Mortgage payments and household consumption in urban China

Da Zhao, Yifan Chen, Jim. H. Shen

1. Introduction

There has been a long-standing debate among economists about the effects of mortgage on the real economy (Di Maggio et al., 2017). During times of exceptionally harsh economic conditions such as the Global Financial Crisis, many countries have provided sizeable mortgage relief, or substantially reduced mortgage rates in an attempt to accelerate consumption recovery. Even though many researchers have confirmed that such interventions are effective (Agarwal et al., 2017), empirical evidence does not provide clarity on how mortgages affect household spending during normal economic times; this paper aims to fill in that gap.

It is challenging to obtain causal estimates on the impact of changes to mortgage debt on household consumption levels. There exist a variety of endogeneity concerns. Interest rates directly determine mortgage payments. Interest rates also reflect the broader economic conditions, which in turn impact on household consumption. Similarly, people’s expectations and economic prospects may also drive changes in consumption trends and mortgage payments at the same time. All these factors make OLS regressions in microdata difficult to interpret.

To overcome these identification challenges, we employ a proprietary dataset of Chinese households: Urban Household Survey (UHS). The dataset is administered by China’s National Bureau of Statistics (NBS). It records the household monthly mortgage payments, and all categories of monthly household consumption. With monthly survey data from 2010 to 2014, we employ two identification strategies. Firstly, we exploit the changes in consumption around mortgage payoff events. Mortgage payoffs will incur a completion of monthly mortgage payment obligations and bring a sudden increase in available cash for households. We define households that pay off their mortgages during the sample period as the treatment group, and those that continue making mortgage payments throughout the sample period as the control group. It is important to note that mortgage payoff dates are predetermined when signing the mortgage contracts many years ago. Thus, these large reductions in mortgage payments will have occurred regardless of the current financial position or the credit-worthiness of the households. By using a difference-in-differences specification, we identify dynamic changes in consumption around mortgage payoffs.

Secondly, we apply an instrument variable (IV) strategy to estimate the effects of transitory mortgage payment adjustments on consumption changes. Adjustable-rate mortgages (ARMs) dominate China’s mortgage markets, causing household mortgage payments to be sensitive to monetary policy. Whenever the mortgage interest rate is adjusted by the People’s Bank of China (PBOC), there is a sizable adjustment in the

JEL classification:
D12
D14
E21

Keywords:
Household consumption
Mortgage payoff
Payment adjustment
Relative payment size

By exploiting variation both in mortgage payoffs and mortgage interest-rate resets, we find that a decline in mortgage payments induces a significant increase in nondurable goods spending, even when households have substantial amounts of liquidity. Following mortgage payoff, households increase consumption expenditures by 61% of the original payment. In comparison, households increase consumption by only 36% in response to a transitory payment adjustment induced by interest rate changes. Households with a higher payment-to-income ratio have a significantly lower marginal propensity to consume (MPC). These results have practical implications for policy makers seeking to design consumption boosting policies and are important for understanding how changes in monetary policy may affect consumer spending patterns.

A R T I C L E  I N F O

JEL classification:
D12
D14
E21

Keywords:
Household consumption
Mortgage payoff
Payment adjustment
Relative payment size

A B S T R A C T

© 2020 Published by Elsevier B.V.
monthly mortgage payment amount alternating between upward and downward shifts. A lower interest rate cannot be locked in by mortgagors through refinancing in China because the new mortgage will still be an ARM that exposes the mortgagor to interest rate increases. The richness variation of the interest rate and the flexibility in monthly mortgage payment provide us a unique opportunity to assess the role mortgage payments may play in changing household consumption. In accordance with Aladangady (2017), we construct an IV for the endogenous variable, mortgage payment, in order to explore the impact on household spending of transitory mortgage payment changes, as induced by the adjustment of interest rates.

We document three main findings. Firstly, households experiencing a mortgage payoff spend 61% of the increased disposable income; most of this consumption is on nondurable goods such as food, clothing and recreation. Secondly, we document significant heterogeneity among households. In particular, even with substantial amounts of liquidity, households with higher relative mortgage payments (higher payment-to-income ratio), have a smaller spending increase response than average households. Thirdly, households only spend about 36% of the monthly mortgage payment saved from an interest rate reduction. This consumption increase is only half the size of that from the determination of a mortgage. One explanation is that mortgage payment reductions which result from interest rate changes, are perceived to be transitory, whilst mortgage payoffs mark a completion of mortgage obligation and incur a permanent increase in disposable income. Despite size differences, we also find that mortgage payment adjustments relate to a consumption increase in nondurable goods.

This paper contributes to the literature in several ways. Firstly, it relates to current studies exploring the impact of mortgage rate resets and debt relief policies on real economy. The current COVID-19 pandemic and the subsequent economic slowdown, bring this policy debate back to the forefront. The question we must address is which mortgage modifying policy: debt balance relief or monthly payment relief, is the best to resolve household financial difficulties, and thus to incentivize consumption? Agarwal et al. (2017) found that debt relief programs designed to improve household balance sheets, have a sizeable impact on a broad range of economic outcomes. Di Maggio et al. (2017) find that a reduction in the federal funds rate from 6.4% to around 3.1% could lead to $940 in monthly mortgage relief, which on average generates a 35% reduction in the federal funds rate from 6.4% to around 3.1% could lead to $940 in monthly mortgage relief, which on average generates a 35% (or $108) increase in automobile consumption and the entire MPC is estimated at 0.8. In this paper, we provide empirical evidence in both of these two settings and compare household responses to these different forms of policies. More specifically, the determination of mortgage contract works similarly to debt balance relief, and the downward transitory mortgage payment adjustment is similar to payment relief. Our empirical evidence indicates that the MPC for temporary mortgage payment changes, is only half the size of the MPC for the permanent determination of a mortgage. These findings enrich the literature by comparing the effects of different mortgage modification policies on household consumption in normal economic times. Moreover, it has potentially important implications for policymakers when designing and evaluating the effectiveness of consumption boosting policies during the economic recovery.

Secondly, this paper contributes to literature by assessing the heterogenous effect of government stimulus programs among heterogenous households (Agarwal et al., 2017, Kueng, 2018; Chetty and Saez, 2016; Parker, 2017; Ni and Saez, 2014). The widely accepted belief is that liquidity constraints are the reason for household consumption responding heterogeneously to income shocks. It is important to note in our sample, that the average ratio of total household net cash-equivalent bank balances (“cash-on-hand”) to disposable income, is more than 75.6%, thus indicating that Chinese households are less likely to suffer liquidity constraints. Contrastingly, we find that it is the relative payment size, rather than liquidity, that explains the heterogenous magnitude of consumption response within households. The marginal propensity to consume (MPC) from a mortgage payoff monotonically decreases with the relative payment size (payment-to-income ratio). By taking account of the household heterogeneity, these results have rich policy implications for improving policy equivalence and effectiveness.

Finally, our paper also relates to the literature analyzing the transmission of monetary policy onto the real economy (Auclert, 2019; Agarwal et al., 2019). A sizeable part of this literature has highlighted the important role of price rigidities, and through which monetary policy impact on bank lending decisions and business investment behavior (Di Maggio et al., 2017). We supplement these studies by exploring the impact that mortgage payments, induced by interest rate changes, have on household consumption decisions. Di Maggio et al. (2017) focus on a significant and prolonged reduction in mortgage rates resulting from economic crises and downturns. Auclert (2019) provides a model and predicts that if all US mortgages were based on an adjustable rate, the effect of monetary policy shocks on consumer spending would be significantly higher. The prevalence of ARMs in our setting enables us to examine the immediate transmission of monetary policy to households during normal economic times. Moreover, unlike most previous literatures, we find the dominant household spending response to be the consumption of nondurables goods. Additionally, households in our sample face relatively volatile and unpredictable adjustments in mortgage rates. The financial expectations among Chinese households are impacted by these mortgage adjustment features which cause a minimal MPC; a reduction in mortgage payments following an interest rate decline is perceived to be temporary, thus resulting in a cautious approach to increasing consumption. Our findings highlight the important role played by interest rate change frequencies. Furthermore, it has potentially important implications for policymakers seeking to customise effective monetary policy through expectation management.

The remainder of our paper is organized as follows. Section II provides the institutional background for China’s mortgage markets as well as its land and housing markets. Section III introduces the dataset. In Section IV we investigate consumption changes in response to mortgage payoffs. In Section V we examine consumption changes following adjustments in mortgage payments. In Section VI we establish heterogeneity in the consumption response and conduct additional robustness checks. Section VII concludes.

2. Institutional background

2.1. China’s mortgage market

In 1994, China announced the privatization of state-owned housing, allowing tenants to buy ownership rights to their current homes (Wang, 2014). Since then, China’s housing prices have soared and most people must take out loans to buy a house. In China, more than four-fifths of all mortgages are provided by commercial banks. Their interest rates are determined largely by the product of the long-term benchmark interest rate and a multiplier (Agarwal et al., 2019), both of which are controlled by the PBOC and therefore leave little room for local banks or households to bargain. Again, it is critical to our identification strategy that almost all mortgage contracts in China are ARMs. Whenever interest rates are adjusted, monthly mortgage payments change correspondingly at the beginning of the next year.

Fig. 1 shows, however, that mortgage interest rates vary considerably depending on the contract length and the mortgage type. For example, the interest rates for commercial loans are typically higher than those for provident fund loans (PFLs). Moreover, the multipliers are not exactly the same across commercial banks and regions. Because the UHS does not report related information on households, benchmark interest rates might not directly reflect the magnitude of a policy change.

Fortunately, the PBOC has collected mortgage balances and the corresponding interest rates from all financial institutions since 2008.

1 The multiplier typically ranges from 0.7 to 1.2.
Therefore, the PBOC reports the quarterly weighted average mortgage interest rate, which we use in our study (see Fig. 2).

2.2. China’s land and housing markets

As discussed above, mortgage payments and household consumption can be affected by confounding factors, so we apply an IV for mortgage payments. As can be seen in Fig. 3, growth in mortgages and housing prices follow a largely consistent trend in China. We construct an index that is positively related to local housing prices.

It is noteworthy that, while most related studies use local housing supply elasticity or the percentage of unavailable land as an IV for housing prices in the U.S. (Aladangady, 2017; Saiz, 2010), this method is invalid in China. For example, the percentages of unavailable land in Shanghai and Shenyang (the capital of Liaoning Province) are 2.03% and 1.98% respectively, but their housing prices differ considerably (Wang et al., 2012).

Previous studies have found that housing prices are correlated with population growth and the supply of land (Chen and Yang, 2013; Wu et al., 2016). According to Lu et al. (2015), China’s local land supply is regulated mostly by the central government and was largely independent of local economic conditions before 2017. Therefore, there exists wide variation in the index of land expansion, which is defined as the ratio of population growth to growth in the land supply. For example, from 2006 to 2016, the ratio was 0.11, 0.40, 0.42, 0.75, and 2.50, respectively, for cities with populations below 0.2 million, in the 0.2–0.5 million range, in the 3.0–5.0 million range, in the 5.0–10.0 million range, and above 10.0 million. This index of land expansion is positively correlated with local housing prices as well as outstanding mortgages (Chen and Yang, 2013; Wu et al., 2016). In section V, we discuss in greater detail how we use interaction between the weighted average of interest rates and the index of land expansion to instrument mortgage payments.
3. Data

The primary dataset for this paper is the UHS, which has been administered by the NBS. The survey design of the UHS is similar to that of the Current Population Survey (CPS) and the Consumer Expenditure Survey (CEX), all of which are used to collect detailed information (e.g. income, cash holdings, expenditures, and other demographic characteristics) on households. Every three years, the NBS draws a first-stage probabilistic sample of households from selected cities and towns in each province over several stages, starting with cities and towns, then covering districts and residential communities, and finally housing units. A final sample is then randomly selected from the first-stage sample for detailed interviews and diary-keeping every month (Feng et al., 2017). Each year, one-third of the households in the final sample are replaced by other households from the first-stage sample. Whereas the majority of existing studies have estimated the MPC for only one type of consumption, such as credit expenditures or automobile purchases (Agarwal et al., 2019; Di Maggio et al., 2017), we can take advantage of UHS to estimate the MPC for all consumption categories.

We have access to monthly UHS data from 2010 through 2014 covering Shanghai, Guangdong, Sichuan, and Liaoning. These provinces vary significantly in economic development and locations. To investigate the credibility and representativeness of the UHS, we compare the data it provides with data from the Chinese Household Financial Survey (CHFS), which covers 25 provinces but is conducted biannually. The CHFS indicates that 6.9% of households in 2011 had mortgages, while the rate is around 7.2% in the UHS data. Moreover, the CHFS indicates that the ratio of households that did not pay off mortgages to those that did between 2011 and 2013 is 1.82, while the corresponding number is 1.83 in the UHS data, a slight difference of only 0.01. This further verifies the representativeness of our main sample.

The UHS provides monthly updates on changes in monthly mortgage payments for every household. Specifically, we consider only households that have been making mortgage payments for at least six months during the sample period, resulting in a sample consisting of 29,406 observations in total. We then form treatment and control groups. We define households that pay off their mortgages during the sample period as the treatment group, and those that maintain mortgage payments throughout the sample period as the control group. Table 1 provides summary statistics for the variables associated with these two groups.

Mortgage Payment is our key variable of interest, representing more than one-fifth of household disposable income in the sample. Therefore, paying off a mortgage and facing a mortgage payment adjustment caused by an interest rate change may have significantly varying effects on consumption. We now turn to our main outcome variable, household consumption. The mean values are between 6436 yuan and 6640 yuan (or 1009 dollars and 1041 dollars) for the treatment and control groups, respectively.7

Regarding the main variables that we used to control for several potentially confounding effects, the age of the household head is around 43 years for both groups. This variable can be used to reflect the life-cycle effect. The average number of household members is around three, with two bringing in income. Meanwhile, more than 70% of household heads are males. As China is still a developing country, the education level of a typical household head in our sample is most likely lower than a bachelor’s degree, which may indicate limited financial literacy and rationality when facing income changes. All of these variables are believed to have effects on total consumption as well as the structure of consumption (Wang, 2014). Because housing prices are almost always rising in China and the treatment group households bought their houses slightly earlier than those in the control group, housing purchase prices and mortgage payments in the treatment group (1481 yuan) are slightly lower than those in the control group (1539 yuan).

We follow Kueng (2018) and define “relative payment size” as the ratio of the total mortgage payment to household disposable income. The ratio of total household net cash-equivalent bank balances (“cash-on-hand”) to disposable income is used as an index to measure household “liquidity”.

In addition to the data from the UHS as described above, we also collect interest rates from the PBOC and data on regional land supplies mainly from the Bureau of Land Resources for the instrument variable construction.

4. Mortgage payoffs

4.1. Identification strategy

One major issue encountered when assessing causality is the potential for reverse causation between consumption and mortgages. To alleviate this concern, many related studies argue that a long-term contract can be used to break the unilateral effects of consumption on mortgages (Scholnick, 2013; Coulibaly and Li, 2006). To be specific, debt contracts

---

The average nominal exchange rate between RMB and US dollars is 6.38 during the sample period.
such as mortgages and auto loans (Stephens, 2008; Di Maggio et al., 2017) are typically signed for terms of five to thirty years, and therefore current consumption cannot affect predetermined mortgage payments. In China, mortgage contracts (such as interest rates, maturity, etc.) are on average signed for terms of 15.6 years (Shen and Yan, 2009), so current consumption has no causal effects on contractually defined mortgage maturity.

Note that the idea of using a contract cannot alleviate the problem of endogeneity caused by variable omission (e.g. informal borrowing or income expectations). In an event-study setting, though, if two groups are endogeneous caused by variable omission (e.g. informal borrowing or maturity.

According to the CHFS (2011,2013), nearly 80% of borrowers never change their repayment schedules. We further classify the remaining 20% into two cases. Some households may pay off all of their mortgages at one time, while others may pay off only parts of their mortgages in advance. Intuitively, no one will pay 99% of a mortgage in advance and leave only 1% to be paid over several months, and therefore the latter case is essentially the same as signing another long-term contract. For the former case, we follow Scholnick (2013) and drop households whenever the last month’s mortgage payment is more than twice the size of the payment in the previous month (about 11.2% of the treatment sample). According to China’s Banking Regulatory Commission (CBRC), the non-performing mortgage loan ratio varies from only 0.26%–0.37% during our sample period. This fact indicates that the effects of misspecification of the treatment group (if there are any) will be limited.

4.2. Model specification

Following Agarwal and Qian (2014), we study the dynamics of the consumption response using a modified version of a distributed lag model, so the results can be interpreted as those of an event study. Formally, our main specification takes the following form, as shown in (1).

\[ C_{it} = \sum_{k=1}^{3} \beta_k \times D_k \times X_{it} + \theta X_{it} + \alpha_i + \epsilon_i + u_{it}, \]  

(1)

where the dependent variable \( C_{it} \) is household consumption at the end of month \( t \) and \( D_k \) is the increase in disposable income and equals 0 for the control group.\(^3\) \( 1_{it} \) is a dummy variable that equals 1 if \( t \) is the kth

\(^3\) As usual, we adjust the income, consumption, and other nominal price variables by reference to city-specific CPIs.

\(^4\) Defined as the average size of a mortgage payment.
month after the determination month. It is noteworthy that we have to drop months where \(k < -4\) or \(k > 3\) from our sample to alleviate concerns about confounding effects. We further set \(k = -4\) (instead of \(k = -1\)) as our benchmark period. \(X_t\) is a vector of household characteristics (e.g. disposable income, age, gender, education, number of household members, and number of income earners) that we use to capture any residual household heterogeneity. \(a_t\) is the household fixed effect included to absorb differences in consumption preferences at the household level. \(f_t\) is the year-month dummy, used to absorb the seasonal variation in consumption expenditures as well as the average of all other concurrent aggregate factors. Standard errors are clustered at the household level.

The key coefficients of interest are \(\beta_0\). Specifically, the coefficient \(\beta_0\) measures the immediate response in consumption during the determination month. The marginal coefficients \(\beta_k (k > 0)\) measure the additional marginal responses \(k\) months after the payoff. Similarly, the coefficients \(\beta_k (k < 0)\) capture differences in consumption trends between the treatment group and the control group in each of the three pre-treatment months (compared with the benchmark period, i.e., \(k = -4\)). The validity of our paper requires statistically or economically meaningful pre-trends. These results suggest that, before the determination month, there are no statistically or economically meaningful pre-trends. These results provide formal evidence in support of our research design: the two groups are balanced and homogeneous. Households begin to increase consumption, however, one month before the determination month (i.e. \(k = -1\)), which suggests an anticipation effect. At the end of the determination month, the MPC jumps significantly to 0.68 and drops slightly during the following three months, indicating a steady state. These results are consistent with those reported in Di Maggio et al. (2017), who point out that in contrast to reported in the literature on household consumption responses to one-time payments, persistent income shock will cause persistently higher MPC.

As there exists evidence for anticipation effects and consumption is in the steady state immediately following the mortgage payoff, we follow Agarwal and Qian (2014) and estimate the MPC over the five months from \(k = -1\):

\[
C_{ij} = \beta_{bef} \times D_i \times 1_{bef} + \beta_{aft} \times D_i \times 1_{aft} + \theta X_{ij} + a_i + f_t + u_{ij},
\]

where \(1_{bef}\) is a dummy variable that equals 1 for the two months before the anticipation (i.e. \(k = -2\) and \(k = -3\)). Correspondingly, \(\beta_{bef}\) measures differences in consumption trends between the two groups during the two months (compared with the benchmark period). \(1_{bef}\) is also a dummy variable that equals 1 for the five months during and after the anticipation (i.e. \(k > -2\)). \(\beta_{aft}\) captures the average monthly MPC for a treated household (compared with the benchmark period, i.e., \(k = -4\)), relative to the change in consumption in the control group. Other variables are the same as those in Equation (1).

Column (1) of Table 2 shows the regression results of a baseline specification using Equation (2), finding an average MPC of 61%. The result is robust to controlling for household net cash-equivalent bank

### Table 2

<table>
<thead>
<tr>
<th>Consumption</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adj-R²</td>
<td>0.42</td>
<td>0.43</td>
<td>0.36</td>
<td>0.41</td>
</tr>
<tr>
<td>Household Fixed Effect</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Time Fixed Effect</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Permanent Income</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Cash-on-hand</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Characteristics</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Note: (1) Standard errors in parentheses are clustered at the household level. (2) ***p < 0.01, **p < 0.05, *p < 0.1.
balances (“cash on hand”), as shown in Column (2). Additionally, we also control for permanent income, which is proxied by average monthly consumption over all household-months and shown in Column (3), and the results remain consistent. We also control for group-by-time fixed effects and report the results in Column (4), identifying the MPC using only variations in mortgage payments within the treatment group in the post-treatment period. The MPC estimate changes only slightly. Overall, a mortgage payoff, which constitutes a disposable income shock, has a significantly positive effect consumption during this sample period.

According to the NBS, the MPC of China’s urban households is about 0.70 during our sample period. We suggest two factors that could explain the difference between the NBS data and our results. First, our sample includes all borrowers and those individuals generally earn higher incomes than the national average (i.e. 5793.77 yuan). Second, the increase in household consumption reported in this paper mainly reflects consumption of non-durable goods (as shown in Table 5), while over the long run durable goods are evenly distributed at any given time and therefore are included in NBS’s calculation of the MPC.

5. Mortgage payment adjustments

As introduced in the institutional background section, almost all mortgage contracts in China are ARMs. Whenever the mortgage interest rate changes, there will be a sizable adjustment in monthly mortgage payments. Monthly mortgage payments can shift either upward or downward. This fact enables us to further focus on households that make mortgage payments continually during the sample period and investigate their consumption change in response to changes in their mortgage payments following an interest rate change. Many potential confounders, both observable and unobservable, may, however, affect consumption and mortgage payments simultaneously. For example, local credit-easing policies may prompt households to consume more local non-tradable goods, bolstering housing prices as well as mortgage payments. Therefore, a simple ordinary least squares (OLS) analysis is likely to result in a biased estimate. We construct an instrument variable (IV) to estimate the effects of mortgage payment adjustments on consumption.

5.1. Identification strategy

To address sources of endogeneity, we follow Chaney et al. (2012) and Aladangady (2017) and instrument mortgage payment adjustments using interaction between the weighted average of mortgage interest rates and the regional index of land expansion (i.e. the ratio of population growth to growth in the land supply).

On the one hand, the relevancy restriction requires the IV to be highly correlated with payment adjustments. Intuitively, housing prices as well as total mortgages outstanding are higher in cities where the index of land expansion is larger (Lu et al., 2015), and mortgage payments will be more sensitive to interest rate changes. On the other hand, the exclusion restriction requires that the IV should have zero covariance with the error term. According to Aladangady (2017), this implies that, conditional on the usual control variables, the magnitude of the consumption response to changes in interest rates does not vary systematically with the regional land expansion index.\(^5\) Notably, using an interaction term as an IV is similar to the design of the Bartik Instrument, which is formed by

\[ C_{i,t} = \beta_1 M_{i,t} + \beta_2 X_{i,t} + \beta_3 r_{i,t} + \beta_4 s_{i} + \alpha_i + f_i + u_{i,t}. \]  
\[ M_{i,t} = \gamma_1 r_{i,t} + \gamma_2 X_{i,t} + \gamma_3 r_{i} + \gamma_4 s_{i} + \alpha_i + f_i + u_{i,t}. \]  
\[ \text{Cov}(r_{i,t}, u_{i,t}) = 0. \]

Table 3 provides estimates from the first-stage regression, as in Equation (4). The results reported in the first row show that the instruments have a significant impact on changes in mortgage payments. As expected, following an increase in interest rates, mortgage payments grow more sharply in cities with higher population density. Overall, the P-values of Stock and Yogo statistics are 0, which indicates that the instruments are strong.

5.2. Model specification

Following Aladangady (2017), the full model, including the first stage, can be described by the following equations and exclusion restrictions:

\[ C_{i,t} = \beta_1 M_{i,t} + \beta_2 X_{i,t} + \beta_3 r_{i,t} + \beta_4 s_{i} + \alpha_i + f_i + u_{i,t} \]
\[ M_{i,t} = \gamma_1 r_{i,t} + \gamma_2 X_{i,t} + \gamma_3 r_{i} + \gamma_4 s_{i} + \alpha_i + f_i + u_{i,t} \]
\[ \text{Cov}(r_{i,t}, u_{i,t}) = 0. \]

Table 3 presents estimates from the first-stage regression, as in Equation (4). The results reported in the first row show that the instruments have a significant impact on changes in mortgage payments. As expected, following an increase in interest rates, mortgage payments grow more sharply in cities with higher population density. Overall, the P-values of Stock and Yogo statistics are 0, which indicates that the instruments are strong.

In Table 4 we report the IV estimates of \( \beta_1 \) based on Equation (3). The baseline results shown in column (1) point to a significant causal effect of mortgage payment adjustments on consumption and suggests an MPC of around 0.36.

Interestingly, the MPC for a change in the mortgage payment is much

\(^5\) For example, the unmeasurable regional long-term productivity in the error term may have a strong correlation with both the index of land expansion and consumption. Interacting the land expansion index with the interest rate can alleviate this issue because the central bank typically resets interest rates on the basis of short-term economic fluctuations. Similarly, unobservable macroeconomic factors may affect consumption and the interest rate simultaneously. However, the index of land expansion is largely predetermined by the government, and therefore will not be correlated with short-term macroeconomic activities.

\(^6\) Concretely, their similarity is that industry share (the index of land expansion) measures exposure to the policy change while the national growth rate (the interest rate) proxies for the size of the policy change.

\(^7\) The weighted average mortgage interest rate is reported only at quarterly frequency by the PBOC.

\(^8\) For each household, we drop months that cannot cover a full quarter.
lower than the size of the MPC as estimated based on the determination of mortgage payments. There are three possible factors that play a role in these differences.

First, expectations: In China, the frequency of interest rate changes is relatively high (Fig. 5), and almost all mortgages are ARMs, which means the monthly mortgage payment size will vary with changes in interest rates. Even though mortgage payments are reduced by interest rate decreases, monthly mortgage payments could be increased immediately in the next period by an interest rate increase. Moreover, the lower interest rates in 2010–2012 in China compared with the U.S. consume 80.0% of reductions in mortgage payments owing to lower average consumption increases the most among all categories. There are two possible economic reasons that could explain the difference. First, our finding reported in another study (Agarwal et al., 2019) that, when mortgages are paid off, food, clothing, recreation, education, and culture article consumption increase significantly. However, this significantly distorts household expectations: a reduction in mortgage payments is perceived to be temporary. Therefore, borrowers in China face higher volatility in monetary policy, which significantly distorts household expectations: a reduction in mortgage payments is perceived to be temporary. Households always expect to experience future mortgage payment adjustments. Our low MPC estimate is similar to the finding reported in another study (Agarwal et al., 2019), where Chinese borrowers’ average consumption response following a drop in interest rates in 2008 is estimated. China’s unique institutional background distinguishes our findings from those of other studies in the U.S. Di Maggio et al. (2017) find that borrowers in the U.S. consume 80.0% of reductions in mortgage payments owing to lower interest rates in 2010–2012. Fig. 5 shows that the Federal Fund Rate remained at around zero for more than seven years after 2009, which suggests greater stability than China’s monetary policy. Hence borrowers in the U.S. are able to view interest rate adjustments as more or less permanent. Moreover, U.S. borrowers can always use the loan refinancing option to lock in a low interest rate when the interest rate decreases.

Second, asymmetry of shocks: While disposable income always increases in the case of the determination of a mortgage, households may face negative disposable income changes when interest rates rise. According to Christelis et al. (2019), responses in the MPC may differ considerably following positive and negative transitory income shocks. Thus, our findings provide an average MPC following both positive and negative disposable income changes.

Third, sampling error: When investigating the MPC out of changes in mortgage payments, we focus only on a subsample of households, i.e. those that continue repaying mortgages throughout the sample period. This subsample is used as the control group in the analysis of mortgage determinations. We show in Table 1 that the treatment and control groups are quite similar along many dimensions. However, there remains a slight difference between these two groups; for example, the control group has slightly higher disposable income, higher educational attainment, and higher average age. These factors may affect financial sophistication, expectation formation, and the MPC for this subsample of households.

### Table 4

<table>
<thead>
<tr>
<th>Consumption</th>
<th>Baseline</th>
<th>Income Expectation (2)</th>
<th>Consumption Credit (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortgage Payment Size</td>
<td>0.36*** (0.11)</td>
<td>0.33*** (0.08)</td>
<td>0.34*** (0.09)</td>
</tr>
<tr>
<td>Realized Income Growth</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumption Credit Growth</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>4630</td>
<td>4630</td>
<td>4630</td>
</tr>
</tbody>
</table>

Note: (1) Standard errors in parentheses are clustered at the household level. (2) **p < 0.01, *p < 0.05, *p < 0.1. (3) The coefficient before Mortgage Payment Size, i.e. β1, can be interpreted as the MPC out of mortgage payments. β1 has a negative sign. A decrease in mortgage payment size induces an increase in consumption, ceteris paribus, and vice versa. Our empirical results also indicate that β1 is negative. To compare the MPCs estimated based on the determination of mortgages, we report |β1| in this table.

6. Heterogeneity

The analysis thus far has focused on average responses. The theoretical literature indicates, however, that households may choose alternative categories when facing shocks of varying sizes (Agarwal et al., 2019; Di Maggio et al., 2017). Moreover, households might respond differently across liquidity and relative payment size (Kueng, 2018), so we now explore these heterogeneities among China’s borrowers.

6.1. Consumption category

We examined consumption changes in multiple categories in response to mortgage payment changes in two settings discussed above: mortgage payoffs using a difference-in-differences model and mortgage payment adjustments using the IV model. In Table 5 we report the consumption responses relative to several consumption categories in both settings. We find that, when mortgages are paid off, food, clothing, recreation, education, and culture article consumption increase significantly. However, the small and statistically insignificant response in durable consumption may appear puzzling because the study by Li (2017) finds that durable consumption increases the most among all categories. There are two possible economic reasons that could explain the difference. First, our sample covers more complete information. Li (2017) uses binary survey data where only data from 2011 to 2013 are observed, with no records from 2012. Thus, unlike the consecutive monthly survey data we use, Li
(2017) defines the treatment group in this study based on when households report a mortgage payment in 2011 but no mortgage payment record in 2013. Consumption data are also reported only for 2011 and 2013 (nonconsecutively). Therefore, Li (2017) is unable to capture the immediate consumption behavior of the treatment group in 2012. Because durable goods are typically much more valuable than non-durables, households have to save for a longer time to accumulate enough money to buy durables. It is possible therefore that Li (2017) cannot observe changes in non-durable goods consumption immediately after mortgage payoffs. Second, our result is consistent with the macro environment where the ratio of durables goods to consumption has dropped significantly since 2004 (see Fig. 6).

Similarly, most of the MPC is concentrated in nondurables in response to smaller and transitory payment adjustments. Compared with mortgage payoffs, the only difference is that the MPC for Food (0.09) and Clothing (0.05) is much smaller than that for Recreation, Education, and Culture Articles (0.18). Essentially, our results are in line with those reported in previous research, such as Agarwal et al. (2019), who also find that consumption rises primarily in non-durable goods when mortgage interest rates drop.

### 6.2. MPC heterogeneity in relative payment size

The results reported in Table 1 indicate that the typical household in our sample holds substantial liquid assets. This fact implies that the traditional theory of liquidity constraint may not help to explain the MPC heterogeneity we observed. Contrary to conventional wisdom, however, some recent studies find that relative payment size is the main explanation for borrowers’ consumption behavior when a mortgage is paid off (Li, 2017; Scholnick, 2013). Furthermore, Kueng (2018) shows that it is important to measure payments in relative terms instead of using the level or a quadratic function of payments (Scholnick, 2013). Thus we follow Kueng (2018) and analyze heterogeneity in the MPC along these two dimensions: relative payment size and liquidity.

\[
C_{it} = \sum_{q=1}^{3} \sum_{q'=-1}^{3} \kappa_{q} \times D_{it} \times 1(r_{it} \in q) \times 1(l_{it} \in q') + \sum_{q=1}^{3} \kappa_{q} \times 1(r_{it} \in q) + \sum_{q=1}^{3} \kappa_{q} \times 1(l_{it} \in q') + \theta X_{it} + \alpha_{i} + \epsilon_{it} + \eta_{it} \tag{6}
\]

| Table 5 | Effects of mortgages on consumption: By categories. |
|---|---|---|---|---|
| | Nondurable | Durable | Food | Clothing | Households Facilities, Articles and Services |
| Mortgage payoff | 0.57*** | 0.08 | 0.24*** | 0.13*** | 0.03 |
| (0.16) | (0.11) | (0.04) | (0.02) | (0.06) |
| Mortgage payment adjustment | 0.30*** | 0.07 | 0.08*** | 0.05** | 0.04 |
| (0.11) | (0.08) | (0.03) | (0.02) | (0.03) |
| Medicine and Medical Services | | | | | |
| Transportation and Communications | | | | | |
| Recreation, Education and Culture Articles | | | | | |
| Residence | | | | | |
| Other Goods and Services | | | | | |
| Mortgage payoff | 0.02 | 0.05** | 0.10*** | 0.02 | 0.01 |
| (0.09) | (0.02) | (0.03) | (0.07) | (0.06) |
| Mortgage payment adjustment | 0.01 | 0.05* | 0.17*** | 0.01 | 0.01 |
| (0.03) | (0.03) | (0.05) | (0.04) | (0.08) |

Note: (1) Standard errors in parentheses are clustered at the household level. (2) ***p < 0.01, **p < 0.05, *p < 0.1. (3) The coefficient before Mortgage payment adjustment, i.e. $\beta_1$, can be interpreted as the MPC out of mortgage payments. $\beta_1$ has a negative sign. A decrease in mortgage payment size induces an increase in consumption, ceteris paribus, and vice versa. Our empirical results also indicate that $\beta_1$ is negative. To compare the MPCs estimated based on Mortgage payoff, we report $|\beta_1|$ in this table.

![Fig. 6. Ratio of durable goods to consumption in China (%).](image-url)
As was the case above, here $D_i$ denotes the increase in disposable income received by all household members, $1(\tau_i \in q)$ is a dummy variable that equals 1 when a household’s relative payment size (i.e. the ratio of the mortgage payment to household disposable income) belongs in the $q$ th tertile, and $1(\tau_i \in \tau)$ is a dummy variable that equals 1 when household liquidity (i.e. the ratio of cash-on-hand to disposable income) belongs in the $\tau$ th tertile. Other variables are the same as those in Equation (1).

$k_{\tau q}$ is the parameter of interest. It represents the MPC of each pairwise group. The results reported in Table 6 show that the MPC declines monotonically with the relative payment size across all liquidity tertiles. For example, when liquidity is low (see the third column), moving from the lowest relative payment size to the highest reduces the MPC from 0.97 to 0.44. We do not, however, find a clear pattern in liquidity. For example, when the relative payment size is large (see the fifth row), the MPC does not decrease monotonically with the relaxation of the liquidity constraint but shows a seemingly inverted U shape (from 0.44 to 0.30, then to 0.38, where 0.30 and 0.38 are statistically nonsignificant). This finding indicates that, compared with the liquidity constraint, relative payment size plays a more important role in explaining the heterogeneity of the MPC across households. When monthly mortgage payments account for a lower percentage of income, people are more likely to spend lavishly to increase consumption immediately. This increase in disposable income is relatively small for them, but the mental cost of planning and smoothing consumption over the long run is comparatively higher. In this situation it is not worthwhile to smooth the consumption.

### 7. Robustness

#### 7.1. Endogeneity of mortgage payoffs

Even though the parallel trend is tested for and satisfied, households who bought houses earlier may be more likely to be in the treatment group. For example, about 21.75% of households in the control group bought their houses after 2000, while the comparable number for the treatment group is only 17.76%. To alleviate this concern, we restrict our sample to households that purchased their houses after 2000 to make these two groups more comparable. We recalculate the results according to Equation (1). As can be seen in Fig. 7, the estimates are similar to those reflected in Fig. 4.

We also employ a new method proposed by Freyaldenhoven et al. (2019) to alleviate this concern. The key requirement with their approach is to find a covariate (say $\tau_i$) that is related to the confounder $u_i$ but unaffected by the treatment indicator. This is similar in difficulty to finding a suitable control variable, but without the additional burden of ensuring that $\tau_i$ proxies perfectly for $u_i$. As Freyaldenhoven et al. (2019) emphasize, this approach works best when a small number of economic factors capture the important sources of endogeneity.

In our paper, the number of confounders is expected to be limited and to include mainly whether a borrower has ever paid off part of mortgage in advance. We argue that an ideal covariate of $\tau_i$ is the years of making mortgage payments since a contract was signed. On the one hand, working experience as well as past and future income growth expectations are the main driving forces behind advance mortgage payoffs and these factors are closely related to $m_i$. In addition, households typically do not change their repayment schedules if a contract has been signed recently or will reach maturity soon. Therefore, $m_i$ is a good predictor of the confounder. On the other hand, $m_i$ was determined many years earlier and is therefore more likely to be an exogenous variable and cannot be affected by the treatment indicator in the current state. Following Freyaldenhoven et al. (2019), we use the closest lead of the treatment variable as an excluded instrument for $\tau_i$. In Fig. 8 we report the results, which are similar to those derived using our baseline model.

#### 7.2. Exclusion restriction

We now further check the validity of our IV assumptions. In particular, we explore whether various determinants of consumption are significantly correlated with the IV, and hence respond differently to interest rate shocks in cities with varying land expansion indexes. According to Aladangady (2017), we can include additional variables among the control variables to test them.

First, interest rate adjustments may have heterogeneous impacts on household expectations regarding future income growth across cities. For example, cities where financial services forms the pillar industry may be more sensitive to interest rate changes than cities that depend mostly on automobile manufacturing. To alleviate this concern, we follow Aladangady (2017) and include realized city-level income growth as an additional control variable. In Column 2 of Table 4 we show that the estimated MPC falls only slightly, to 0.33.

Second, credit-easing will directly promote household consumption. At the same time, it is possible that consumption credit is more sensitive to interest rates when land is in relatively short supply (Davidoff, 2016). To address this issue, we include and aggregate each household’s consumption credit growth at the city level as another control variable and the MPC again falls only slightly, to 0.34 (see column 3 in Table 4). Taken together, these results suggest that the exclusion restriction is a plausible assumption and therefore the IV strategy consistently estimates the local average treatment effects of interest-rate-induced variations in mortgage payments across cities with varying land expansion indexes.

### 8. Discussion and concluding remarks

In order to assess the impact of household mortgage debt on consumer spending, we take advantage of matching monthly mortgage payment data to a panel of consumer expenditure data. The results appear robust to a variety of endogeneity concerns. Using a difference-in-differences design, we find that borrowers who pay off their mortgages during the sample period (the treatment group) increase consumption significantly compared with those who continue paying their mortgages (the control group). The MPC is slightly larger than 61% and appears to be stable over time. Interestingly, the relative payment size (the ratio of the mortgage payment to total disposable income) explains the heterogeneous magnitude of consumption increases across households better than the conventionally acknowledged factor—liquidity constraints. Specifically, the MPC monotonically decreases with the relative payment size. Using an IV method, we further estimate that the MPC out of a temporary payment adjustment is only 36%. We also find a heterogeneous increase across consumption categories, with increases primarily in nondurable goods.

Nowadays emerging markets are trying to migrate from an investment-driven model to a consumption-driven model. The results of this paper are useful for understanding mechanisms through which these countries could design policies and accelerate their transition. As there is increasing concern regarding the declining consumption rate within...
these economies as well as debates surrounding how best to boost consumption, our findings provide additional insights that can help to explain the declining rate through the mortgage mechanism. Concretely, our paper suggests that a policy design that aims at relieving the household debt burden in China would have a sizable impact on aggregate consumption among borrowers. The quantitative results reported in this study can provide an advantage in designing and evaluating the effectiveness of policies that can boost consumption in China.

Declaration of competing interest

This is to certify that we have no conflict of interests with other parties.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.econmod.2020.07.008.
References

Daviddoff, T., 2016. Supply constraints are not valid instrumental variables for home prices because they are correlated with many demand factors. Critic. Financ. Rev. 5 (2), 177–206.