Technological and Economic Development of Economy
ISSN: 2029-4913 / eISSN: 2029-4921
2022 Volume 28 Issue 3: 804–830
https://doi.org/10.3846/tede.2022.16787

# MACROPRUDENTIAL POLICY, HOUSE PRICE FLUCTUATION AND HOUSEHOLD CONSUMPTION

Yang QI[1], Haixiao QIN[1*], Peide LIU[2], Jianxu LIU[1], Saulius RASLANAS[3], Nerija BANAITIENĖ[3#]

[1]*School of Economics, Shandong University of Finance and Economics, Jinan, China*
[2]*School of Management Science and Engineering, Shandong University of Finance and Economics, Jinan, China*
[3]*Faculty of Civil Engineering, Vilnius Gediminas Technical University, Vilnius, Lithuania*

Received 01 October 2021; accepted 27 February 2022

**Abstract.** House purchasing has become an important asset allocation choice for most families in China. House price fluctuation is also one of the important factors that leads to systematic risks in the financial market, which might cause economic crises and then reduce consumption. Since China formally established the dual-pillar management framework of macroprudential policy in 2019, it has played a crucial role in maintaining the stability of house prices. This article employs the mediating effect model to comb the internal mechanism of the interaction between macroprudential policies, housing prices, and household consumption and test by the panel data of 30 provinces and cities in China from 2004 to 2019. Experience implies that macroprudential policy can not only stabilize consumption demand directly and effectively, but also affect consumption indirectly through the cross of the real estate market and the credit market. Further research has also found that macroprudential policies may fail between regions with higher GDP and high-income groups. This finding will contribute to research on the relationship between macroprudential policies and real economics. In addition, it would be helpful in making policies to increase consumption.

**Keywords:** macroprudential policy, household consumption, mediating effect.

**JEL Classification:** C12, C54, D12, O18.

## Introduction

In recent years, with the deepening of urbanization in China, the speed of development of the real estate market is increasing and the wealth accumulated by the real estate market has become an important part of Chinese household consumption. Since 1998, China's average increase in house prices has exceeded 300% and property appreciation has become the main

*Corresponding author. E-mail: *qhx1324@126.com*
#Corresponding author. E-mail: *nerija.banaitiene@vilniustech.lt*

source of appreciation of consumer wealth. The house price not only has gone up, but also has risen with high fluctuations (Figure 1). For example, China's household wealth rose by more than 90% due to appreciation of property in 2018 (China Economic Trends Research Institute, 2019). This makes house price fluctuations more closely related to consumer wealth expectations.

On the other hand, fluctuation in housing prices is also an important indicator to control financial risks. The 2008 subprime mortgage crisis, which originated in the US real estate market, has made people realize that real estate price fluctuation plays a critical role in the systemic financial threat transmission mechanism. The bursting of the housing bubble not only cause systemic financial risks, but also transmit to the economy. The decline in asset prices will reduce social investment, the willingness to supply will decline, social unemployment will increase, consumer income will decrease, and social demand will continue to decline. Income inequality tends to increase with early economic development and tends to decrease when a country reaches a certain level of development (Soava et al., 2020). Between 2000 and 2007, total wealth grew by 10.3%, followed by a sharp 7.5% decline in 2008, after which growth resumed at a modest pace, averaging 5.7% from 2008 onward (Credit Suisse Research Institute, 2020). In this sense, the financial crisis has a permanent negative effect on the growth of household wealth. The continuous decline in social wealth caused by the contraction of both ends of supply and demand can lead to a spiral recession.

Macroprudential policies are the effect methods not only to control the financial risks, but also to protect household wealth and consumption. This paper tries to explore the effectiveness of macroprudential policies on consumption with data from the Chinese provincial panel. We attempt to reveal the significance of macroprudential policies in economics. The remainder of this paper is organized as follows. The first section gives a brief literature review, the second section introduces the hypothesis, and analyses the theoretical background. The

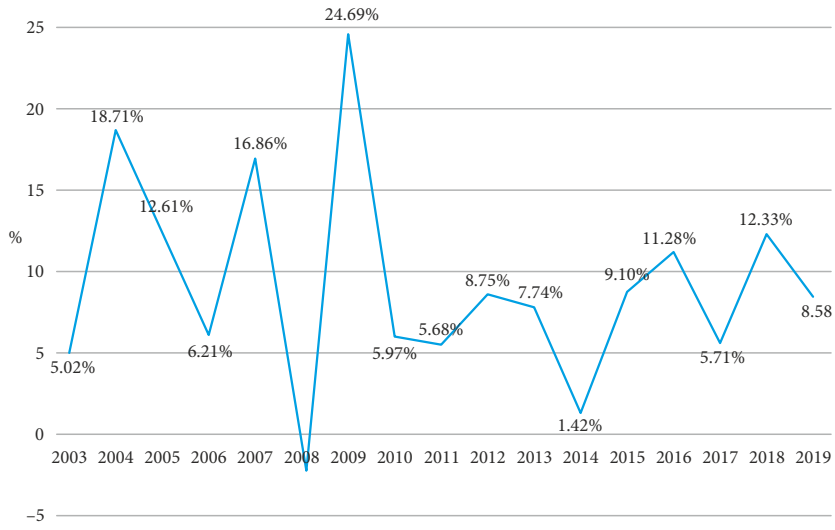



Figure 1. Residential property price growth (National Bureau of Statistics of China, n.d.)

third section is about the methodology, which includes the introduction of the mediating effect model. The fourth section is the data and results, which makes more analyses on the different effectiveness of macroprudential policies.

## 1. Literature review

In terms of the implementation of macroprudential policy, the macroprudential policies in most countries around the world are related to the real estate market (Akinci & Olmstead-Rumsey, 2018) and the financial markets (Angeloni et al., 2015). The housing market is enormous and closely related to other markets, and its depression and boom could not only create considerable fluctuations in credit and leverage, but also destabilize the financial and macroeconomic systems (Crowe et al., 2013). In the macro economy, financial institutions promote economic growth mainly through liquidity creation (Berger & Sedunov, 2017). However, the credit and off-balance-sheet credit commitments that exist on the balance sheet, while raising the hierarchy of social liquidity, also contribute to institutional risk-taking (Angeloni et al., 2015). Institutional risk-taking behavior is characterized by excessive credit and leverage, excessive maturity mismatch, concentrated risk exposure, improper incentives, and moral hazard (see European Systemic Risk Board [ESRB], 2018). Therefore, the credit market has become one of the main sources of financial systemic risk.

Consumer consumption depends on both liquid wealth and mortgage-backed property access to get credit to ease its own budget constraints. Rising house prices could provide ample investment benefits to households, especially those who sell houses. In the meanwhile, housing assets are considered as high-quality collateral, the higher the house price, the more available mortgage funds, the more flexible consumption choices. House price changes occur in cycles (Zavadskas et al., 2008; Kaklauskas et al., 2009; Trojanek, 2021). Therefore, the cycle of house prices and consumption growth is closely synchronized (Aoki et al., 2004; Attanasio et al., 2005; Katagiri, 2018). However, high house prices are often tied to financial systemic risk (Caballero & Simsek, 2020). In the cycle of rising house prices, there are asset bubbles, bloats, and bursts. Rising housing prices, on the one hand, enhance consumer wealth and, on the other hand, make real estate deviate from the real value, resulting in the possibility of house price fluctuations and increasing the leverage ratio of residents, and increase the financial systemic risk. It can be seen that, on the one hand, real estate has become an important part of the asset al.ocation of Chinese residents; on the other hand, the real estate market has become one of the main sources of systemic risks of financial risks. House prices have become an important indicator of consumption and financial risk.

In the face of different financial systemic risks, the Central Bank adopts a variety of macroprudential policy tools. Existing studies have analyzed the impact of macroprudential policies on house price fluctuations and leverage ratios from the perspective of the effects of macroprudential policy instruments. In the real estate market, the effectiveness of macroprudential policy implementation is mainly based on the stability of house price fluctuations to measure. Compared to other macroprudential policy instruments, the loan-to-value ratio is the most effective policy tool for the real estate market (Funke & Paetz, 2013). Other macroprudential policy tools, such as leverage ratio, loan loss reserve rate and countercyclical

capital requirements, and dynamic reserve ratio, are not the most effective policy tools for interfering with consumer demand compared with loan-to-value ratios.

In the credit market, commonly applied macroprudential policy tools include the loan-to-value ratio, dynamic reserve ratio, and the dynamic reserve policy. Its validity is mainly rooted in the change in the credit scale and the fluctuation of the leverage ratio. According to empirical facts, every 1% reduction in the loan-to-value ratio cap could prominently reduce the annual growth rate of a mortgage by 0.25% to 0.5% (Morsink & Krznar, 2014). However, the loan-to-value ratio has an inverted "U" shape in restraining credit growth. Social leverage falls first and then growth, consumers seek private capital, and the loan-to-value tool exists with the possibility of failure (Alam et al., 2019). Dynamic deposit reserves can effectively reduce commercial bank credit growth and pro-cyclical changes in leverage ratio, while dynamic provision policies smooth the contribution of credit during a downturn (Braggion et al., 2018) and capital managements can effectively rule out credit volatility (Landi, 2017). The above analysis shows that different macroprudential policy tools can effectively cut house price growth and smooth credit fluctuations.

In summary, there are existing studies that focus on the effect of macroprudential policies on house price and credit, and on the impact of house price fluctuations on consumption, but there is still less analysis on the mechanism of macroprudential policies affecting consumption. Moreover, the Central Bank usually adopts a combination to implement macroprudential policy, but research focuses on analyzing the effect of a single macroprudential policy tool and the whole effect of macroprudential policy. This article attempts to analyze the impact mechanism and magnitude of the central bank's implementation of macroprudential policies on consumption from the perspective of effect measurement. There are two marginal contributions in this article. The first is to comprehensively analyze the impact of macroprudential policies on consumption from the perspective of the combination of macroprudential policies; the second is based on regional differences in consumption in China, differences in consumer income, and differences in the nature of consumer goods, to analyze the differences in the effects of macroprudential policies is of great significance for enhancing China's consumer demand and expanding research on macroprudential policies

## 2. Theoretical background and hypotheses

The impact of macroprudential policies on consumption can be divided into direct and indirect paths. Macroprudential policies aim to regulate the danger of the financial system. The implementation of macroprudential policies can stabilize asset prices and prevent asset bubbles, cut consumer expectations of the future financial crisis, and thus promote current consumption.

The indirect path of macroprudential policy is shown in two points. First, wealth fare is a determinant of consumption (Modigliani, 1966). Macroprudential policy in the real estate market directly affects the growth of consumer wealth, as one of the elements affecting consumption. Second, frequent variations in financial markets lead to greater uncertainty for consumers, reduce consumer confidence, and have a prominent negative impact on consumption. Changing consumer investment decisions, particularly the promotion of financial

system risks, has allowed consumers to save more discreetly and has a direct impact on their current consumption (Baiardi et al., 2013).

According to the possible influence path of macroprudential policy on consumption, this paper proposes the following hypotheses:

*Hypothesis 1:* Macroprudential policy directly affects the next phase of consumption.

Through the research of the dynamic stochastic general equilibrium model, it has been found that the macroprudential policy and monetary policy implemented by the Central Bank can effectively improve the welfare level of citizens when the negative impact occurs in the economy (Caballero & Simsek, 2020). The level of welfare depends on the level of household consumption. The path of monetary policy that affects consumption mainly influences consumption by releasing or tightening liquidity and changing consumer price expectations. This path illustrates that the Central Bank's direct policy changes the level of consumption by influencing consumer expectations. With the continuous innovation of financial products, the allocation of household assets is becoming increasingly diversified. Financial systemic risk affects the consumer's investment decision-making and then affects the consumer's consumption level. Macroprudential policy mainly controls financial systematic risks, and its influential path to consumption affects next-period consumption through changing the expectation of the consumer.

*Hypothesis 2:* Macroprudential policies affect consumption through real estate.

On the one hand, controlling house prices is one of the main roles of macroprudential policies. From a real estate market perspective, macroprudential policies can effectively combat housing demand shock (Turdaliev & Zhang, 2019), monetary policy shocks (Alpanda & Zubairy, 2017), interest rate shocks (Mendicino & Punzi, 2014), credit shock (Liu & Molise, 2020) and technology shocks (Rubio & Comunale, 2017), effectively curbing house price volatility. On the other hand, the appreciation of housing assets has become the absolute source for wealth development of Chinese residents; housing is both consumer goods and investment assets. The micro-survey data in China can also prove this point. Rising house prices may have the wealth utility of boosting consumption (Bostic et al., 2009).

There are differences in the effects of housing wealth among different age groups. An empirical study based on the overlapping generation model illustrates that the effects on housing wealth of the elderly are higher (Campbell & Cocco, 2007; Gan, 2010), but some scholars (Attanasio et al., 2009; De Nardi et al., 2010; Li & Shen, 2013) have addressed that inheritance opportunities cut down the tendency to family consumption from the perspective of inheritance and put forward the opposite view. There are also prominent regional differences in the performance of housing wealth effects between countries (Jawadi et al., 2017; Alp & Seven, 2019; Chen et al., 2020). In general, the effect of housing wealth in low-income countries is greater. However, the real estate market can have more than one set of prices because purchasers are heterogeneous (Zhou et al., 2015; Feng et al., 2021). Additionally, in different stages of financial development, consumer enthusiasm for consumption also has a certain difference, and this can be seen in the shock of housing wealth shock on consumption before the 2008 financial crisis (Čeh Časni, 2018).

The above-mentioned analyses all found that housing price on household consumption is influential, and this effect also has differences due to age and financial development stage. Macroprudential policy has a prominent effect on the control of housing prices; therefore, housing prices can become a macroprudential policy on the impact of consumption intermediaries. However, there is no notable relationship with current consumption due to the high illiquidity of housing assets, which makes the wealth effect lag, that is, rising house prices, cannot change the current cash flow statement of consumers immediately (Auclert et al., 2020).

*Hypothesis 3:* Macroprudential policies affect consumption through credit channels.

Reducing the social leverage ratio is also one of the main roles of macroprudential policies. The social leverage ratio is the ratio of the balance of social loans to the gross domestic product (GDP). The risk of the credit market is also one of the financial systemic risks. Financial institutions in the credit market are closely linked and jointly bear the risk of the market. The increased risk in the credit market can carry or amplify the fragility of the financial market and accumulate financial systemic risk. Macroprudential policy directly affects the total amount of loans by regulating social leverage.

The increase in credit supply directly improves the level of consumer consumption. Consumers can obtain loans from financial institutions to support consumption through collateral credit. From expenditure information, consumers can use short-term overdraft credit lines to increase consumption. Bank increases in consumer credit lines can also promote consumption (Agarwal et al., 2018; Liu, 2020). However, due to liquidity constraints, consumers cannot always get loans from financial institutions to support expenditures, and they cannot get credit when their own income is highly uncertain or too low (Tobin, 1970; Flemming, 1973; Cherednychenko & Meindertsma, 2019). The increase in household leverage in recent years also has a negative impact on consumer spending behavior. Too much household leverage reduces the likelihood of households getting more consumer credit and clips consumption. And when financial institutions offer fewer credit rationing to industries and companies of consumers, they are pessimistic about future incomes and spend less, increasing prudent savings (Gomes, 2008).

Macroprudential policies can smooth the volatility of the credit market and reduce financial systemic risk. The smooth effect of macroprudential policy mainly reflects that macroprudential policy can restrict social leverage. The macroprudential policy can adjust the reserve ratio to change the balance sheet of financial institutions, or directly according to the balance sheet of financial institutions to maintain compliance with the leverage ratio, affecting the size of the credit market, so that the total amount of consumer loans decline, thus passively deleveraging, increase in consumption level indirectly.

*Hypothesis 4:* Macroprudential policies affect expenditure through the interaction of real estate and credit channels.

From the credit information, the increase in the debt scale and the investment in housing mutually promote, two thirds of the total household credit flow into the real estate market,

the price of the growth of the house price and the increase in the credit scale have relative synchronicity, because asset al.ocation is mainly housing assets, the purchase of houses by the consumer is mainly mortgage loans. Especially during the 2008 financial crisis and the 2015 real estate inventory removal policy, China's real estate credit measures strengthen the function of real estate rescue and digestion of the housing inventory, with housing assets due to the rapid price appreciation of the price and rapid increase in household leverage.

Leveraging consumers can dampen the pace of consumption growth and even produce a crowding-out effect (Dynan & Edelberg, 2013). Because regardless of whether house prices rise or fall, uncertainty expectations for future economic development will increase in mortgage households. Borrowers can only spend carefully to ensure they can repay their mortgages. That high debt itself could dampen consumption growth (Andersen et al., 2016). High debt levels can have severe consequences for fiscal stability, and fiscal consolidation is needed to restore economic growth (Albu & Albu, 2021). China's microdata also suggest that a higher consumer leverage ratio prominently dampens expenditure, especially since banks' debt restrictions do more to curb consumption than other types of debt restrictions. Housing debt, this notably curbs expenditure and, in poor areas and high-debt households, it has a more negative relationship (Mian et al., 2013).

The co-growth of house prices and credit is also a process of systemic risks accumulating in the financial system. Although the apparent soar in house prices in recent years continues to boost the wealth stock in the consumer sector, Bernanke et al. (1999) argued that there is a financial accelerator mechanism when housing assets are used as loan collateral, assuming that housing assets are the only type of investment. In the good stage of financial development, the consumer demand for housing assets increased, which raises the price of housing assets, consumers, then mortgage housing assets to obtain loans, and continue to invest in housing assets; then the growth of credit is actually based on the housing asset bubble-style price soar. When some families face a liquidity crisis, cannot repay loans, or society curtails the demand for housing assets, housing assets will be based on the path of appreciation of reverse depreciation, destruction of household stock wealth, and consumer loss of expenditure and other abilities to promote economic development, resulting in great damage to the financial system and social economy, financial crisis, macroprudential policies in the real estate market and credit market, through the stabilization of house prices lift and limit leverage measures to diminish financial risk, and ultimately achieve stable consumption growth role.

*Hypothesis 5:* Macroprudential policies have different effects on consumers in different regions and different income levels.

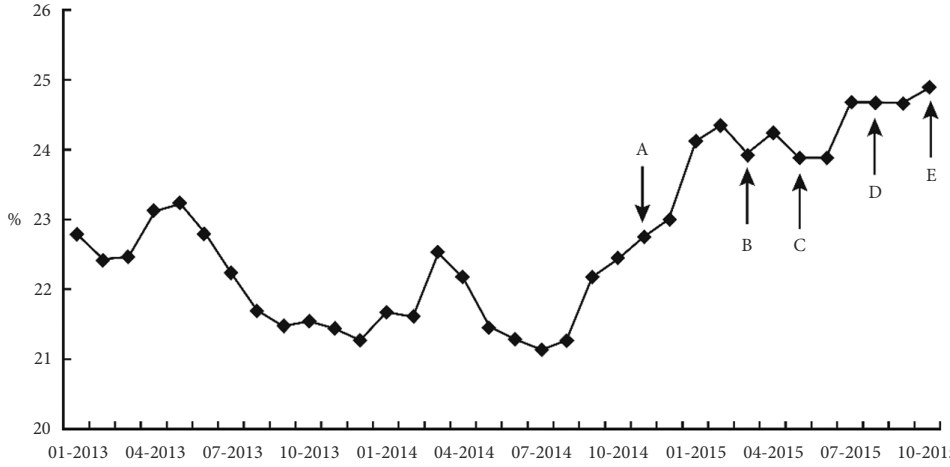
There is obvious heterogeneity in economic development and cultural customs in China, and the marginal propensity to consume is different between local citizens and urban and rural residents.

China's dual financial structure may also impede the transmission channels of macroprudential policies. The dual financial structure of China consists mainly of two aspects: price (such as interest rate determination) and quantity (such as credit rationing) (He & Wang, 2012). Price, on the one hand, still has benchmark interest rates on deposits and loans; on the

other hand, money market interest rates are entirely determined by the market. In number, there is widespread credit discrimination (Anzoategui et al., 2015) and financial exclusion for residents. From the point of view of credit technology, the demand side of low-income loans that lack good collateral is excluded from the low-interest rate market of the formal financial system and has to turn to informal financial institutions to accept higher market interest rates.

The above facts lead to the implementation of the policy and cannot obtain the due effect. For example, the Central Bank cut the reserve requirement ratio five times in a row between 2014 and 2015. The loose macroprudential policies have not lowered the interest rate on private lending in Wenzhou, but the financing costs of informal financial institutions have continued to rocket (Figure 2).

The root of this problem is that the dual financial structure of China interferes with the response of different groups to policy. Macroprudential policies are primarily implemented by financial institutions when they tighten official credit supplies and regulate the housing market in large cities. It cannot decide the allocation of credit to the groups that really need it, and China's special financial environment makes China's macroprudential policies different from mature countries in the market economy. If consumer heterogeneity is ignored, then the efficiency of macroprudential policies may be misevaluated.




*Notes:* A, B, and C indicate that the central bank expanded the upper limit of the floating range of deposit interest rates of financial institutions to 1.2 times, 1.3 times, and 1.5 times the benchmark interest rate in November 2014, March 2015, and May 2015, respectively. D indicates that the central bank released the upper limit of interest rate fluctuations for time deposits with maturities of one year or more in August 2015. E indicates that the central bank completely abolished the deposit interest rate ceiling in October 2015.

Figure 2. Inflation – adjusted aggregate private lending rates in Wenzhou, China (monthly trend)

## 3. Methodology

### 3.1. Mediating effect model

According to the analysis, macroprudential policies can affect consumption directly or indirectly through the real estate and credit markets. To verify the validity of Hypothesis 1, Hypothesis 2, and Hypothesis 3, this paper applies the medium effect verification method (see James & Brett, 1984). A variable may be considered a mediator to the extent to which it carries the influence of a given independent variable on a given dependent variable (Soto-Acosta et al., 2016). Mediating effect analysis is an important step to check whether a variable becomes a mediator and to what extent it acts as a mediator. It can not only explain the mechanism behind the relationship but also integrate the existing research and theory, which has obvious theoretical and practical significance. The step-by-step regression coefficient is the most commonly used test of the intermediary effect.

First, to test the overall effect of macroprudential policies on consumption, the regression equation is set as follows:

$$mpc_{i,t} = c + \beta_{11} mp_t + \beta_{12} controlI + u_1. \tag{1}$$

Second, examine the effects of macroprudential policies on expenditure through the real estate and credit markets. As mentioned above, macroprudential policies will have an overwhelming impact on consumption through the real estate and credit markets. Therefore, we use the mediating effect test procedure to test the regression equation as follows:

$$lnhouse_{i,t} = c + \beta_{21} mp_t + \beta_{22} controlI + u_2; \tag{2}$$

$$lever_{i,t} = c + \beta_{31} mp_t + \beta_{32} controlI + u_3; \tag{3}$$

$$mpc_{i,t} = c + \beta_{41} mp_t + \beta_{42} lnhouse_{i,t} + \beta_{43} controlI + u_4; \tag{4}$$

$$mpc_{i,t} = c + \beta_{51} mp_t + \beta_{52} lever_{i,t} + \beta_{53} controlI + u_5, \tag{5}$$

where $i$ is province and $t$ is time (year). $mpc_{i,t}$ refers to the marginal propensity to consume of the inhabitants of province $i$. $mp_t$ denotes the implementation of China's macroprudential policies. *lnhouse* is the logarithm of house prices. *lever* represents the ratio of household debt to disposable income. *control* are control variables, including different classes of monetary policy tools (see "4. Data and empirical results" for details).

The inspection procedure is illustrated in Figure 3.

Finally, to ensure the robustness of the results, we use three regression methods synchronously, namely, OLS regression, fixed effects (FE) regression, and random effects (RE) regression, respectively. If only OLS regression is applied, the estimation of the relationship between variables may be biased. Moreover, OLS regression treats only the entire static panel as a cross-sectional data process; it ignores individual characteristics. Therefore, we also reported the results of FE regression and RE regression commonly used in panel data. The fixed effect is to consider that the sample individual has both individual and time-varying characteristics, as well as individual characteristics that do not change with time allowing the explanatory variables to have a certain endogeneity. Random effects require that all variables be strictly uncorrelated with $u_i$.

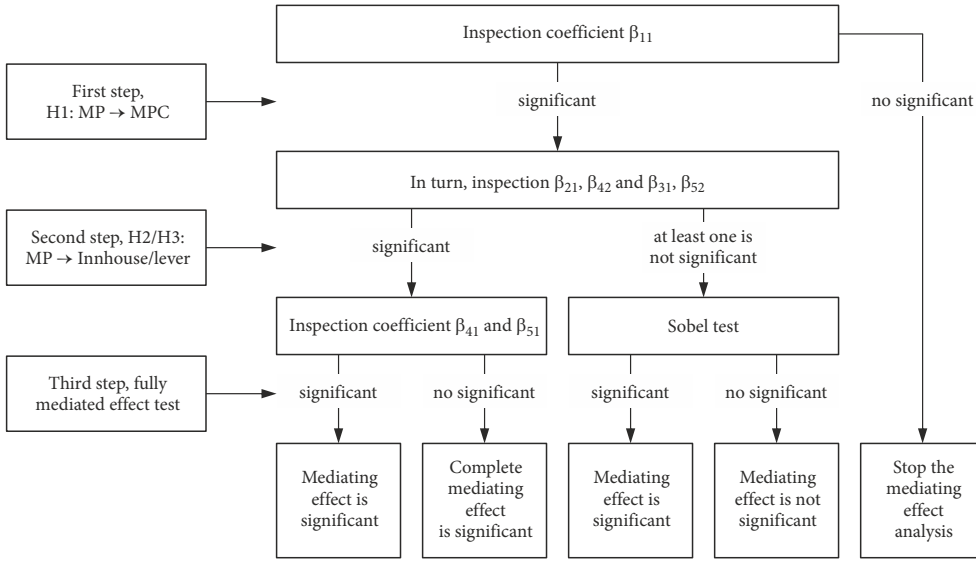



Figure 3. Mediation test

### 3.2. System GMM method

In fact, panel data may or may not have entophytic problems. To avoid endogeneity, the system generalized estimation method (System GMM) can be utilized.

For the original model:

$$y_{i,t} = \beta_0 + \rho_{i,t-1} y_{i,t-1} + \beta_1 x_{i,t} + u_i + \varepsilon_{i,t}. \tag{6}$$

Among them, $y_{i,t}$ is the explained variable, $y_{i,t-1}$ is the one-phase lagging variable, and $x_{i,t}$ is the strictly exogenous explanatory control variable. $u_i$ is the disturbance term that does not change with time, and $\varepsilon_{i,t}$ is the residual.

Since the lag order naturally has endogenous problems, use $\Delta y_{i,t-1}\left(y_{i,t-1} - y_{i,t-2}\right)$ and $\Delta y_{i,t-2}$, $\Delta y_{i,t-3}$ etc., as instrumental variables of $y_{i,t-1}$, it is related to $y_{i,t-1}$ and $\varepsilon_{i,t}$ is strictly irrelevant and satisfies the exogenous hypothesis.

The use of System GMM regression is to select the lag 2–4 periods as the tool variable, considering that there may be no strict erogeneity of the explanatory variable. In this paper, the robust standard error is given in the regression results to overcome the heteroscedasticity of the error term in the correlation dimension. According to the results of the AR (1) and AR (2) of Arellano-Bond test, the zero assumption of first-order autoregressive is not shown. And there is no zero assumption of second-order autoregressive. The Hansen test confirms that the tool variables are properly set and there is no problem of over-identification, which suggests that the estimation results are credible.

This paper also lists the System GMM regression results as a supplement to the intermediate effect measure robustness. The regression equation is defined in Eq. (14).

### 3.3. Quantile regression

All above regression methods are mean reversion. Compared with mean reversion, quantile regression does not require information to follow a specific distribution, but estimates multiple variations from multiple regression curves according to different percentage of distribution, which may reflect different effects of response variables on different quantiles. Quantile regression can deal with the heterogeneity of data from different sources, different times, and different places without too much assumption (Santos & Sequeira, 2014; Haseeb et al., 2021).

The quantile divides the probability distribution range into the tangent point of a continuous interval with an equal probability. Let $p$ be a number between 0 and 1, the percentile distribution of the continuous random variable $y$, expressed in $Q(p)$, can be expressed as:

$$p = P\left(y \le Q(p)\right) = F\left(Q(p)\right) = \int_{-\infty}^{Q(p)} f(y)dy. \tag{7}$$

The $f(y)$ is the density distribution function. Conversed from Eq. (7), $Q(p)$, $0 \leqq p \leqq 1$. The definition is as follows:

$$Q(p) = F^{-1}(p) = inf\left\{y : F(y) \ge p\right\} \quad 0 \leqq p \leqq 1. \tag{8}$$

$F^{-1}$ represents the inverse function of the cumulative distribution function, and *inf* represents the maximum lower bound. It is worth noting that $Q(0.5)$ is the median. The first and third quartiles are $Q(0.25)$ and $Q(0.75)$, respectively, and the 95th percentile is represented as $Q(0.95)$. Similarly to the average estimate of a random sample will lead to the minimum of the sum of squares of error; the median value of the random sample $\left\{y_1, y_2, \ldots y_n\right\}$ of the random variable $y$ will lead to the minimum of the sum of absolute deviations. Therefore, $Q(p)$ can be interpreted as the optimal solution that minimizes the weighted average of samples with a value greater than or equal to $Q(p)$ and samples with a value less than or equal to $Q(p)$ in general:

$$\min\left[\sum_{i\in\left\{i:y_i\le Q(p)\right\}} p\left|y_i - Q(p)\right| + \sum_{i\in\left\{i:y_i\ge Q(p)\right\}} (1-p)\left|y_i - Q(p)\right|\right]. \tag{9}$$

Suppose that $y$ is a linear function of a variable, as illustrated in the following:

$$y = X'\beta + \varepsilon, \tag{10}$$

where $y$ is the response variable, $\beta$ is the unknown parameter vector of the covariate $X$, and $\varepsilon$ is the random error. Hence, the problem is changed to settle a problem of the optimal estimator of $\beta$:

$$\hat{\beta}(p) = \underset{\beta\in R^k}{\arg\min}\left[\sum_{i\in\left\{i:y_i\ge X'\beta\right\}} p\left|y_i - X'\beta\right| + \sum_{i\in\left\{i:y_i< X'\beta\right\}} (1-p)\left|y_i - X'\beta\right|\right]. \tag{11}$$

For any quantile $p$ between 0 and 1, $\hat{\beta}(p)$ can be regarded as the $p$-th regression quantile that minimizes the sum of weighted absolute residuals (Budría & Moro-Egido, 2014).

When using panel data, quantile regression models not only perform better in computing, but also in solving heterogeneity problems. Consider the following model specifications:

$$Y_{i,t} = X'_{i,t}\beta_p + \alpha_i + \varepsilon_{i,t}, \tag{12}$$

where $Y_{it}$ represents the dependent variable, $MPC_{it}$. $X_{it}$ is an explanatory variable, especially a series of control variables, such as macroprudential policy, housing price, leverage ratio, etc. $\beta_p$ is the coefficient of p-th quantile, $\alpha_i$ the time-varying individual fixed effect, and $\varepsilon_{it}$ is the error term.

Using the estimation program proposed by Powell (2020) to estimate the panel quantile regression model is not only easy to implement but also has consistent and asymptotically normal distribution. The estimation process is as follows:

The first step is to estimate the unobserved fixed effect $\widehat{\alpha}_i = E_T\left[Y_{i,t} - X'_{i,t}\hat{\beta}_p\right]$, $\hat{\beta}_p$ is a consistent estimator of $\beta_p$. The second step is to use $\hat{Y}_{i,t} = Y_{i,t} - \hat{\alpha}_i$ to perform standard quantile regression on the control variable $X_{i,t}$ and obtain the estimator of the p-th quantile as shown in Eq. (11).

Therefore, the panel quantile regression equation is set to:

$$mpc_{i,t}\left(\tau \mid x_{i,t}, \alpha_i\right) = \beta_{1\tau} mp_t + \beta_{2\tau} house_{i,t} + \beta_{3\tau} lever_{i,t} + \beta_{4\tau} controlI + \alpha_i. \tag{13}$$

## 4. Data and empirical results

### 4.1. The data

In this paper, 30 provinces and municipalities of China mainland from 2004 to 2019 (excluding Tibet Autonomous Region) were selected as samples. The main information is as follows:

(1) The marginal propensity to consume ($mpc_{i,t}$). This article calculates the marginal propensity to consume using information of disposable income and general consumption expenditure of 30 provinces published by the National Bureau of Statistics from 2004 to 2019. In 2013, the income and expenditure of urban and rural dwellings in China was changed to national unified accounting, so there are some differences between the households surveyed by sampling survey in different provinces. To avoid the problem of inconsistent standards and excessive volatility cauterized by the replacement of household survey information, this paper assumes that the expenditure income elasticity of dwellings is constant ε in the short term, and the marginal consumption propensity value can be multiplied with the income consumption ratio, thus reducing the influence of statistical range difference.

(2) Macroprudential policy ($mp_{t-1}$). Macroprudential policy is the policy of the Central Bank to protect against financial systemic risks in the future. The data source commonly utilized internationally is the iMaPP database, established by Alam et al. (2019). The database(https://www.elibrary-areaer.imf.org/Macroprudential/Pages/iMaPPDatabase.aspx) measures macroprudential policies in 134 countries between 1990 and 2019. Because macroprudential policy belongs to preventive policy, this paper takes the number of macroprudential policies as the representative variable to avoid the discussion of reverse causality.

(3) The price of a house (*lnhouse*) is taken by taking the logarithm of the average hose price per square meter.

(4) Residents' leverage ratio (*lever*). There is no uniform standard for the numerical calculation of the leverage ratio. This paper applies the method of Zhou et al. (2019) to calculate the ratio of stock debt to individual disposable income.

(5) Control variables. To better describe the level of economic and financial development, we choose per capita gross domestic product (*lnGDP*), lending rate (R), and monetary growth rate (*m2*) as macroeconomic control variables. Among them, the loan interest rate is the one-year loan weighted average benchmark interest rate minus the year-to-year CPI. The rate of change in the broad money cater is chosen for monetary growth. All above data are from the wind database and the National Statistics Bureau.

Table 1. Variable descriptions

| Variable | Description | Mean | Std. Dev. | Minimum | Maximum |
|---|---|---|---|---|---|
| *mpc* | Marginal propensity to consume | 0.666 | 0.045 | 0.570 | 0.810 |
| *mp* | Macroprudential policy | 4.375 | 3.425 | 0.000 | 13.000 |
| *lnhouse* | Logarithmic house prices | 8.151 | 0.578 | 7.020 | 10.208 |
| *lever* | leverage | 0.422 | 0.279 | 0.005 | 1.324 |
| *lnGDP* | Logarithmic GDP per capita | 10.147 | 0.617 | 8.322 | 11.661 |
| *R* | The loan interest rate | 2.777 | 1.464 | –2.931 | 7.660 |
| *m2* | Monetary growth | 0.118 | 0.053 | 0.057 | 0.293 |

Table 1 is a descriptive statistical feature of the main variables. The data illustrate that the mean value of the consumer's marginal propensity to consume (*mpc*) is 0.666 and the standard deviation is 0.045 within the sample interval, which proves that the data fluctuate little. The average is slightly below what Chinese scholars estimated in 2012, based on 1991–2009. The reason is that the value of the *mpc* is related to income and is expended at the same time. The average disposable income of dwellings in China has grown 11.43% in the last two decades. According to Keynes (2018), consumption increases with an increase of income, but the increase in expenditure is generally less than the increase in income. The *mpc* in this article is lower than before 2009. This hints that the increase in expenditure of China is lower than the increase in income.

The average macroprudential policy is 4.375, but the standard deviation is 3.425, the maximum is 13, and the minimum is 0. This hints that the financial cycle has greater volatility, the central bank's policy implementation should be based on the current financial market risk camera choice, during the period of financial systemic risk, the use of macroprudential policy tools are more frequent, and in other periods macroprudential policy tools are not frequently utilized.

#### 4.1.1. Stationarity test of data

Tables 2 and 3 hint the test results of variance expansion factor (VIF) and panel unit root. Variance expansion factor (VIF) is 5.11, which is much lower than the critical value 10. The panel data utilized in this paper can be considered as non-existence of multicollinearity problems. When using panel data for measurement analysis, this paper first checks the sta-

Table 2. Variance inflation factor test

| Variable | VIF | 1/VIF |
|---|---|---|
| *lnhouse* | 5.10 | 0.196071 |
| *lnGDP* | 3.69 | 0.271350 |
| *lever* | 3.09 | 0.323941 |
| *m*2 | 1.76 | 0.568930 |
| *R* | 1.70 | 0.587376 |
| *mp* | 1.19 | 0.837464 |
| Mean VIF | 2.75 | |

Table 3. Panel HT unit root test

| Variable | Test value | *P* values | Conclusion |
|---|---|---|---|
| *mpc* | 0.7276 | 0.0000 | smooth |
| *mp* | 0.0000 | 0.0000 | smooth |
| *lnhouse* | 0.6403 | 0.0000 | smooth |
| *lever* | 0.5168 | 0.0000 | smooth |
| *lnGDP* | 0.2999 | 0.0000 | smooth |
| *R* | 0.2664 | 0.0000 | smooth |
| *m*2 | 0.0000 | 0.0000 | smooth |

tionarity of data; the most common way to check the stationarity of information is the unit root test. The data applied in this paper are short panel data. Table 3 reports the result of the HT test. The *P* value is 0. Through the stationarity test, it is found that the data are stable and no co-integration test is needed.

### 4.2. Empirical results

Table 4 reports the regression result of Eq. (2) of the direct impact of macroprudential policies on consumption. Table 4 shows a series of regression results using the OLS, FE, RE, and System GMM regression. The regression results prove the $\beta_{11}$ coefficient test (see Figure 3). Thus, Hypothesis 1 is validated.

The coefficient in front of macroprudential policy is negative, that is, macroprudential policy can resist financial systemic risk, maintain financial environment, change consumer investment decision, and increase total spending. From the result of regression, the coefficient between macroprudential policy and *mpc* is relatively small, which is because the consumer's *mpc* has not changed much and is relatively stable in recent 20 years, so the coefficient is minor. This also proves that macroprudential policies do play their due role, stabilizing expectations and stabilizing consumption.

The change of per capita GDP has an overwhelming effect on the decline of the *mpc*, income, and per capita GDP often change in the same direction, the *mpc* is with the increase of income and decline. The influence coefficient of interest rate change and monetary growth on the *mpc* is not obvious, that is, the implementation of monetary policy has no notable promotion or hindrance on the change of the *mpc*.

Table 5, Table 6, reports the regression results of Eq. (2) and (3). Table 5 evaluates the impact of macroprudential policies on housing prices; Table 6 examines the impact of macroprudential policies on household leverage. The regression method is the same as that in Table 4.

From the regression results, we can see that macroprudential policy can overwhelmingly restrain the fluctuation of house prices and increase residential leverage, $\beta_{21}$ and $\beta_{31}$ test passed. Tables 5 and 7 suggest that the impact coefficient of macroprudential policies on the rate of change of house prices is less than that of the dwellings' leverage ratio. Macro prudential policies are transmitted through financial markets rather than in the real estate market,

Table 4. The direct impact of macroprudential policies on consumption

| Variable | OLS $mpc_{i,t}$ | FE $mpc_{i,t}$ | RE $mpc_{i,t}$ | System GMM $mpc_{i,t}$ |
|---|---|---|---|---|
| $mp_t$ | –0.00117** | –0.00103*** | –0.00104*** | –0.00103*** |
| | (–2.28) | (–3.44) | (–3.45) | (–3.61) |
| $lnGDP_{i,t}$ | –0.03227*** | –0.03245*** | –0.03245*** | –0.03769*** |
| | (–9.96) | (–11.77) | (–11.98) | (–6.40) |
| $R_t$ | 0.00055 | 0.00179* | 0.00175* | 0.00159* |
| | (0.33) | (1.83) | (1.80) | (1.79) |
| $m2_t$ | –0.01263 | –0.03070 | –0.03017 | –0.03848 |
| | (–0.28) | (–1.11) | (–1.10) | (–1.11) |
| Constant | 0.99844*** | 0.99837*** | 0.99846*** | 1.05167*** |
| | (29.34) | (34.50) | (34.33) | (17.65) |
| *F*-statistic | 30.29 | 47.01 | | |
| *R*-squared | 0.2032 | 0.2966 | 0.2966 | |
| Wald test (*chi*2) | | | 193.17 | 7501.42 |
| Hansen *J*-test | | | | 0.153 |
| AR(1) | | | | 0.007 |
| AR(2) | | | | 0.757 |

*Notes*: *t*-statistics in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 5. The impact of macroprudential policies on the real estate market

| Variable | OLS $lnhouse_{i,t}$ | FE $lnhouse_{i,t}$ | RE $lnhouse_{i,t}$ | System GMM $lnhouse_{i,t}$ |
|---|---|---|---|---|
| $mp_t$ | –0.00663*** | –0.00719*** | –0.00663*** | –0.00741*** |
| | (–6.83) | (–7.66) | (–6.83) | (–7.17) |
| $lnhouse_{i,t-1}$ | 0.98800*** | 0.83047*** | 0.98800*** | 1.01608*** |
| | (82.00) | (31.66) | (82.00) | (24.38) |
| $lnGDP_{i,t}$ | 0.00971 | 0.09358*** | 0.00971 | –0.02996 |
| | (0.82) | (4.22) | (0.82) | (–0.75) |
| $R_t$ | –0.00376 | –0.00608** | –0.00376 | –0.00270 |
| | (–1.20) | (–1.97) | (–1.20) | (–0.64) |
| $m2_t$ | 0.51226*** | 0.30397*** | 0.51226*** | 0.44839*** |
| | (6.21) | (3.47) | (6.21) | (5.18) |
| Constant | 0.05646 | 0.51326*** | 0.05646 | 0.24098 |
| | (0.82) | (4.46) | (0.82) | (1.43) |
| *F*-statistic | 5166.21 | 1622.08 | | |
| *R*-squared | 0.9831 | 0.9513 | 0.9485 | |
| Wald test (*chi*2) | | | 25831.03 | 9.72e+06 |
| Hansen *J*-test | | | | 0.158 |
| AR(1) | | | | 0.000 |
| AR(2) | | | | 0.626 |

*Notes*: *t*-statistics in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

so they have a greater impact on credit markets. Policy authorities can limit the increase in leverage ratio directly from the supply side, which can be effectively controlled. The fluctuation of the house price is influenced by the mediation of afford and demand. Although, in theory, housing supply is positively and linearly related to housing price, it can also be assumed that housing supply and housing price are nonlinearly connected (Yeap & Lean, 2020).

In Table 5, the FE regression suggests that the coefficient of change of GDP and house price is overwhelmingly positive, reflecting that economic development has increased the level of house price. The interest rate on loans and the coefficient of house prices are evidently negative, so the move up in house prices is indeed related to interest rates, which drive dwellings to save less and invest in high y ielding assets. The coefficient of money growth and house price fluctuation is clearly positive, and the large coefficient suggests that loose quantitative monetary policy is one of the main driving factors of house price roar in China, which verifies the fact that housing assets have higher return on assets.

The coefficient of GDP and leverage ratio in Table 6 are remarkable positive, reflecting the mutual pull of economic growth and credit growth. The coefficient between interest rate and leverage ratio is evidently negative, and the roar in lending rates will clearly diminish the consumer demand for borrowing and diminish consumer leverage from the demand side. The coefficient of monetary growth and leverage ratio is negative, indicating that expansionary monetary policy has increased household income. With consumers temporarily failing to increase lending, the household leverage ratio will drop markedly.

Table 6. The impact of macroprudential policies on credit markets

| Variable | OLS $lever_{i,t}$ | FE $lever_{i,t}$ | RE $lever_{i,t}$ | System GMM $lever_{i,t}$ |
|---|---|---|---|---|
| $mp_t$ | –0.01022*** | –0.01097*** | –0.01093*** | –0.01156*** |
| | (–4.16) | (–6.41) | (–6.38) | (–8.90) |
| $lnGDP_{i,t}$ | 0.293*** | 0.290*** | 0.291*** | 0.290*** |
| | (18.92) | (18.51) | (19.10) | (9.26) |
| $R_t$ | –0.001 | –0.007 | –0.007 | –0.012** |
| | (–0.09) | (–1.34) | (–1.27) | (–2.43) |
| $m2_t$ | –0.925*** | –0.838*** | –0.842*** | –0.790*** |
| | (–4.32) | (–5.35) | (–5.40) | (–4.17) |
| Constant | –2.393*** | –2.356*** | –2.361*** | –2.349*** |
| | (–14.72) | (–14.31) | (–14.60) | (–7.33) |
| *F*-statistic | 132.71 | 164.65 | | |
| *R*-squared | 0.5278 | 0.5962 | 0.5962 | |
| Wald test (*chi*2) | | | 681.53 | 334.15 |
| Hansen *J*-test | | | | 0.102 |
| AR(1) | | | | 0.064 |
| AR(2) | | | | 0.467 |

*Notes*: *t*-statistics in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Tables 7 and 8 report the regression results of Eqs (4) and (5). According to the mediating effect test principle, $\beta_{41}$ and $\beta_{51}$ are evident, that is, macroprudential policy does affect consumers' consumption level, while $\beta_{42}$ is significant. Macroprudential policies can influence consumption by influencing the real estate market. $\beta_{52}$ is not evident, then we think that macroprudential policy may not affect consumption through a single credit market, this article carried out the Sobel test found that the test cannot pass; hence, macroprudential policy can not affect consumer consumption through credit market, Hypothesis 2 is established and Hypothesis 3 is not valid.

In Table 7, the macroprudential policy is about 10% stronger than before, taking into account housing prices. The real estate market interferes with the effect of macroprudential policies to stabilize consumption, indicating that changes in house prices have obvious wealth effects and the spending fluctuation of spending increases slightly. The stability of housing prices has raised expectations for future economic growth. Consumers will reduce some of their investment in housing assets and release some liquidity into spending, so the *mpc* has risen. This also proves that macroprudential policies can indeed increase citizens' confidence in the stability of the financial system as a whole.

Table 7. The impact of macroprudential policies on the real estate market

| Variable | OLS $mpc_{i,t}$ | FE $mpc_{i,t}$ | RE $mpc_{i,t}$ | System GMM $mpc_{i,t}$ |
|---|---|---|---|---|
| $mp_t$ | –0.00125** | –0.00117*** | –0.00117*** | –0.00110*** |
| | (–2.43) | (–3.93) | (–3.92) | (–3.42) |
| $lnhouse_{i,t}$ | –0.014** | –0.026*** | –0.025*** | –0.034* |
| | (–2.39) | (–3.74) | (–3.71) | (–1.86) |
| $lnGDP_{i,t}$ | –0.021*** | –0.015*** | –0.015*** | –0.00795 |
| | (–3.68) | (–2.68) | (–2.92) | (–0.43) |
| $R_t$ | 0.000 | 0.002* | 0.002* | 0.002** |
| | (0.28) | (1.71) | (1.68) | (2.08) |
| $m2_t$ | –0.012 | –0.041 | –0.039 | –0.021 |
| | (–0.27) | (–1.49) | (–1.43) | (–0.53) |
| Constant | 1.000*** | 1.033*** | 1.030*** | 1.057*** |
| | (29.54) | (34.41) | (34.39) | (12.61) |
| *F*-statistic | 25.62 | 41.49 | | |
| *R*-squared | 0.2127 | 0.3180 | 0.3179 | |
| Wald test (*chi*2) | | | 212.49 | 6245.76 |
| Hansen *J*-test | | | | 0.232 |
| AR(1) | | | | 0.002 |
| AR(2) | | | | 0.898 |

*Notes*: *t*-statistics in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 8. The impact of macroprudential policies on consumption through credit markets

| Variable | OLS $mpc_{i,t}$ | FE $mpc_{i,t}$ | RE $mpc_{i,t}$ | System GMM $mpc_{i,t}$ |
|---|---|---|---|---|
| $mp_t$ | –0.00099* | –0.00089*** | –0.00090*** | –0.00094*** |
| | (–1.90) | (–2.85) | (–2.86) | (–2.85) |
| $lever_{i,t}$ | 0.017* | 0.013 | 0.013 | –0.005 |
| | (1.80) | (1.54) | (1.60) | (–0.23) |
| $lnGDP_{i,t}$ | –0.037*** | –0.036*** | –0.036*** | –0.032*** |
| | (–8.72) | (–9.88) | (–10.08) | (–3.35) |
| $R_t$ | 0.001 | 0.002* | 0.002* | 0.003*** |
| | (0.34) | (1.93) | (1.89) | (3.27) |
| $m2_t$ | 0.003 | –0.020 | –0.020 | –0.048 |
| | (0.07) | (–0.71) | (–0.68) | (–1.07) |
| Constant | 1.040*** | 1.028*** | 1.030*** | 0.991*** |
| | (25.38) | (29.46) | (29.54) | (10.72) |
| *F*-statistic | 25.00 | 38.19 | | |
| *R*-squared | 0.2087 | 0.3003 | 0.3003 | |
| Wald test (*chi*2) | | | 196.41 | 7102.63 |
| Hansen *J*-test | | | | 0.161 |
| AR(1) | | | | 0.001 |
| AR(2) | | | | 0.835 |

*Notes*: *t*-statistics in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The increase in house price and the coefficient of marginal propensity to consume are negative, indicating that while the price climbs, the marginal propensity to consume decreases, which indicates that the lift of house price in China has an obvious wealth effect. The coefficient of GDP and marginal propensity to consume is momentously negative, which is the same as what is illustrated in Tables 4 and 5. The coefficient of interest rate and money growth rate and marginal propensity to consume is still not momentous, indicating that interest rate and quantitative monetary policy are effective variables that directly affect the real estate market and credit market, and spending is not directly sensitive to it.

Above, we proved that macroprudential policies have a direct impact on household consumption and will indirectly affect consumption through the real estate market.

According to Hypothesis 4, macroprudential policies can affect the level of consumer consumption through the interaction of the real estate channel and the credit channel. The regression equation is set as follows:

$$mpc_{i,t} = c + \beta_{61} mp_t + \beta_{62} house_{i,t} + \beta_{63} lever_{i,t} + \beta_{64} controI + u_6. \quad (14)$$

Table 9 reports the regression results. The second, third, fourth, and fifth columns illustrate the results of the OLS, FE, RE, and System GMM regression, respectively. Unlike Table 6, the coefficient between macroprudential policy and the *mpc* is momentously negative and smaller. This expresses that through the combined role of housing prices and leverage, mac-

Table 9. The impact of macroprudential policies on consumption through the intersection of the housing market and the credit market

| Variable | OLS $mpc_{i,t}$ | FE $mpc_{i,t}$ | RE $mpc_{i,t}$ | System GMM $mpc_{i,t}$ |
|---|---|---|---|---|
| $mp_t$ | –0.001* | –0.001*** | –0.001*** | –0.001*** |
| | (–1.70) | (–2.91) | (–2.89) | (–2.68) |
| $lnhouse_{i,t}$ | –0.030*** | –0.037*** | –0.036*** | –0.032 |
| | (–4.17) | (–4.91) | (–4.94) | (–1.13) |
| $lever_{i,t}$ | 0.044*** | 0.031*** | 0.032*** | 0.018 |
| | (3.86) | (3.50) | (3.61) | (0.66) |
| $lnGDP_{i,t}$ | –0.022*** | –0.016*** | –0.017*** | –0.015 |
| | (–3.86) | (–2.97) | (–3.22) | (–0.72) |
| $R_t$ | 0.000 | 0.002* | 0.002* | 0.002** |
| | (0.23) | (1.91) | (1.87) | (2.09) |
| $m2_t$ | 0.030 | –0.019 | –0.016 | –0.005 |
| | (0.64) | (–0.67) | (–0.58) | (–0.12) |
| Constant | 1.108*** | 1.122*** | 1.119*** | 1.067*** |
| | (25.50) | (28.75) | (29.00) | (9.85) |
| *F*-statistic | 24.64 | 37.50 | | |
| *R*-squared | 0.2368 | 0.3363 | 0.3362 | |
| Wald test (*chi*2) | | | 230.6 | 7614.03 |
| Hansen *J*-test | | | | 0.145 |
| AR(1) | | | | 0.002 |
| AR(2) | | | | 0.881 |

*Notes*: *t*-statistics in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

roprudential policies strengthen the policy function of stabilizing household consumption level. The influential coefficient of house price fluctuation and leverage ratio and *mpc* is critical and opposite. In terms of value, the real estate market affects consumption a little more than the credit market, which is evidence that while household leverage will dampen spending growth, rising house prices at the same rate will have a wealth effect that offsets the negative effect of rising leverage ratio and promotes consumption.

According to Hypothesis 5, macroprudential policies have different effects on the level of consumer consumption in different regions and income levels. The regression equation is set as follows for differences in different regions:

$$mpc_{i,t} = c + \beta_{71} mp_t + \beta_{72} house_{i,t} + \beta_{73} lever_{i,t} + \beta_{74} mp_t * dump + \beta_{75} controlI + u_7. \quad (15)$$

Table 10 reports the regression results of Eq. (15). The product term of macroprudential policy (*mp*) and the regional virtual variable are added based on Eq. (1). To avoid the multicollinearity problem, the regression equation does not add the product term of the western virtual variable and the macroprudential policy, and the result of multiplying the western virtual term and the macroprudential policy (*mp*) is similar to the eastern one. Specifically,

the coefficient between the product term and the *mpc* of the central zone and the macroprudential policy is virtually under the OLS, FE, and RE regression, but in the opposite direction. According to the FE return, consumer spending will decline after macroprudential policies tighten in the central part, but its force will be less than macroprudential policies to promote national consumption.

The influence of macroprudential policy is not significant in the eastern and western regions, because the main function channel of macroprudential policy is to influence economic behavior by influencing the balance sheet of financial institutions. In the eastern region, financial development is advanced; according to the micro questionnaire survey table, the first source of borrowing is friends. Even under the macroprudential policy control, financial institutions dwindle the credit to consumers and tighten the real estate market loan value ratio, private capital still can provide liquidity funds to help consumers afford housing assets, especially in the region of the private financial developed eastern region, and macroprudential policy has less impact on disbursement. Overall, the level of economic and financial development in different regions is diverse and the degree of policy affected is also different.

Table 10. The effects of macroprudential policies in different regions

| Variable | OLS $mpc_{i,t}$ | FE $mpc_{i,t}$ | RE $mpc_{i,t}$ | System GMM $mpc_{i,t}$ |
|---|---|---|---|---|
| $mp_t$ | 0.00024 | –0.00134*** | –0.00122*** | 0.00001 |
| | (0.43) | (–3.58) | (–3.26) | (0.02) |
| $lnhouse_{i,t}$ | –0.03203*** | –0.03737*** | –0.03571*** | –0.04981* |
| | (–4.52) | (–4.92) | (–4.89) | (–1.88) |
| $lever_{i,t}$ | 0.04053*** | 0.03073*** | 0.03155*** | 0.02727 |
| | (3.62) | (3.44) | (3.56) | (1.03) |
| The eastern region $*mp_t$ | –0.00065** | 0.00014 | 0.00011 | –0.00023 |
| | (–2.38) | (0.73) | (0.57) | (–0.67) |
| The central region $*mp_t$ | –0.00251*** | 0.00113* | 0.00084 | –0.00199 |
| | (–3.72) | (1.96) | (1.48) | (–1.40) |
| $lnGDP_{i,t}$ | –0.01957*** | –0.01587*** | –0.01698*** | –0.00349 |
| | (–3.51) | (–2.93) | (–3.23) | (–0.18) |
| $R_t$ | 0.00022 | 0.00187* | 0.00182* | 0.00174* |
| | (0.14) | (1.96) | (1.89) | (1.76) |
| $m2_t$ | 0.02562 | –0.01961 | –0.01634 | 0.00070 |
| | (0.57) | (–0.71) | (–0.59) | (0.02) |
| Constant | 1.10880*** | 1.11965*** | 1.11666*** | 1.09156*** |
| | (25.81) | (28.74) | (28.92) | (10.07) |
| *F*-statistic | 21.45 | 28.81 | | |
| *R*-squared | 0.2671 | 0.3427 | 0.3422 | |
| Wald test (*chi*2) | | | 232.13 | 5887.86 |
| Hansen *J*-test | | | | 0.124 |
| AR(1) | | | | 0.002 |
| AR(2) | | | | 0.267 |

*Notes*: *t*-statistics in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 11. Effects of different income macroprudential policies

| Variable | 10th $mpc_{i,t}$ | 25th $mpc_{i,t}$ | 50th $mpc_{i,t}$ | 75th $mpc_{i,t}$ | 90th $mpc_{i,t}$ |
|---|---|---|---|---|---|
| $mp_t$ | –0.00018 | –0.00046 | –0.00086*** | –0.00131*** | –0.00163*** |
| | (–0.35) | (–1.21) | (–2.90) | (–3.10) | (–2.78) |
| $lnhouse_{i,t}$ | –0.027** | –0.031*** | –0.037*** | –0.043*** | –0.048*** |
| | (–2.12) | (–3.29) | (–5.02) | (–4.15) | (–3.29) |
| $lever_{i,t}$ | 0.036** | 0.034*** | 0.032*** | 0.029** | 0.027 |
| | (2.28) | (2.93) | (3.51) | (2.25) | (1.50) |
| $lnGDP_{i,t}$ | –0.023** | –0.020*** | –0.016*** | –0.012 | –0.009 |
| | (–2.20) | (–2.63) | (–2.78) | (–1.47) | (–0.80) |
| $R_t$ | 0.001 | 0.001 | 0.002* | 0.002 | 0.003 |
| | (0.65) | (1.10) | (1.83) | (1.60) | (1.31) |
| $m2_t$ | 0.016 | 0.003 | –0.017 | –0.039 | –0.055 |
| | (0.35) | (0.07) | (–0.62) | (–1.00) | (–1.01) |

*Notes*: *t*-statistics in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 11 reports the results of Eq. (13) of the panel quantile regressions for different incomes. The basic theory of panel quantile regression is to treat the dependent variable as a function distribution and to estimate the image of the dependent variable at the conditional quantile point based on the sum of the minimum weighted residual absolute values.

Panel quantile regression was applied to inspect the impact trajectory of macroprudential policy affecting at different *mpc* level in the sample interval. The higher income level, the lower the *mpc* is. The impact of macroprudential policies on the *mpc* is markedly different. From the regression results, it is found that the higher income groups are less affected by the policy, and the lower income groups are more affected by the policy. In particular, on the 10-point and 25-point points, consumer wealth reserves are relatively high, the marginal propensity to consume is stable, macroprudential policy is not sensitive, and the coefficient is not obvious. The higher the marginal propensity to consume, the more effective the macroprudential policy will be. Considering that low-income groups are less resistant to risk and therefore more susceptible to financial risks, macroprudential policies have a stronger impact on low-income groups.

In the high-income group, the household leverage ratio is more important, and the household leverage ratio and the *mpc* coefficient are not evident. This suggests that high-income groups have more good collateral to use for credit and that a higher leverage ratio can effectively curb disbursement growth, so the leverage ratio has a greater impact on the high-income population; low-income groups, subject to liquidity constraints and difficult access to credit, are less sensitive to the leverage ratio.

The combined effects of the leverage ratio and housing prices suggest that the leverage ratio has a greater impact on high-income groups, while housing prices have a smaller force impact on low-income groups. This implies that although the increase in house prices caused a wealth effect, but the impact on high-income groups is limited, the wealth effect of

housing assets in the middle and low-income groups is more prominent. The leverage ratio can inhibit high-income groups' consumption, but, in general, the wealth effect of real estate will offset its negative impact; it is difficult to distinguish the impact of macroprudential on high-income groups' disbursement.

## Conclusions

From the perspective of disbursement, this paper evaluates the mechanism of macroprudential policy, discusses the relationship between the real estate market and the credit market in the macroprudential policy transmission mechanism, and emphasizes the intermediary function of the real estate market from two dimensions: wealth effect and collateral effect. From the perspective of disbursement, this paper evaluates the mechanism of macroprudential policy, discusses the relationship between real estate market and credit market in macroprudential policy transmission mechanism, and emphasizes the intermediary function of real estate market from three dimensions: wealth effect, collateral effect and psychological expectations. Based on this, this article studies the tangible impact of macroprudential policy on citizens' consumption in China, along with the idea of "macroprudential policy implementation → real estate market/credit market change → residents' consumption adjustment".

It is found that macroprudential policies have direct and indirect effects on consumption, that is, macroprudential policies effectively restrain systemic risks in financial markets, improve consumer expectations, and increase consumption. Macroprudential policies have also produced wealth effects and raised the consumption level by stabilizing fluctuations in the real estate and credit markets. Finally, this article also evaluates the influence of macroprudential policy on different regions and different income groups, among which the Eastern and Western regions and high-income groups are not sensitive to macroprudential policy changes at the same time, and the mediating effect of the real estate market decreases gradually with increasing income; low-income groups are not sensitive to the change of credit market, and there is indeed a financial exclusion phenomenon. Furthermore, the test results based on mediating effect reveal that there is "macroprudential policy-real estate market-consumption" in the transmission process of China's macroprudential policy, and the credit market needs to work with the real estate market to effect on consumption.

The excessive rise of the housing price accumulates uncertainty in the financial system and increases the leverage ratio, which causes great damage to the wealth of residents in the economic downturn and makes the economy enter a state of dual decline of effective demand and asset price. Based on the above research results, this paper argues that pre-implemented macroprudential policies not only directly affect consumption, but also stabilize consumption by effectively restraining housing price fluctuations. The direct effect of the credit market on consumption is not significant, but when it is associated with the real estate market, the impact of the credit market on consumption has a significant change, indicating that the real estate market is not only an important factor that affects the consumption of residents, but also an important link of the credit market that affects consumption.

Based on the analysis of regional differences and income differences, this article finds that the impact of the real estate market on residents' consumption decreases with the increase of income. Objectively, this is consistent with the relatively low marginal consumption ten-

dency of high-income groups. Currently, the COVID-19 pandemic has greatly influenced economic development, and countries are actively implementing loose monetary policies to prevent economic recession. Although loose monetary policy can hardly change the trend of economic decline, it has promoted the rise of household wealth. Due to the heterogeneity of macroprudential policies in the real estate market, macroprudential policies are ineffective for high-income groups. Therefore, in the process of using macroprudential policy tools, more attention should be paid to the effects of macroprudential policies on heterogeneous consumer groups to further improve macroprudential policy tools.

In conclusion, this paper verifies the impact of macroprudential policies on consumption, which indicates that macroprudential policies are not only a tool to control financial systemic risks, but also a tool to influence consumer speculation, maintain the stability of effective demand throughout the economic cycle, and provide a strong guarantee for residents' property security.

As any other research, ours suffers from some limitations, which can be addressed in future research. First, the core explanatory variables come from iMaPP of IMF. The data construction method is text analysis. Its advantage is that it can quantify the changes in macroprudential policies in various countries with a unified standard, but it cannot directly measure the intensity difference of the same number of changes. We look forward to employing higher quality data to measure the change of macro-prudential policy intensity to verify our results. Second, we mainly proved this. In China, the impact of macroprudential policy on consumption has an intermediary effect and can be transmitted through the real estate market, because more than 70% of the wealth of Chinese residents exists in the form of housing. We did not test whether there is a similar phenomenon in other countries. For example, the proportion of financial assets of US residents is higher than that of housing assets, so our conclusion may be far from its scope of application. Thus, in future research, a similar process from different countries could be used to provide a more international perspective on the subject. Third, using quantile regression, we try to clarify consumers' sensitivity to macroprudential policies under different income levels. However, we have not really separated urban residents from rural residents. Especially in China, there is a large number of rural floating population who leave the countryside to work in cities. Their housing assets are unprofitable in remote rural areas and cannot produce any direct benefit; this has caused some trouble in our research. Therefore, we need more micro household survey data to study our conclusions. In the following research, we will try to pay more attention to the influencing factors of the implementation of macroprudential policy on micro-individual behavior.

## Acknowledgements

This paper is supported by Project of cultural masters and "the four kinds of a batch" talents, the Special Funds of Taishan Scholars Project of Shandong Province.

## Author contributions

The paper is the joint efforts of the authors, their contributions vary on conceptualisation, methodology, analysis, investigation, resources, writing – review and editing. All authors have read and agreed to the published version of the manuscript.

## Data availability statement

The data used to support the findings of this study are available from the corresponding author upon request.

## Disclosure statement

The authors declare that they have no competing financial, professional and personal interests from other parties.

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