), which include deposits and investments in wealth management products, mutual funds, and insurance-type products. Specifically, we regress the log of total deposits or AUM on several dummy variables indicating the timing of the months before or after the prepayment month, with the same set of controls as in Table 2. Results are reported in Table 4.

In Column (1), we only include one dummy variable $AfterPrePay_{i,t}$, which equals one if borrower i has made at least one prepayment before month t. The coefficient before $AfterPrePay$ is -0.615, which is statistically significant at the 1% level. In terms of economic magnitude, it implies that individuals' deposits decrease by 61.5% after making the mortgage prepayment.

In Column (2), we decompose the prepayment indicators into three: one for the 6 months before prepayment ($t-6$ to $t-1$), one for the 6 months after prepayment (t to $t+5$), and one for the period beyond 6 months after prepayment ($t+6$ to the end of sample). The coefficients before the three dummies are compared to the level of average deposits from the beginning of our sample to six months before the prepayment. The coefficient before $Prepay[+6, end]$ is significantly negative and similar to the magnitude estimated in Column (1). The coefficients before $Prepay[-6, -1]$ and $Prepay[0, +5]$ demonstrate the short-term pattern around the prepayment month. That is, we see that households tend to build up their deposits (about 33% increase) right before the scheduled prepayment.[10] In the month of the prepayment and the five months after, the total deposit decreases and becomes 23.5% lower than the level from the beginning to six months before the prepayment. In Columns (3) and (4), we rerun the regressions using AUM and find highly similar results.

In Figure 4, we visualize the time-series pattern of household savings 12 months before and after the prepayment month. One can see that their savings (both deposit and AUM) overshoot one month around the prepayment month and are gradually reduced over the 12-month post-prepayment period by more than 50% relative to the level over the -12 to -6 months prior to the prepayment. The significant reduction over the long term in prepaying

[10] It typically requires a few months to apply for early mortgage payments and obtain the approval.

households' deposits and AUM is supportive of our hypothesis.

[Insert Table 4 and Figure 4 near here]

5. Implications to Monetary Policy Transmission

In the previous section, we find evidence showing that Chinese households tend to prepay their mortgages using their saving, as LPR is adjusted below their mortgage rate, leading to a reduction in consumption and borrowing. In this section, we explore the effect at the city level to examine the macroeconomic consequence of the monetary policy.

5.1. Interest Rate Gap and Mortgage Prepayment: City-level Evidence

We first conduct the baseline analysis in Table 2 at the city level. The dependent variable, labeled as $PrepayCount_{c,t+1\to t+6}$, is the number of mortgage prepayments scaled by the total number of mortgage repayments in city c averaged over month $t+1$ to $t+6$. We also calculate $RateGap\_City_{c,t}$, which is the difference between the average interest rate of existing mortgages in city c for month t ($M\_City_{c,t}$) and LPR_t. Specifically, we estimate the following regression,

$$\text{PrepayCount}_{c,t+1\to t+6} = \alpha + \beta \cdot \text{RateGap\_City}_{c,t} + \text{Controls} + \mu_c + \gamma_t + \varepsilon_{c,t}. \quad (3)$$

Controls represent a set of macroeconomic variables such PMI, the changes in CPI, GDP growth, GDP per capita, the average housing price, and the monthly change of housing price. We also include city and year-month fixed effects. The time fixed effects can rule out the possible effect at the country level; for example, it could be that the adjustment of LPR contains information about the perspective of the future economy, which in turn leads to more mortgage prepayment. Similar to our individual analysis, the identification relies on the heterogeneity of each city's current mortgage rate, or more precisely, on the fixed component, namely the local margin.

[Insert Table 5 near here]

Table 5 reports summary statistics of the city-level variables. The average *RateGap_City* is 0.528% with a standard deviation of 0.291% for the city-level sample. Regression results are presented in Table 6 and consistent with our findings at the loan-level in Table 2. For instance, in Column (2) of Panel A, where all control variables and fixed effects are included, the coefficient before *RateGap_City* equals 0.0059 (t-stat=7.86). This suggests that a one-standard-deviation increase in *RateGap_City* is associated with a 42.9% standard-deviation increase in the *PrepayCount* ratio over the subsequent 6 months. In Panel B, we present the result separately for each month from $t+1$ through $t+6$. The coefficients before RateGap_City remains positive and statistically significant across all these months.

[Insert Table 6 near here]

We further conduct three robustness tests. First, homeowners might not use LPR as the reference rate to assess their own mortgage rate (as it is a quite specialized term). Alternatively, a more reasonable candidate can be the average interest rate of newly issued mortgages in the city. Thus, we calculate $RateGap\_CityAlt_{c,t}$ as the difference of interest rate between existing and new mortgage loans, and rerun the regression of equation 3. The results remain significant and robust; see Panel A of Table 7.

Second, in addition to the count of prepayment, the yuan-value of mortgage prepayments can also serve as a valid measure of the intensity of prepayment behavior. Thus, we calculate the ratio of the yuan-value of mortgage prepayments to the total value of mortgage repayments as an alternative dependent variable in the regression of equation 3. The average $PrepayValue$ is about 55%, which means that more than half of mortgage repayments are prepayments in this sample period. Panel B shows our results are robust to using the value-based prepayment measure.

Third, following the methodology of Berger et al. (2021), we calculate the proportion of existing mortgages with interest rates exceeding the LPR, denoted as $Frac > 0_{c,t}$. This is motivated by the finding shown in Figure 2; the effect of $RateGap_{i,t}$ on prepayment is significant only if $RateGap_{i,t}$ is positive. The average of $Frac > 0$ equals 84.9% with a standard deviation of 12.4%. In Panel C, we use $Frac > 0$ instead of *RateGap_City* as the key explanatory variable. The coefficient before $Frac > 0$ appears to be positive with t-stat

of 5.1. Economically, a one-standard-deviation increase in the fraction of the population with rates higher than the LPR is associated with a 17.7% standard-deviation increase in prepayment counts.

As we discussed in Section 2, the cross-sectional variations of $Frac > 0$ are determined by homeowners' local margins at mortgage issuance, which are plausibly not correlated with households' current expectations about future economic conditions. Furthermore, using $Frac > 0$ exploits the "kink" in RateGap's effect on prepayment decisions and further buttresses the identification power of our tests. In the following analysis, we use $Frac > 0$ as our instrumental variable to examine the causal impacts of mortgage prepayments on consumption and total lending.

[Insert Table 7 near here]

5.2. Mortgage Prepayment and Household Consumption

Our hypothesis implies that borrowers tend to reduce their consumption and deposit after making the prepayment. The key ingredient is the financial friction in mortgage refinancing; households finance the prepayment with their savings. In comparison, refinancing a new loan with a lower interest rate can lead to higher consumption, as evidence in the US. In the previous section, with account level data, we show that households' deposit levels significantly reduced after prepayment. In the following, we use the city-level consumption data from UnionPay to examine the effect of prepayment on consumption.

The challenge for this test is to identify the causal effect of LPR adjustments on household consumption through the mortgage prepayment channel. Other factors, which may not be related to monetary policy, could also drive the correlation between mortgage prepayment and consumption reduction. For example, it is possible that a city's residents are pessimistic about the local economy, leading to consumption reduction and household deleveraging (i.e., prepaying mortgage with savings). Such a channel is compelling, and we acknowledge it could partially drive the correlation we observe between consumption and prepayment. However, we are more interested in the transmission mechanism of monetary policies.

Therefore, we adopt an IV approach: we instrument the prepayment variable, $PrepayCount_{c,t}$, with $Frac > 0_{c,t-1}$, and examine how it affects the consumption growth rate over the months $t+1$ to $t+6$. The exclusion restriction is that $Frac > 0_{c,t-1}$ is not correlated with mortgage borrowers' expectation of the future local economy in city c. We argue this assumption is plausible: $Frac > 0_{c,t-1}$ mainly depends on the distribution of borrowers' local margin, where the local margin is fixed and the distribution of local margin is determined by the distribution of mortgage issuance time and the local policy at issuance. It is not obvious that this is related to borrowers' current expectations of the future economy.

Specifically, we estimate the following 2-stage IV regression,

$$\Delta\text{Consumption}_{c,t+1\to t+6} = \alpha + \beta \cdot \widehat{\text{PrepayCount}}_{c,t} + \text{Controls} + \mu_c + \gamma_t + \varepsilon_{c,t} \qquad (4)$$

where the dependent variable is the log change of total consumption of city c from month $t+1$ to month $t+6$. Total consumption is measured by the total spending via UnionPay bank cards. Other control variables and fixed effects are the same as the regression of equation 3.

[Insert Table 8 near here]

Table 8 present the results. Columns (1) and (2) present the results of the first-stage and second-stage regressions, respectively. In the first-stage regression, $Frac > 0$ exhibits a strong positive correlation with the mortgage prepayment ratio. This is consistent with findings in Panel C of Table 7. The F-stat equals 17.6 and rules out the concern of a weak IV.

In the second-stage regression, the coefficient before $PrepayCount$ is -39.2 with t-stat $= -2.46$. This suggests that mortgage prepayments driven by lowered LPR make households reduce their subsequent consumption. The economic magnitude is also meaningful: a one-standard-deviation increase in the fraction of prepayments is associated with a 19.6% ($= 0.005 \times 39.2$) decrease in aggregate consumption, which is about the 54% of its standard deviation. In Column (3), we also conduct an OLS regression. The coefficient before $PrepayCount$ is smaller in magnitude and equals -17.91 (t-stat$= -4.91$). Overall, the results suggest that low interest rates curtail, rather than stimulate, household consumption,

through the household prepayment channel. This outcome is contrary to the findings in the US and also to the objectives of the monetary policy.

Furthermore, we exploit the heterogeneity in the types of consumption to provide more convincing evidence supportive of our channel. Our hypothesis implies that the reduction should be more pronounced in non-necessity consumption. We adopt two categorizations to distinguish necessity versus non-necessity, based on the consumption type information provided by UnionPay.

The first one is based on discretionary and essential consumption. Discretionary consumption is expected to be more significantly affected. According to the data provided by UnionPay, essential consumption includes food, gasoline, utilities, household services and telephone services. Discretionary consumption covers alcohol, tobacco, cars, electronic devices, entertainment, and inter-city transportation. Panel A of Table 9 presents the results. For both IV and OLS regressions, the coefficients before *PrepayCount* are larger in magnitude for discretionary consumption than for essential consumption, consistent with our prediction.

The second categorization is based on the size of the spending. A larger amount of spending is more likely related to the consumption of durable goods, luxury activities, and so on. Also, homeowners' large consumption would be more affected or delayed by mortgage prepayments compared to smaller consumption. We use 1,000 RMB as the cutoff to define small versus large spending. The results in Panel B show that large-scale consumption is more significantly affected by mortgage prepayments than small amount spending, in both IV and OLS regressions.

Overall, the evidence supports our hypothesis that the lowered LPR rates led to household consumption reduction through the mortgage prepayment channel, a counterproductive policy consequence.

[Insert Table 9 near here]

5.3. Policy Implications

In the final section, we discuss the implications of our findings on the effectiveness of monetary policies in China. In our city-level analysis, we use $Frac > 0$ as an IV to identify the causal effect of LPR adjustments on household consumption through the mortgage prepayment channel. An economically more meaningful way, however, to think of $Frac > 0$ is to view it as a predictor of monetary policies' effectiveness. That is, for cities where more borrowers paying mortgage rates higher than LPR, reductions in LPR are more likely to be counterproductive in boosting household borrowing and consumption.

We illustrate this intuition by running the following OLS regression,

$$\Delta\text{Consumption}_{c,t+1\to t+6} = \alpha + \beta\text{HighFrac}_{c,t-1} \cdot \Delta\text{LPR}_t + \text{Controls} + \mu_c + \gamma_t + \varepsilon_{c,t}, \quad (5)$$

where $HighFrac_{c,t-1}$ is a dummy variable that equals one if $Frac > 0_{c,t-1}$ is above the 70th percentile of the sample, and zero otherwise. ΔLPR_t refers to the monthly changes in LPR. Controls include $Frac > 0_{c,t-1}$ and the same set of the control variables and fixed effects as in Table 8. The point estimate of β gauges how the sensitivity between LPR changes and subsequent consumption varies with $HighFrac$. The sensitivity between LPR changes and subsequent consumption ought to be negative, provided an effective monetary policy.[11] We expect β to be positive. The results presented in Table 10 are consistent with this conjecture; the coefficient before the interaction term is 0.040 (t-stat = 2.23).

[Insert Table 10 near here]

A natural question arises is in the presence of refinancing restriction, how to make monetary policy effective through the household mortgage channel? While our setting cannot give a direct answer, Agarwal et al. (2022), who study a similar episode in China around 2008 sheds light. In 2008, as a response to the economic slowdown due to the global financial crisis, the Chinese regulators reduced the benchmark mortgage interest rate by 2.3% and, importantly and different from the episode we study, such decrease applied to all existing mortgage loans. Such a universal adjustment led to a meaningful increase in mortgage

[11] ΔLPR_t is subsumed by the year-month fixed effects.

borrowers' monthly disposable income. Agarwal et al. (2022) find an immediate increase in consumption among mortgage borrowers, and the spending rose primarily in the discretionary category and non-durable goods. Their findings are generally aligned with the evidence in the US (Berger et al., 2021). Taken together the findings of Agarwal et al. (2022) and our paper, one can see that it is crucial to allow household mortgage rates to float with the central bank's benchmark rate to make the monetary policy transmission effective. Deregulation on mortgage refinancing might also help but probably would not be as effective as floating mortgage rate, as refinancing is costly and not every borrower would refinance based on the US evidence.

Finally, we examine other macroeconomic consequences beyond the household sector. We have shown that the expansionary monetary policy led households to prepay mortgage loans. One may wonder whether less borrowing from households necessarily means less lending in aggregate. It could be the case that the prepayments from households can be lent out to other sectors or even households through other forms of loans (such as credit cards and short-term loans). From the perspective of central banks, the aggregate effect is of more importance. If these channels dominate the effect of mortgage prepayments, the monetary policy transmission could be still effective.

To answer this question, we examine the impacts of prepayments on total lending by all financial institutions in a city. We replace the dependent variable in equation 4 with $\Delta\text{Lending}_{c,t+1\to t+6}$, the growth rate of total lending of city c from month $t+1$ to month $t+6$. That is, we conduct IV and OLS regressions as follows,

$$\Delta\text{Lending}_{c,t+1\to t+6} = \alpha + \beta \cdot \widehat{\text{PrepayCount}}_{c,t} + \text{Controls} + \mu_c + \gamma_t + \varepsilon_{c,t} \tag{6}$$

[Insert Table 11 near here]

Table 11 presents the results. The F-stat from the first-stage regression equals 21.3, ruling out the concern of weak IV. In both the second stage of IV regression and OLS, the coefficients before *PrepayCount* are significantly negative. This suggests that mortgage prepayments following interest rate cuts lead to a reduction in total lending from financial institutions, another counterproductive consequence of expansionary monetary policies.

6. Conclusion

Despite of restrictions on mortgage refinancing, Chinese households prepaid an unprecedented amount of mortgage loans between 2021 and 2023, when the government cut interest rates to combat economic slowdown. Using loan-level data from a leading commercial bank in China, we find that households are likely to prepay when the gap between their own mortgage rate and the benchmark rate becomes positive and increases. Evidence further suggests that households prepay with their savings (rather than through refinancing), and the prepayment is associated with household deleverage and consumption reduction. Combining with the data of UnionPay card spending, we find macro-level evidence that as the national lending rate decreases, cities with more mortgage borrowers having a positive rate gap tend to experience greater prepayment, consumption reduction, and lending contraction, suggesting counter-productive monetary policy transmission.

References

Agarwal, S., Deng, Y., Gu, Q., He, J., Qian, W., Ren, Y., 2022. Mortgage Debt, Hand-to-Mouth Households, and Monetary Policy Transmission. Review of Finance 26, 487–520.

Agarwal, S., Green, R. K., Rosenblatt, E., Yao, V., 2015. Collateral pledge, sunk-cost fallacy and mortgage default. Journal of Financial Intermediation 24, 636–652.

Agarwal, S., Qian, W., Seru, A., Zhang, J., 2020. Disguised corruption: Evidence from consumer credit in china. Journal of Financial Economics 137, 430–450.

Agarwal, S., Rosen, R. J., Yao, V., 2016. Why Do Borrowers Make Mortgage Refinancing Mistakes? Management Science 62, 3494–3509.

Andersen, S., Campbell, J. Y., Nielsen, K. M., Ramadorai, T., 2020. Sources of Inaction in Household Finance: Evidence from the Danish Mortgage Market. American Economic Review 110, 3184–3230.

Auclert, A., 2019. Monetary Policy and the Redistribution Channel. American Economic Review 109, 2333–2367.

Badarinza, C., Campbell, J. Y., Ramadorai, T., 2016. International Comparative Household Finance. Annual Review of Economics 8, 111–144.

Bajo, E., Barbi, M., 2018. Financial illiteracy and mortgage refinancing decisions. Journal of Banking & Finance 94, 279–296.

Beraja, M., Fuster, A., Hurst, E., Vavra, J., 2019. Regional Heterogeneity and the Refinancing Channel of Monetary Policy*. The Quarterly Journal of Economics 134, 109–183.

Berger, D., Milbradt, K., Tourre, F., Vavra, J., 2021. Mortgage Prepayment and Path-Dependent Effects of Monetary Policy. American Economic Review 111, 2829–2878.

Bhutta, N., Keys, B. J., 2016. Interest Rates and Equity Extraction during the Housing Boom. American Economic Review 106, 1742–1774.

Caballero, R. J., 1990. Consumption puzzles and precautionary savings. Journal of Monetary Economics 25, 113–136.

Chen, H., Michaux, M., Roussanov, N., 2020a. Houses as ATMs: Mortgage Refinancing and Macroeconomic Uncertainty. The Journal of Finance 75, 323–375.

Chen, H., Qian, W., Wen, Q., 2021. The Impact of the COVID-19 Pandemic on Consumption: Learning from High-Frequency Transaction Data. AEA Papers and Proceedings 111, 307–311.

Chen, H., Qian, W., Wen, Q., 2023. Singles Day and Consumer Spending Offline.

Chen, K., Ren, J., Zha, T., 2018. The Nexus of Monetary Policy and Shadow Banking in China. American Economic Review 108, 3891–3936.

Chen, Z., He, Z., Liu, C., 2020b. The financing of local government in China: Stimulus loan wanes and shadow banking waxes. Journal of Financial Economics 137, 42–71.

Christelis, D., Georgarakos, D., Jappelli, T., Van Rooij, M., 2020. Consumption Uncertainty and Precautionary Saving. The Review of Economics and Statistics 102, 148–161.

Cloyne, J., Ferreira, C., Surico, P., 2020. Monetary Policy when Households have Debt: New Evidence on the Transmission Mechanism. The Review of Economic Studies 87, 102–129.

Deng, Y., Quigley, J. M., Van Order, R., 2000. Mortgage Terminations, Heterogeneity and the Exercise of Mortgage Options. Econometrica 68, 275–307.

Di Maggio, M., Kermani, A., Keys, B. J., Piskorski, T., Ramcharan, R., Seru, A., Yao, V., 2017. Interest Rate Pass-Through: Mortgage Rates, Household Consumption, and Voluntary Deleveraging. American Economic Review 107, 3550–3588.

Di Maggio, M., Kermani, A., Palmer, C., 2016. Unconventional Monetary Policy and the Allocation of Credit. SSRN Electronic Journal .

Dunn, K. B., McConnell, J. J., 1981. Valuation of GNMA Mortgage-Backed Securities. The Journal of Finance 36, 599–616.

Eichenbaum, M., Rebelo, S., Wong, A., 2022. State-Dependent Effects of Monetary Policy: The Refinancing Channel. American Economic Review 112, 721–761.

Garriga, C., Kydland, F. E., Šustek, R., 2017. Mortgages and Monetary Policy. The Review of Financial Studies 30, 3337–3375.

Gourinchas, P.-O., Parker, J. A., 2001. The Empirical Importance of Precautionary Saving. American Economic Review 91, 406–412.

Green, J., Shoven, J. B., 1986. The Effects of Interest Rates on Mortgage Prepayments. Journal of Money, Credit and Banking 18, 41.

Greenwald, D., 2018. The Mortgage Credit Channel of Macroeconomic Transmission.

Huang, Y., Ge, T., Chu, W., 2019. Monetary policy framework and transmission mechanism. Handbook of China's Financial System .

Iacoviello, M., 2005. House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle. American Economic Review 95, 739–764.

Kaplan, G., Violante, G. L., 2014. A Model of the Consumption Response to Fiscal Stimulus Payments. Econometrica 82, 1199–1239.

Kaplan, G., Violante, G. L., Weidner, J., 2014. The Wealthy Hand-to-Mouth. NBER Working Paper Series .

Keys, B. J., Pope, D. G., Pope, J. C., 2016. Failure to refinance. Journal of Financial Economics 122, 482–499.

Mian, A., Rao, K., Sufi, A., 2013. Household Balance Sheets, Consumption, and the Economic Slump. The Quarterly Journal of Economics 128, 1687–1726.

Miles, D., 2004. The UK Mortgage Market: Taking a Longer-Term View .

Parker, J. A., Preston, B., 2005. Precautionary Saving and Consumption Fluctuations. American Economic Review 95, 1119–1143.

Rubio, M., 2011. Fixed- and Variable-Rate Mortgages, Business Cycles, and Monetary Policy. Journal of Money, Credit and Banking 43, 657–688.

Schwartz, E. S., Torous, W. N., 1989. Prepayment and the Valuation of Mortgage-Backed Securities. The Journal of Finance 44, 375–392.

Xiong, W., 2023. Derisking Real Estate in China's Hybrid Economy. NBER Working Paper Series .

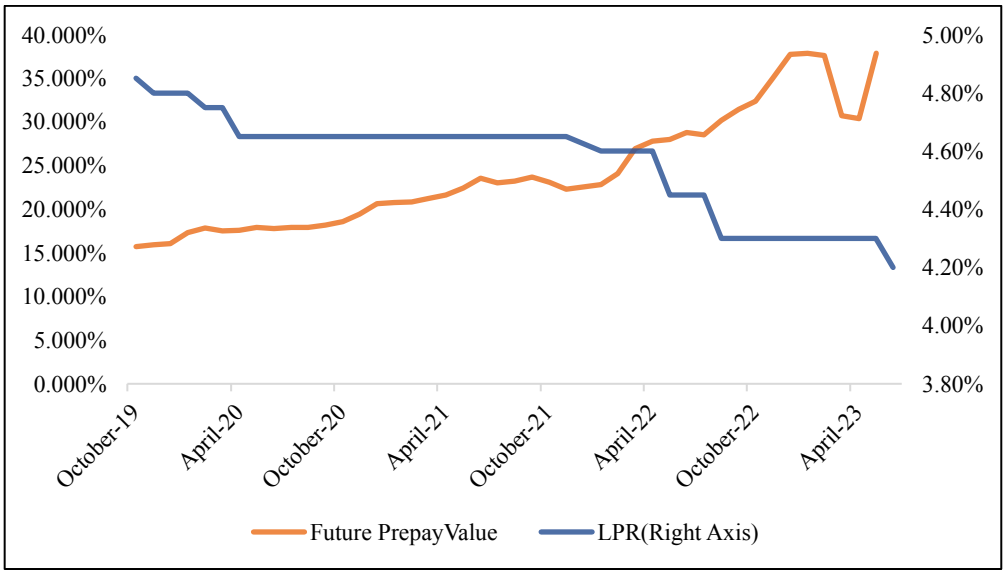


Fig. 1. The time series of mortgage prepayments and LPR

This figure plots the time-series trend of mortgage prepayment and the LPR from October 2019 to June 2023. We report the time series of LPR and future $PrepayValue$. In month t, the future $PrepayValue$ is the moving average prepayment value relative to total repayment value in the next 1 year.

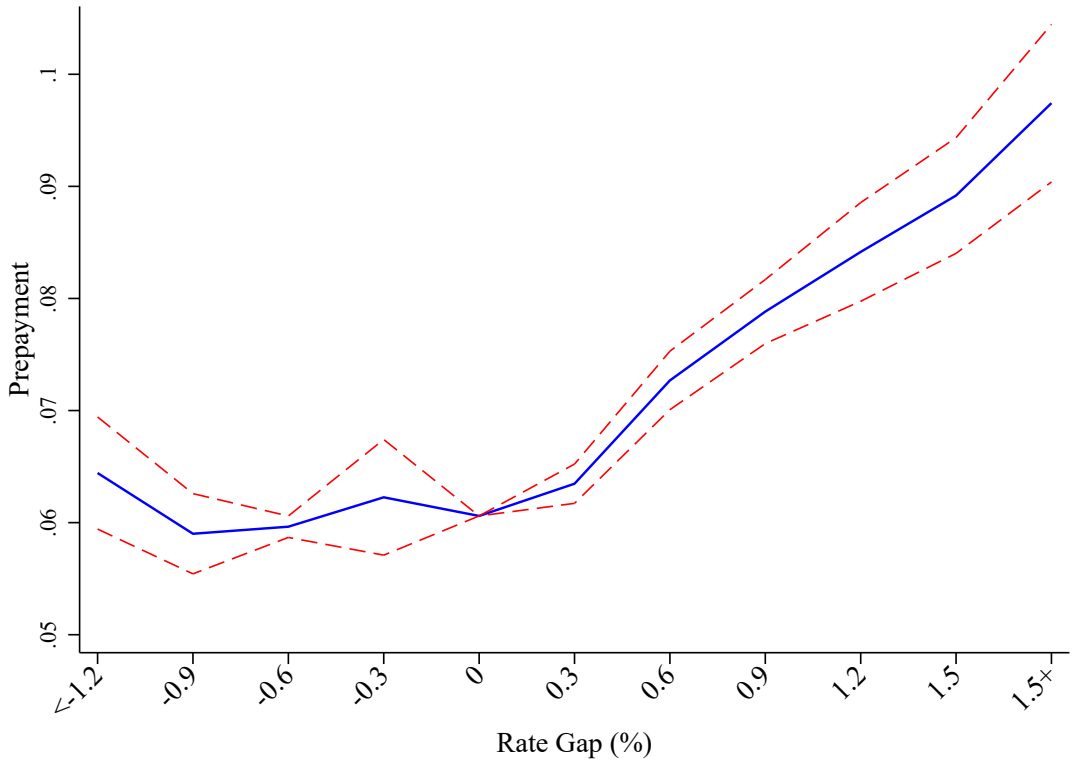
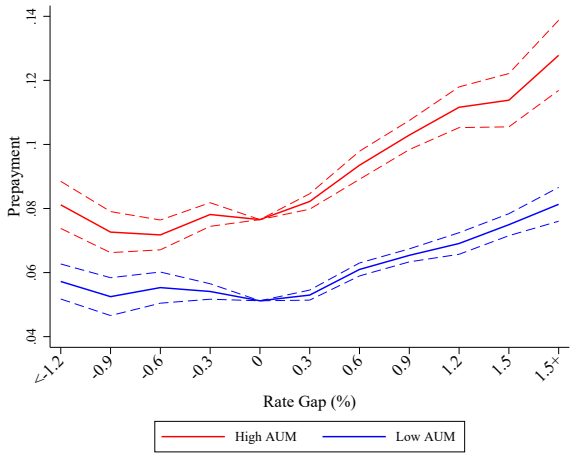


Fig. 2. Interest rate gaps and mortgage prepayments

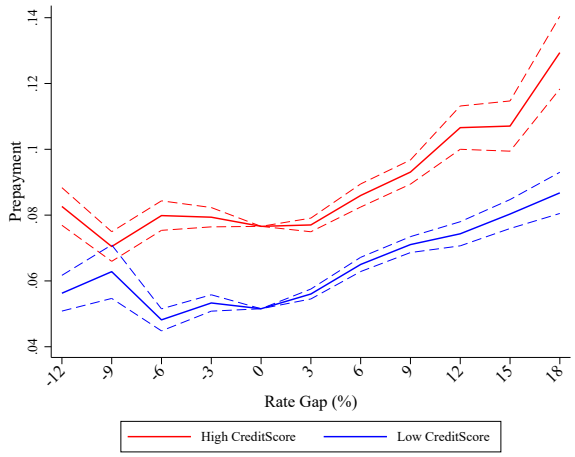
This figure presents the fraction of individuals making prepayment within each 30-bps interest rate gap bin. The x-axis denotes the 30-bps gap bins based on the difference between households' mortgage rates and LPR. The y-axis represents the fraction of individuals making prepayment (in decimal) for each gap bin, as well as their 95% confidence intervals. These fractions are estimated using the following regression:

$$\text{Prepay}_{i,(t+1,t+6)} = \beta_{\text{gapbin}}\, 1(\text{RateGap bin})_{i,t} + \text{Controls}_{i,t} + \varepsilon_{i,t}$$

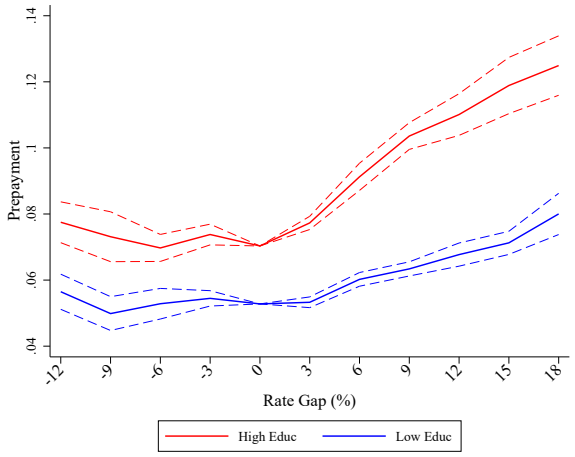
The dependent variable is a dummy variable which equals one if individual i prepays his or her mortgage between month $t+1$ and $t+6$, and zero otherwise. $1(\text{RateGap bin})_{i,t}$ is a dummy variable that indicates the 30-bps gap bins spanning from -120 bps to +180 bps. The control variables include loan to value (LTV), LTV^2, mortgage age dummies, age, log AUM, gender, education, internal credit score, and city fixed effect. All variables are defined in Appendix A.



(a) Panel A: By AUM



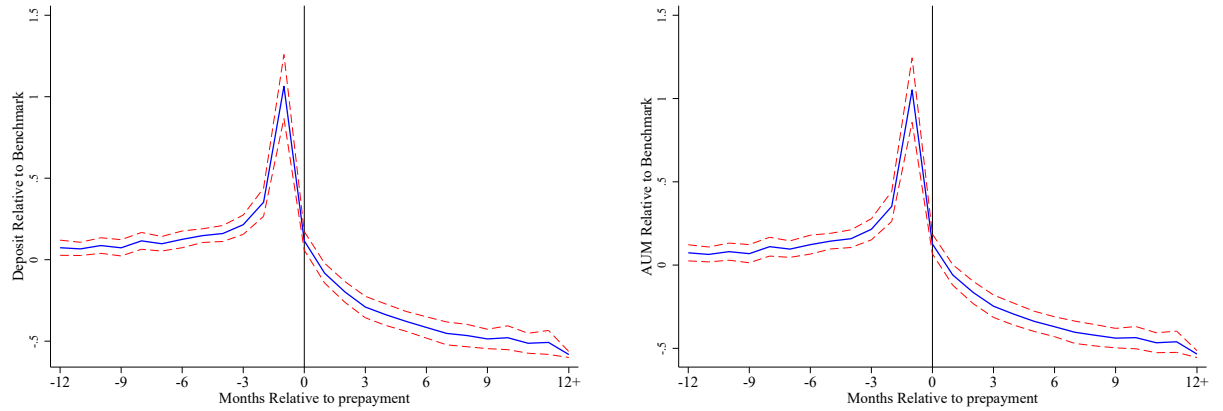
(b) Panel B: By CreditScore



(c) Panel C: By Education

Fig. 3. Interest rate gaps, household characteristics and mortgage prepayments

This figure presents the fraction of individuals making prepayment within each 30-bps interest rate gap bin using subsamples divided by repaying households' characteristics. The results are estimated using the same specifications in Figure 2, using subsamples. In Panel A, we present the results for the high-AUM individuals (AUM>70th percentile) and low-AUM individuals separately; In Panel B, we present the results for the high-credit score individuals (credit score>70th percentile) and low-credit score individuals separately; In Panel C, we present the results for the high-Education individuals (Education level≥Bachelor) and low-Education individuals separately.



(a) Panel A: Deposit change around prepayment

(b) Panel B: Asset change around prepayment

Fig. 4. Prepayment and liquid assets

This figure presents the variation of liquid assets around prepayment. The x-axis denotes the relative month around prepayment. The y-axis represents the change of liquid asset, relative to 12 months prior to prepayment, as well as their 95% confidence intervals. These values are the coefficients estimated using the following regression:

$$\text{LogLiquidAsset}_{i,t} = \sum_{j=-12}^{j=12+} \beta_{i,j} \times \text{Prepay}(j)_{i,t} + \text{Prepayer}_i + \text{Controls}_{i,t} + \varepsilon_{i,t}$$

The dependent variable is the log value of liquid asset. $\text{Prepay}(j)_{i,t}$ is a dummy variable that equals 1 when the individual prepays at time $t-j$. $\text{Prepay}(12+)_{i,t}$ equals one when the individual prepays twelve months ago. Prepayer_i is a dummy variable that equals 1 if the individual prepays during the sample period. The control variables include loan to value (LTV), LTV^2, mortgage age dummies, age, gender, education, internal credit score, city fixed effect, and year-month fixed effect. All variables are defined in Appendix A. In Panel A, we present the results using deposits as the liquid assets; In Panel B, we present the results using total assets in the commercial bank as the liquid assets.

Table 1: Summary statistics

This table reports summary statistics of the main variables for loan-level analysis. All variables are defined in Appendix A. Panel A presents the summary statistics for the main variables at the individual-month level analysis. Panel B presents the means of main variables for the individuals that did not make any mortgage prepayments and the individuals that made at least one mortgage prepayment during the sample period. The sample includes 100,000 clients of the commercial banks with no missing values for the main variables. The sample period is from October 2019 to June 2023.

Panel A: Variables for loan-level analysis

	N	Mean	STD	P25	P50	P75
$Prepay_t$	2695881	0.011	0.105	0	0	0
$Prepay_{t+1 \to t+6}$	2695881	0.059	0.236	0	0	0
M	2695881	4.926	0.645	4.505	4.9	5.39
RateGap	2695881	0.344	0.643	0.005	0.345	0.79
Age	2695881	37.665	7.947	32	36	43
HighEduc	2695881	0.3056	0.461	0	0	1
Sex	2695881	0.668	0.471	0	1	1
Score	2695881	777.338	47.598	767	784	799
LogAUM	2695881	7.824	2.263	6.451	7.792	9.233
LTV	2695881	0.374	14.06	0.239	0.33	0.393
LogBalance	2695881	5.388	0.428	5.180	5.423	5.650
Deposit Value	2695881	22745.600	170252.400	113.690	1838.170	8284.080
AUM Value	2695881	29946.400	249976.600	127.240	2017.690	9570.980

Panel B: individuals without prepayments vs individuals with prepayments

	IDs without Prepayment	IDs with Prepayment
Number of Individuals	69614	30386
Score	777.94	782.15
Sex	0.68	0.63
Age	38.08	37.23
HighEduc	0.27	0.37
AUM	20348.58	29873.14
House Area	105.02	107.32
House Value	713190.5	938152.5
House Price per m2	6913.38	8958.53
Mortgage Rate	4.88	4.98
RateGap	0.29	0.33
Current Mortgage Balance	330997.9	410848
Initial Mortgage Value	414518.7	519295.3
LTV	0.74	0.72
Mortgage Age	5.39	4.53
Normal Mortgage Repayment	2822	5231.81
Average Prepayment	NA	78429.95

Table 2: Interest rate gaps and mortgage prepayments at the loan level

This table presents the effects of interest rate gaps on mortgage prepayments at the loan level. In Panel A, the dependent variable, $Prepay_{i,t+1\to t+6}$, is a dummy variable which equals one if individual i prepays his or her mortgage between month $t+1$ to $t+6$, and zero otherwise. In Panel B, the dependent variable is a dummy variable which equals one if she prepays in month $t+k$ and zero otherwise. The timestamp is indicated under each column heading. $M_{i,t}$ is the mortgage rate for individual i in month t. $RateGap_{i,t}$ is the difference between the mortgage rate of individual i and the loan prime rate (LPR) in month t. Individual-level control variables include individual i's gender, education status, age, credit score, total assets in the commercial bank, the quadratic term of the loan-to-value ratio, mortgage balance, and indicators for mortgage age in month t. Macro-level control variables include the average price of new houses in individual i's city in month t, the changes in the housing prices, and the lagged housing prices. All variables are defined in Appendix A. In Panel A, we include city fixed effect and year-month fixed effect in Column (1) and city times year-month fixed effect in Column (2). We include city times year-month fixed effect in Panel B. The sample is from October 2019 to June 2023. The t-statistics, shown in parentheses, are calculated using standard errors clustered by time. $***$, $**$, and $*$ indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Baseline

	(1)	(2)
	$Prepay_{t+1 \to t+6}$	
RateGap	0.0091***	0.0069***
	(12.97)	(12.78)
Controls	YES	YES
City FE	YES	-
Year-Month FE	YES	-
City-Time FE	NO	YES
R^2	1.38%	1.19%
N	2685149	2685149

Panel B: Dynamic

	(1) t+1	(2) t+2	(3) t+3	(4) t+4	(5) t+5	(6) t+6
RateGap	0.0015***	0.0015***	0.0016***	0.0013***	0.0014***	0.0014***
	(5.95)	(5.79)	(6.78)	(6.12)	(6.19)	(6.53)
Controls	YES	YES	YES	YES	YES	YES
City-Time FE	YES	YES	YES	YES	YES	YES
R^2	0.41%	0.25%	0.21%	0.19%	0.18%	0.18%
N	3004914	2828837	2736838	2684197	2652431	2621350

Table 3: Interest rate gaps, individual characteristics, and mortgage prepayments

This table presents the impacts of individual characteristics on the relationship between interest rate gaps and mortgage prepayments. The dependent variable, $Prepay_{i,t+1\to t+6}$, is a dummy variable which equals one if individual i prepays his or her mortgage between month $t+1$ to $t+6$, and zero otherwise. $M_{i,t}$ is the mortgage rate for individual i in month t. $RateGap_{i,t}$ is the difference between the mortgage rate of individual i and the loan prime rate (LPR) in month t. $HighAUM_{i,t}$ is a dummy variable if individual i's AUM is above the 70th percentile of the sample, and zero otherwise. $HighEduc_i$ is a dummy variable if individual i has a degree higher than a bachelor's and zero otherwise. $HighCredit_{i,t}$ is a dummy variable if individual i's credit score is above the 70th percentile of the sample, and zero otherwise. All control variables are the same as those in Table 2 and defined in Appendix A. We include city fixed effect and year-month fixed effect. The sample is from October 2019 to June 2023. The t-statistics, shown in parentheses, are calculated using standard errors clustered by time. $***$, $**$, and $*$ indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)
		$Prepay_{t+1\to t+6}$	
*RateGap*HighAUM*	0.0127***		
	(11.96)		
HighAUM	0.0074***		
	(15.15)		
*RateGap*HighEduc*		0.0096***	
		(6.77)	
HighEduc		0.0104***	
		(16.21)	
*RateGap*HighScore*			0.0041***
			(4.64)
HighScore			0.0073***
			(11.55)
RateGap	0.0051***	0.0059***	0.008***
	(7.72)	(8.16)	(11.42)
Controls	YES	YES	YES
City FE	YES	YES	YES
Year-Month FE	YES	YES	YES
R^2	1.43%	1.40%	1.40%
N	2685149	2685149	2685149

Table 4: Mortgage prepayment and deposits and AUM at the loan level

This table presents the effect of mortgage prepayment on individuals' deposits and assets under management (AUM). In Panel A, the dependent variable, $LogDeposit_{i,t}$, is the natural logarithm of the deposit of individual i in month t. In Panel B, the dependent variable, $LogAUM_{i,t}$, is the natural logarithm of the AUM of individual i in month t. $AfterPrePay_{i,t}$ is a dummy variable which equals one if individual i made at least one prepayment before month t, and zero otherwise. $AfterPrePay[-6,-1]_{i,t}$ is a dummy variable which equals one if individual i makes a prepayment between month $t+1$ and $t+6$, and zero otherwise. $AfterPrePay[0,+5]_{i,t}$ is a dummy variable which equals one if individual i makes a prepayment between month $t-5$ and t, and zero otherwise. $AfterPrePay[+6,end]_{i,t}$ is a dummy variable which equals one if individual i makes at least one prepayment six months ago, and zero otherwise. All control variables are the same as those in Table 2 and defined in Appendix A. We include year-month fixed effect and city fixed effect. The sample is from October 2019 to June 2023. The t-statistics, shown in parentheses, are calculated using standard errors clustered by time. $***$, $**$, and $*$ indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)
	$LogDeposit_t$		$LogAUM_t$	
AfterPrePay	-0.6152***		-0.5744***	
	(-60.46)		(-57.91)	
AfterPrePay[-6,-1]		0.3299***		0.3228***
		(10.10)		(10.08)
AfterPrePay[0,+5]		-0.235***		-0.2067***
		(-26.62)		(-23.75)
AfterPrePay[+6,end]		-0.612***		-0.5694***
		(-63.73)		(-64.59)
Controls	YES	YES	YES	YES
City FE	YES	YES	YES	YES
Year-Month FE	YES	YES	YES	YES
R^2	0.67%	0.82%	0.58%	0.73%
N	2428937	2428937	2428937	2428937

Table 5: Summary statistics of city-level variables

This table reports summary statistics of the main variables for the city-level analysis in this paper. All variables are defined in Appendix A. The sample for the city-level analysis includes 267 cities. The sample period is from October 2019 to June 2023.

	N	Mean	STD	P25	P50	P75
$PrepayCount_t$	8550	0.009	0.005	0.006	0.008	0.011
$PrepayValue_t$	8550	0.508	0.284	0.339	0.463	0.619
$PrepayCount_{t+1\to t+6}$	8550	0.010	0.004	0.006	0.009	0.012
$PrepayValue_{t+1\to t+6}$	8550	0.554	0.252	0.386	0.499	0.660
M_City	8550	5.117	0.246	4.949	5.113	5.271
RateGap_City	8550	0.528	0.291	0.323	0.516	0.715
$\Delta Lend_{t+1\to t+6}$	5772	0.006	0.006	0.002	0.006	0.010
$\Delta Consume_{t+1\to t+6}$	6624	-0.019	0.363	-0.204	-0.057	0.090
CPI	8550	2.315	1.290	1.300	2.100	2.800
GDP Growth	8550	0.007	0.048	-0.022	-0.001	0.037
LogGDP Per Cap	8550	10.983	0.484	10.619	10.919	11.314
PMI	8550	49.585	2.646	49	50.1	50.8
$\Delta HousingPrice$	8420	0.001	0.085	-0.031	0	0.033
LogHousingPrice	8550	8.837	0.454	8.549	8.746	9.004
Frac>0	8550	0.849	0.124	0.779	0.880	0.948

Table 6: Interest rate gaps and mortgage prepayments at the city level

This table presents the effects of interest rate gaps on mortgage prepayments at the city level. In Panel A, the dependent variable, $PrepayCount_{c,t+1\to t+6}$, is the ratio of the number of mortgage prepayments to the total number of mortgage repayments of city c between month $t+1$ and month $t+6$. In Panel B, the dependent variable is $PrepayCount_{c,t+k}$, which is the ratio of the number of mortgage prepayments to the total number of mortgage repayments of city c in month $t+k$. The timestamp is indicated under each column heading. LPR_t is the loan primary rate in month t. $M\_City_{c,t}$ is the average interest rate of existing mortgages in city c for month t. $RateGap\_City_{c,t}$ is the difference between $M\_City_{c,t}$ and LPR_t. Control variables include PMI, the changes in CPI, GDP growth, GDP per capita, the average housing price, and the average change in housing price in city c for month t. We also include city fixed effect and year-month fixed effect. The sample is from October 2019 to June 2023. The t-statistics, shown in parentheses, are calculated using standard errors clustered by time. $***$, $**$, and $*$ indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Baseline

	(1)	(2)
	$PrepayCount_{t+1\to t+6}$	
RateGap_City	0.0060***	0.0059***
	(7.83)	(7.86)
Controls	NO	YES
City FE	YES	YES
Year-Month FE	YES	YES
R^2	85.92%	86.25%
N	8550	8420

Panel B: Dynamic

	(1)	(2)	(3)	(4)	(5)	(6)
	t+1	t+2	t+3	t+4	t+5	t+6
RateGap_City	0.0024***	0.0012***	0.0013***	0.001***	0.0011***	0.0011***
	(4.02)	(2.30)	(3.20)	(2.47)	(3.53)	(2.95)
Controls	YES	YES	YES	YES	YES	YES
City FE	YES	YES	YES	YES	YES	YES
Year-Month FE	YES	YES	YES	YES	YES	YES
R^2	52.18%	52.06%	52.14%	52.08%	52.23%	52.30%
N	9973	9711	9711	9457	9202	8949

Table 7: Interest rate gaps and mortgage prepayments at the city level, robustness tests

This table presents the robustness tests of the effects of interest rate gaps on mortgage prepayments at the city level. In Panel A, the dependent variable, $PrepayCount_{c,t+1\to t+6}$, is the ratio of the number of mortgage prepayments to the total number of mortgage repayments of city c between month $t+1$ and month $t+6$. $LocalNewRate_{c,t}$ is the average interest rate of newly-issued mortgages in city c for month t. $M\_City_{c,t}$ is the average interest rate of existing mortgages in city c for month t. $RateGap\_CityAlt_{c,t}$ is the difference between $M\_City_{c,t}$ and $LocalNewRate_{c,t}$. In Panel B, the dependent variable, $PrepayValue_{c,t}$, is the ratio of the value of mortgage prepayments to the total value of mortgage repayments of city c between month $t+1$ and month $t+6$. LPR_t is the loan primary rate in month t. $RateGap\_City_{c,t}$ is the difference between $M\_City_{c,t}$ and LPR_t. In Panel C, we follow Berger et al., (2021) and use the fraction of existing mortgages with interest rates higher than the LPR, $Frac > 0_{c,t-1}$, as the key independent variable. Control variables are consistent with those in Table 5. We also include city fixed effect and year-month fixed effect. The sample is from October 2019 to June 2023. The t-statistics, shown in parentheses, are calculated using standard errors clustered by time. $***$, $**$, and $*$ indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Replace LPR with average interest rate of newly-issued mortgages	
	$PrepayCount_{t+1\to t+6}$
RateGap_CityAlt	0.0005***
	(3.71)
Controls	YES
City FE	YES
Year-Month FE	YES
R^2	85.95%
N	8365
Panel B: Replace the number of prepayments with the value of prepayments	
	$PrepayValue_{t+1\to t+6}$
RateGap_City	0.2313***
	(5.06)
Controls	YES
City FE	YES
Year-Month FE	YES
R^2	82.52%
N	8420

Panel C: Fraction of existing mortgages with interest rates higher than the LPR	
	$PrepayCount_{t+1 \to t+6}$
Frac>0	0.0057***
	(4.89)
Controls	YES
City FE	YES
Year-Month FE	YES
R^2	84.32%
N	8420

Table 8: Mortgage prepayments and consumption at the city level

This table presents the effects of mortgage prepayments on consumption growth at the city level. The dependent variable, $\Delta Consume_{c,t,t+6}$, is the average growth of consumption made through UnionPay cards in city c between months $t+1$ and $t+6$. $PrepayCount_{c,t}$ is the ratio of the number of mortgage prepayments to the total number of mortgage repayments of city c for month t. $Frac > 0_{c,t-1}$ is the fraction of existing mortgages with interest rates higher than the LPR in city c for month $t-1$. We follow Berger et al., (2021) and use $Frac > 0$ as the instrument variable for $PrepayCount$. Control variables are consistent with those in Table 5. We also include city fixed effect and year-month fixed effect. The sample is from October 2019 to June 2023. We report the result of two stages of IV regressions in Columns (1) and (2), and OLS results in Column (3). The t-statistics, shown in parentheses, are calculated using standard errors clustered by time. $***$, $**$, and $*$ indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)
	IV		OLS
	$PrepayCount_t$	$\Delta Consume_{t+1\to t+6}$	$\Delta Consume_{t+1\to t+6}$
$Frac{>}0_{t-1}$	0.0108***		
	(4.19)		
$PrepayCount_t$		-39.2045***	-17.9126***
		(-2.46)	(-4.91)
F-Stat	17.56		
Controls	YES	YES	YES
City FE	YES	YES	YES
Year-Month FE	YES	YES	YES
R^2	74.79%	60.38%	61.72%
N	6212	6212	6212

Table 9: Mortgage prepayments and different types of consumption at the city level

This table presents the effects of mortgage prepayments on different types of consumption growth at the city level. In Panel A, the dependent variables are the growth of essential consumption in Columns (1) and (2), and the growth of discretionary consumption in Columns (3) and (4), respectively. $\Delta Consume(Essn)_{c,t+1\to t+6}$ ($\Delta Consume(Disc)_{c,t+1\to t+6}$) is the average growth of essential (discretionary) consumptions in city c between months $t+1$ and $t+6$. We report the results of the IV regressions in Columns (1) and (3), and the results of OLS regressions in Columns (2) and (4), respectively. In Panel B, the dependent variables are the growth of small consumption in Columns (1) and (2), and the growth of large consumption in Columns (3) and (4), respectively. Small (Large) consumptions in a city for a month are the sum of the consumptions with values lower (higher) than 1,000 RMB in that city for the month. $\Delta Consume(S)_{c,t+1\to t+6}$ ($\Delta Consume(L)_{c,t+1\to t+6}$) is the average growth of small (large) consumptions in city c between months $t+1$ and $t+6$. We follow Berger et al., (2021) and use $Frac > 0$ as the instrument variable for $PrepayCount$. Control variables are consistent with those in Table 5. We also include city fixed effect and year-month fixed effect. The sample is from October 2019 to June 2023. The t-statistics, shown in parentheses, are calculated using standard errors clustered by time. $***$, $**$, and $*$ indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Mortgage prepayment and essential vs discretionary consumption

	(1)	(2)	(3)	(4)
	$\Delta Consume(Essn)_{t+1\to t+6}$		$\Delta Consume(Disc)_{t+1\to t+6}$	
	IV	OLS	IV	OLS
$PrepayCount_t$	11.5909	-9.0012***	-45.1167*	-19.9098***
	(1.20)	(-3.38)	(-1.74)	(-4.42)
Controls	YES	YES	YES	YES
City FE	YES	YES	YES	YES
Year-Month FE	YES	YES	YES	YES
R^2	34.55%	34.90%	56.29%	57.62%
N	6212	6212	6212	6212

Panel B: Mortgage prepayment and small vs large consumption

	(1)	(2)	(3)	(4)
	$\Delta Consume(S)_{t+1\to t+6}$		$\Delta Consume(L)_{t+1\to t+6}$	
	IV	OLS	IV	OLS
$PrepayCount_t$	-11.6167	-8.4457***	-38.7418**	-19.0878***
	(-0.80)	(-3.72)	(-2.49)	(-5.1)
Controls	YES	YES	YES	YES
City FE	YES	YES	YES	YES
Year-Month FE	YES	YES	YES	YES
R^2	58.95%	59.30%	58.27%	60.78%
N	6212	6212	6212	6212

Table 10: Changes in LPR, frac, and consumption growth

This table presents the impacts of mortgage prepayment on the relation between changes in LPR and consumption growth at the city level. The dependent variable, $\Delta Consume_{c,t,t+6}$, is the average growth of consumption made through UnionPay cards in city c between months $t+1$ and $t+6$. $Frac > 0_{c,t-1}$ is the fraction of existing mortgages with interest rates higher than the LPR in city c for month $t-1$. $HighFrac_{c,t-1}$ is a dummy variable that takes the value one if $Frac > 0_{c,t-1}$ is above the 70th percentile of the sample, and zero otherwise. ΔLPR_t is the change in LPR from month $t-1$ to month t. Control variables are consistent with those in Table 5. We also include city fixed effect and year-month fixed effect. The sample is from October 2019 to June 2023. The t-statistics, shown in parentheses, are calculated using standard errors clustered by time. $***$, $**$, and $*$ indicate significance at the 1%, 5%, and 10% levels, respectively.

	$\Delta Consume_{t+1,t+6}$
$HighFrac_{t-1} * \Delta LPR_t$	0.0401**
	(2.23)
Controls	YES
City FE	YES
Year-Month FE	YES
R^2	60.38%
N	6212

Table 11: Mortgage prepayments and financial institutions lending at the city level

This table presents the effects of mortgage prepayments on lending growth at the city level. The dependent variable, $\Delta Lend_{c,t,t+6}$, is the average growth of lending from financial institutions in city c between months $t+1$ and $t+6$. $PrepayCount_{c,t}$ is the ratio of the number of mortgage prepayments to the total number of mortgage repayments of city c for month t. $Frac>0_{c,t-1}$ is the fraction of existing mortgages with interest rates higher than the LPR in city c for month $t-1$. We follow Berger et al. (2021) and use $Frac>0$ as the instrument variable for $PrepayCount$. Control variables are consistent with those in Table 5. We report the result of two stages of IV regressions in Columns (1) and (2), and OLS results in Column (3). We also include city fixed effect and year-month fixed effect. The sample is from October 2019 to June 2023. The t-statistics, shown in parentheses, are calculated using standard errors clustered by time. $***$, $**$, and $*$ indicate significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)
	IV		OLS
	$PrepayCount_t$	$\Delta Lend_{t+1\to t+6}$	$\Delta Lend_{t+1\to t+6}$
$Frac>0_{t-1}$	0.0115***		
	(4.62)		
$PrepayCount_t$		-1.3525***	-0.039*
		(-3.12)	(-1.88)
F-Stat	21.34		
Controls	YES	YES	YES
City FE	YES	YES	YES
Year-Month FE	YES	YES	YES
R^2	66.43%	38.49%	39.75%
N	5564	5564	5564

Appendix A. Variables Definition

Variable	Definition
Individual-level variables	
$Prepay_{i,t+1+6}$	A dummy variable which equals one if individual i prepays his or her mortgage between month $t+1$ to $t+6$, and zero otherwise.
$m_{i,t}$	The mortgage rate for individual i in month t.
$RateGap_{i,t}$	The difference between the mortgage rate of individual i and the loan prime rate (LPR) in month t.
$LogDeposit_{i,t}$	The natural logarithm of the deposit of individual i at the commercial bank in month t.
$LogAUM_{i,t}$	The natural logarithm of the AUM of individual i at the commercial bank in month t.
$Age_{i,t}$	The age of the individual i in month t.
$HighEduc_{i,t}$	A dummy variable which equals one if individual i has a degree higher than a bachelor's and zero otherwise.
$Male_{i,t}$	A dummy variable which equals one if individual i is a male and zero otherwise.
$Score$	The internal credit score of individual i in month t.
LTV	The ratio of mortgage balance to housing value.
$LogBalance$	The natural logarithm of remaining mortgage balance for individual i in month t.
City-level variables	
$PrepayCount_{c,t}$	The ratio of the number of mortgage prepayments to the total number of mortgage repayments in city c for month t.
$PrepayValue_{c,t}$	The ratio of the value of mortgage prepayments to the total value of mortgage payments in city c for month t.

Variable	Definition
$M\_City_{c,t}$	The average interest rate of existing mortgages in city c for month t.
LPR_t	The LPR rate in month t.
$LocalNewRate_{c,t}$	The average interest rate of newly-issued mortgages in city c for month t.
$RateGap\_City_{c,t}$	M_City - LPR
$RateGap\_CityAlt_{c,t}$	M_City - LocalNewRate
$Frac > 0_{c,t}$	The fraction of existing mortgages with interest rates higher than LPR in city c for month t.
$\Delta Consume_{c,t+1\to t+6}$	The average growth of consumption made through UnionPay cards in city c between from $t+1$ to $t+6$
$\Delta Consume(Disc)_{c,t+1\to t+6}$	The average growth of discretionary consumption made through UnionPay cards in city c between from $t+1$ to $t+6$. The discretionary categories include alcohol, tobacco, car, electronic devices, entertainment, and inter-city transportation.
$\Delta Consume(Essn)_{c,t+1\to t+6}$	The average growth of essential consumption made through UnionPay cards in city c between from $t+1$ to $t+6$. The essential categories include food, gasoline, utilities, household and telephone services.
$\Delta Consume(S)_{c,t+1\to t+6}$	The average of growth of small consumptions in city c between month $t+1$ and $t+6$. Small consumptions in a city for a month are the sum of the consumptions with values lower than 1,000 RMB in that city for the month.
$\Delta Consume(L)_{c,t+1\to t+6}$	The average of growth of large consumptions in city c between month $t+1$ and $t+6$. Large consumptions in a city for a month are the sum of the consumptions with values higher than 1,000 RMB in that city for the month.

Variable	**Definition**
$\Delta Lend_{c,t,t+6}$	The average growth of lending from financial institutions in city c between from $t+1$ to $t+6$.
$GDPGrowth_{c,t}$	Yearly real GDP growth rate.
$GDPPerCap_{c,t}$	The natural logarithm of GDP per capita.
CPI_t	The change of the Consumer Price Index in the prior month.
PMI_t	The Purchasing Managers' Index for the prior month.
$LogHousingPrice_{c,t}$	The natural logarithm of average housing price in city c for month t. Price is computed using housing appraisal value and housing area recorded in mortgage database.
$\Delta HousingPrice_{c,t}$	The log change of housing price in city c for month t.

Appendix B. Model

B.1. Model Setup

Consider a household that lives for three periods $t = 0, 1$ and 2, but Consumes only at $t = 1$ and 2. Preferences over consumption of household i at $t = 1, 2$ are

$$ln(c_{i,1}) + ln(c_{i,2})$$

In period 0, household i purchases a house with a mortgage and needs to pay back in the last two periods. The mortgage rate is m_i. The total amount of the mortgage if paid in period 2 is M_i. If she decides to prepay a proportion of p, she needs to prepay $\frac{M_i p_i}{1+m_i}$ in period 1 and repay $M_i(1 - p_i)$ in period 2. Households receive income $w_{i,1}$ in period 1 and make their consumption, saving, and prepayment (if any) decisions in period 1. In period 2, households receive income $w_{i,2}$, pay back the rest of their mortgages, and consume. As such, households maximize their utility by making mortgage (pre) payments, saving, and consumption decisions. Note that for simplicity, there is no uncertainty because the income path $(w_{i,1}, w_{i,2})$ is known at $t = 0$. Assume there is no default.

Note that households could save at the rate r but they cannot borrow with this rate because of refinance constraints.

Additionally, as there is no default on mortgage payments, we assume their life-time income can afford the mortgage payment, i.e.,

$$w_{i,1}(1 + r) + w_{i,2} > M_i.$$

We also assume that income in either period alone can not afford the mortgage payment, thus

$$w_{i,1}(1 + r) < M_i$$

$$w_{i,2} < M_i$$

The optimization decision for household i is specified as follows

$$\max_{p_i, c_{i,1}} ln(c_{i,1}) + ln(c_{i,2})$$

s.t.

$$(w_{i,1} - \frac{M_i p_i}{1+m_i} - c_{i,1})(1+r) + w_{i,2} - M_i(1-p_i) = c_{i,2}$$

$$0 \leq p_i \leq 1$$

$$w_1 - \frac{M_i p}{1+m_i} - c_{i,1} \geq 0$$

B.2. Solutions

Because mortgage prepayment could be considered a means of savings at the rate m_i, then we have

- If $m_i > r$, prepayment dominates savings and households prepay the mortgage as much as they can. As a result,

$$c_{i,1} = w_{i,1} - \frac{M_i p_i}{1+m_i}$$

$$c_{i,2} = w_{i,2} - M_i(1-p_i)$$

Based on F.O.C. with respect to p_i, if the constraints on p_i are not binding, we have

$$p_i = \frac{w_{i,1}(1+m_i) - w_{i,2} + M_i}{2M_i}, \tag{1}$$

and

$$c_{i,1} = \frac{w_{i,1}(1+m_i) + w_{i,2} - M_i}{2(1+m_i)},$$

$$c_{i,2} = \frac{w_{i,1}(1+m_i) + w_{i,2} - M_i}{2},$$

if

$$w_{i,1}(1+m_i) - w_{i,2} \leq M_i.$$

When

$$w_{i,1}(1+m_i) - w_{i,2} > M_i,$$

$p_i = 1$, the household fully prepays the mortgage. Then based on F.O.C. with respect to $c_{i,1}$, we have

$$c_{i,1} = \frac{w_{i,1}(1+r) + w_{i,2} - \frac{M_i(1+r)}{1+m_i}}{2(1+r)}$$

$$c_{i,2} = \frac{w_{i,1}(1+r) + w_{i,2} - \frac{M_i(1+r)}{1+m_i}}{2}$$

- If $m_i \leq r$, saving dominates the mortgage prepayment and households do not prepay their mortgages. As a result, $p_i = 0$. The borrowing constraint is not binding. Based on F.O.C. with respect to $c_{i,1}$, we have

$$c_{i,1} = \frac{w_{i,1}(1+r) + w_{i,2} - M_i}{2(1+r)}$$

$$c_{i,2} = \frac{w_{i,1}(1+r) + w_{i,2} - M_i}{2}$$

if

$$w_{i,2} - M_i \leq w_{i,1}(1+r).$$

Otherwise,

$$c_{i,1} = w_{i,1}$$

$$c_{i,2} = w_{i,2} - M_i.$$

However, this case would not happen given the assumption that $w_{i,2} < M_i$

B.3. Discussions

First, from the equation 1, conditional on prepayment, the proportion of prepayment p_i increases with the mortgage rate m_i and income $w_{i,1}$.

Second, when the saving rate r decreases from r_a to r_b ($r_a > r_b$), households with m_i between r_b and r_a choose to prepay their mortgages. Because we assume that income in

either period alone can not afford the mortgage payment, i.e.,

$$w_{i,1}(1+r_a) < M_i,$$

we only consider consumption when $p_i < 1$. Therefore, before the change in the saving rate,

$$c^a_{i,1} = \frac{w_{i,1}(1+r_a) + w_{i,2} - M_i}{2(1+r_a)},$$

$$c^a_{i,2} = \frac{w_{i,1}(1+r_a) + w_{i,2} - M_i}{2}.$$

After the change,

$$c^b_{i,1} = \frac{w_{i,1}(1+m_i) + w_{i,2} - M_i}{2(1+m_i)},$$

$$c^b_{i,2} = \frac{w_{i,1}(1+m_i) + w_{i,2} - M_i}{2},$$

Since income in period 2 cannot afford the full mortgage payment, i.e., $w_{i,2} < M_i$, we have $c^b_{i,1} < c^a_{i,1}$ and $c^b_{i,2} < c^a_{i,2}$. Consumption decreases after the reduction in the saving rate.