

博士論文

Doctorate Thesis

Essays on Housing and Macroeconomics

(住宅とマクロ経済学に関する研究)

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Abstract

This thesis empirically investigates the relationship between housing and macroeconomics and explores it in depth in the following three chapters.

In the first chapter, the positive impact of the booming housing market on the macroeconomy is emphasized from a macro perspective by comprehensively analyzing the role of housing prices in the unconventional monetary transmission mechanism in Japan. The quantitative effects of unconventional monetary policy shocks are examined through structural vector autoregression with the extension using time-varying parameters. The empirical results show that expansionary monetary policy shocks lead to increased household consumption, residential investment, inflation, housing loans, and housing prices. Simultaneously, a positive housing price shock also increases household consumption, residential investment, inflation, and housing loans. Combining these two results, an accelerator function of housing prices in policy transmission is confirmed. On the other hand, the magnitude of responses to shocks varies across different monetary policy regimes. However, a significant and persistent response of housing prices to the policy shock provides an extra transmission channel even if the real effects of monetary policy on output and inflation are diminished, revealing the contribution of housing prices is non-trivial but pronounced.

Next, the impact of unconventional monetary policies on household consumption in Japan should be heterogeneous since different households have different balance sheets. The second chapter documents such heterogeneous effects of unconventional monetary policy shocks on households' expendit-

ures in different net saving positions. Using Japanese household survey data on household balance sheet positions, income, and expenditures, I enhance the cash-flow channel's role in explaining the unconventional monetary policy. Households in a lower net saving position (with a high level of debt) exhibit significantly positive expenditure responses to expansionary monetary policy shocks. In contrast, households in the upper net saving position (with a low level of debt) respond little or in an opposite direction. I also find that households in lower net saving positions primarily drive the aggregate effects of unconventional monetary policy on household consumption.

Finally, I study the impact of housing prices on the macroeconomy by looking at housing prices' relationship with homeowners' self-employment decisions. The third chapter provides evidence of a negative relationship between housing wealth and self-employment transitions using the 2010-2018 China Family Panel Studies data. To deal with potential endogeneity issues, I employ individual fixed effects and two instrumental variables. My robust results indicate that a 10% increase in housing wealth will decrease the probability of homeowners becoming self-employed by 0.53 to 0.58 percentage points, which is interpreted as the crowd-out channel: homeowners will choose to invest in high-return sectors such as housing markets, lowering their incentive to start their own business. Additionally, based on the setting of Chinese mortgage markets in which partial homeowners (homeowners who have an outstanding mortgage) cannot obtain a new mortgage from banks, I explore the differences between partial and full homeowners (homeowners without outstanding mortgages) regarding the effect of housing wealth on self-employment transitions. The estimates show that the negative effect of rising housing wealth becomes stronger when individuals are partial homeowners, suggesting that mortgage debt diminishes the likelihood of self-employment by amplifying risk aversion as the portfolio choice channel. Therefore, this chapter reveals a negative impact of housing prices on economic development, especially in developing economies.

Thus, this thesis analyzes the positive and adverse impacts of housing (markets) on the macroeconomy from the above three chapters.

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Chapter 1

Do housing prices play a role in unconventional monetary policy transmission in Japan?

1.1 Introduction

Motivated by the co-movement of housing prices and output among major economies, whether housing prices play a major role in monetary policy transmission has been a live topic that attracts considerable attention among policymakers and academic researchers in recent years, which is further enhanced by the subprime crisis in the United States and a series of recent economic crises worldwide (Piazzesi and Schneider, [2016](#)). This has rekindled the long-running debate about whether and how monetary policy should respond to housing price deviations.

A growing literature has studied the impact of monetary policy shocks on the macroeconomy in a New Keynesian framework via collateral effects of housing prices, following Aoki, Proudman and Vlieghe ([2004](#)) and Iacoviello ([2005](#)). When tightening monetary policy shocks hit the economy, with sticky prices, monetary policy changes influence the real short-term interest rate, which discourages households' current consumption and, therefore, out-

put. Such effects can be further reinforced via dropped housing prices, leading to a shrink in collateral value that tightens the borrowing constraint and depresses consumption and housing investment, which causes a more profound decline in output.

Although the above accelerator function of housing prices in transmitting the monetary policy seems to be plausible, the core of such a mechanism is the assumption of a positive short-term rate. Suppose the short-term rate hits the zero lower bound (ZLB); then, based on the typical New Keynesian framework, housing prices will no longer effectively transmit monetary policy through the collateral channel. This is one reason there is minimal literature focusing on the role of housing prices in transmitting unconventional monetary policy when the short-term interest rate is at its ZLB. In Japan, one of the pioneer countries for adopting unconventional monetary policies, the short-term interest rate has been at ZLB since 2001. However, there is a huge amount of literature examining the effects of unconventional monetary policy on the GDP and inflation (Bowman et al., 2015; Kimura and Nakajima, 2016; Michaelis and Watzka, 2017; Miyao and Okimoto, 2020) while few have investigated the potential role of housing prices.

The blooming housing finance markets following the credit market liberalization during the 1980s accelerated the spillover effects of housing markets on the broader economic activities (Bjørnland and Jacobsen, 2010). Housing constructions and investments have accounted for a large portion of advanced economies like those in the US and Europe. Moreover, mortgages and other housing-related lendings (based on housing value) are a big part of banks' assets in many countries, so the deviation in housing prices affects the banking system and even the entire macroeconomy (Musso, Neri and Stracca, 2011). In addition, the financial market's liberalization made housing prices more reactive to monetary policy innovations (Iacoviello, 2005).

Japan witnessed a booming housing market during the 1980s, peaking around

1990, and followed by a massive drop in real estate values. Since then, housing prices have shown a downward trend until recent years. On the other hand, households' mortgage indebtedness surged markedly during the boom period of the housing market and remained stable after the burst of the real estate bubble (Aron et al., 2012). Moreover, the housing market's role in the Japanese macroeconomy remained prominent even after the boom and bust during the last '90s. Figure 1.1 shows that the recession was intensified in residential investment. However, private consumption dropped to a much smaller scope during the financial crisis period from 2007 to 2009, consistent with the US case (Musso, Neri and Stracca, 2011). Though the exact mechanism of how housing prices are connected to the recession remains controversial, it is clear that the housing market considerably drove the recession.

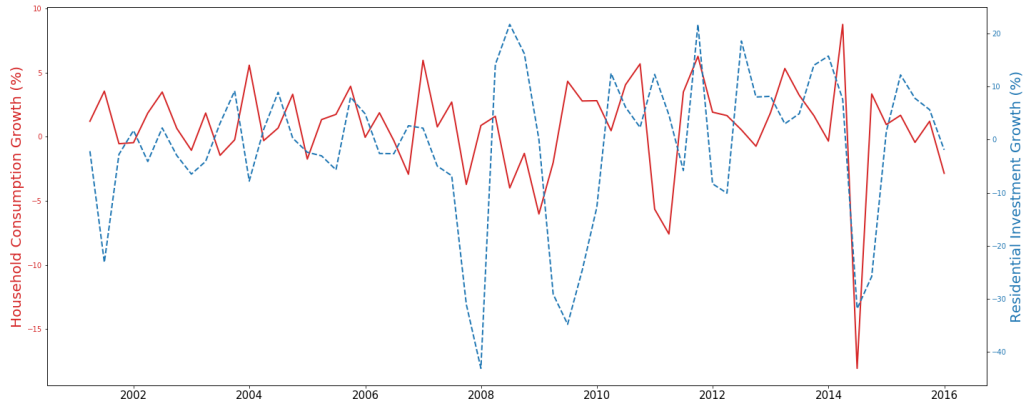


Figure 1.1: Household consumption and residential growth in Japan

Notes: Annual growth rates of quarterly real household consumption and residential investment.

Source: Economic and Social Research Institute.

Combined with the lack of credit market liberalization, the housing wealth effect (collateral effect) was once thought to be almost nonexistent in Japan (Aron et al., 2012). However, especially in recent years, rapid growth has been observed in mortgage share in total banking loans (see Figure 1.2)¹.

¹Also with the rising average loan-to-value (LTV) ratio of mortgages in Japan that has been observed in recent years.

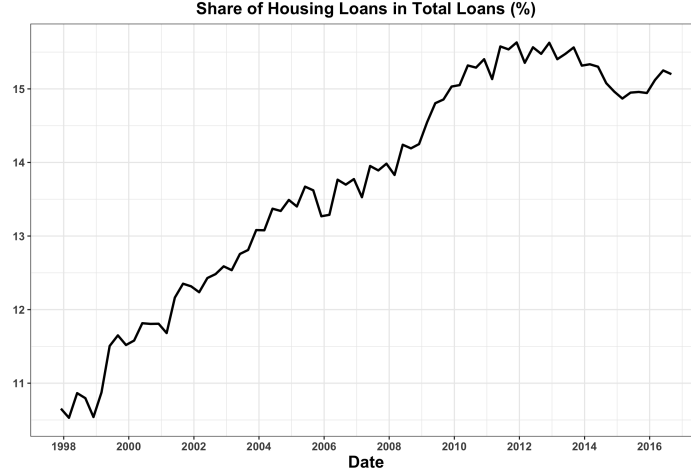


Figure 1.2: Rising share of housing loans in Japan

Notes: The share of housing loans in total banking lending.

Source: The Bank of Japan.

In such a context, this chapter aims to give a comprehensive empirical investigation of the role of the Japanese housing market in transmitting the unconventional monetary policy. I first establish a benchmark analysis based on a structural vector autoregression approach (SVAR), estimated using monthly macro data in Japan over a sample period from 2001:M3 to 2015:M12.

One of the critical issues when estimating the unconventional monetary policy's effect is that different policy variables often lead to different estimates. To choose an appropriate policy instrument variable, we first need to know the development of Japanese unconventional monetary policies. Here, I briefly summarize the timeline of the Bank of Japan (BoJ)'s unconventional monetary policies, which is given by Miyao (2016) as follows:

- February 1999 ~ 2001: Zero interest rate policy
- March 2001 ~ 2006: Quantitative easing policy (QE)
- October 2010 ~ 2013: Comprehensive monetary easing policy (CME)
- April 2013 ~ 2016: Quantitative and qualitative easing policy (QQE)

We can see that, after the short-term interest rate reaches ZLB, quantitative

easing or expansionary monetary base has been the dominating monetary policy instruments implemented by the BoJ for at least fifteen years, suggesting that using the monetary base as the unconventional monetary policy variable is practically reasonable. Representative literature investigating the effect of the BoJ's unconventional monetary policy, such as Bowman et al. (2015), Kimura and Nakajima (2016), Michaelis and Watzka (2017), and Miyao and Okimoto (2020), also uses quantitative easing (the monetary base) as the primary policy variable².

Based on the above setting, I focus on the real economy's responses to unconventional monetary policy (the monetary base) and housing price shocks. In my benchmark SVAR model, I provide evidence of the role that the housing market plays in transmitting unconventional monetary policy shocks in Japan, which can be explained in two ways: a) an expansionary monetary base shock generates a sustained rise in household consumption, residential investment, inflation, mortgage lending, and real house prices while b) positive housing price shocks also increase consumption, residential investment, inflation, and mortgage loans. This is consistent with the accelerator function of housing prices studied in New Keynesian literature such as Iacoviello (2005) and Iacoviello and Neri (2010), and such estimation is found to be robust using an alternative policy variable.

Additionally, asset prices, particularly housing prices, may not constantly respond across different monetary policy regimes (Paul, 2020). To address this question, I also propose a different SVAR framework to re-examine the role housing prices play in transmitting unconventional monetary policy: an SVAR model with time-varying parameters (TVP-SVAR). Though the TVP-SVAR model proposed by Primiceri (2005) has been a popular tool in checking monetary policy's effect for many years, the use of TVP-SVAR to investigate housing prices' potential role in transmitting unconventional

²I also use 10-year Japanese government bond yield to create term spread shock as an alternative policy variable in the robustness test.

monetary policy in Japan has been rare. Compared to the benchmark constant-coefficient SVAR model, the TVP-VAR model can better capture policy shocks' dynamic responses across different periods. Since there is a significant difference in Japanese housing prices before and after the crisis (see Figure 1.3), the estimation results may mask some essential findings without considering this variation.

The extended analyses are found to be interesting and important. The time-varying responses to policy shocks show a similar sign with the benchmark SVAR estimates. However, the size of such effects varies significantly in different policy regimes. The most substantial impacts of monetary policy shocks on consumption and inflation are observed after the crisis until the implementation time of QQE. On the other hand, housing market variables respond persistently even after QQE. Furthermore, positive housing price shocks show more potent effects before the crisis than in other periods. Overall, I do find the function of housing prices as an accelerator in transmitting unconventional monetary policy.

This chapter complements the recent contributions of Bowman et al. (2015), Kimura and Nakajima (2016), Michaelis and Watzka (2017), Koeda (2019), and Miyao and Okimoto (2020), who attempt to investigate the effect of the unconventional monetary policy of the BoJ when the short-term call rate reaches its ZLB, as well as Wu and Xia (2016), Paul (2020), and Huber and Punzi (2020), who study the relationship between housing prices and unconventional monetary policy in the United States and other advanced economies³.

This study also empirically supports the flourishing theoretical literature on how housing prices affect business cycle fluctuations and the impact of unconventional monetary policies on property values. Damjanovic and

³Huber and Punzi (2020) also document the effect of unconventional monetary policy on the Japanese housing market with a shorter period, not including the period of QQE.

Girdénas (2014) study the relationship between house prices and quantitative easing when the short-term rate hits ZLB. Elenev (2017) proposes that large-scale asset purchases boost aggregate demand via additional bank lending to homeowners, increasing housing prices, and building expectations of future financial stability.

The rest of the chapter is organized as follows. Section 2 details my empirical analysis, illustrating framework specification and presenting the estimation results. Section 3 concludes the chapter. Some supplementary materials appear in the Appendix.

1.2 Empirical Analysis

1.2.1 Benchmark Framework

In this subsection, an SVAR model is estimated to examine my target variables' responses to two structural shocks: the unconventional monetary policy shock and the housing price shock. The estimation is set up on a monthly model for the Japanese economy. Variables chosen in the SVAR reflect the recent theoretical New-Keynesian frameworks, such as those outlined in Damjanovic and Girdénas (2014) and Elenev (2017). Let the vector of endogenous variables be defined as

$$X_t \equiv [c_t, inv_t, \pi_t, mb_t, ex_t, mg_t, s_t, hp_t]',$$

where c_t denotes the (log) real consumption, inv_t the (log) real residential investment, π_t the consumer price index (CPI) in the form of year-on-year change, mb_t the (log) monetary base, ex_t the (log) real effective exchange rate, mg_t the (log) housing loans, hp_t the (log) real housing price index, and s_t the (log) real stock price index. Economic activities are represented by real consumption and real residential investment, and real housing price index and real housing loans reflect the housing market. Additionally, the

stock prices are controlled in the framework to account for the wealth effects generated by financial asset price variations. Time series data of these variables are shown in Figure 1.3; detailed definitions and sources are provided in Appendix A.1.

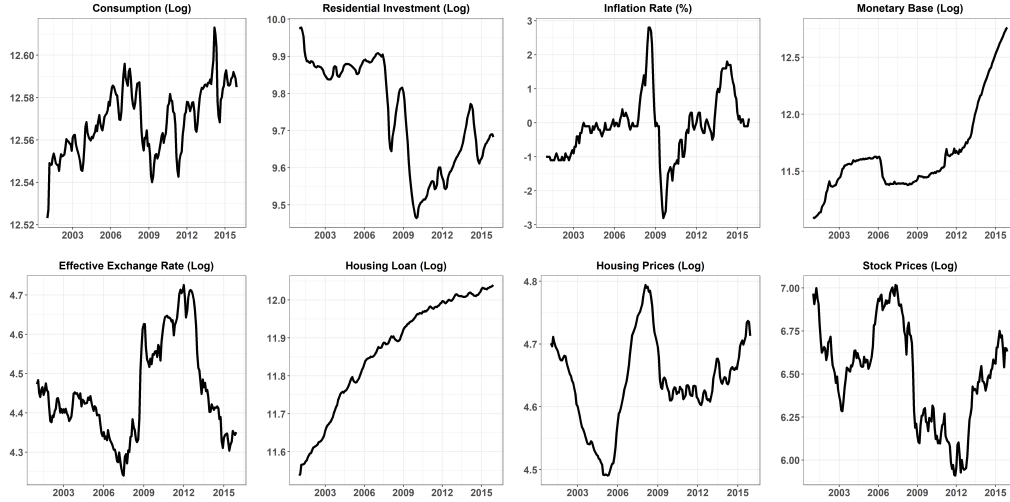


Figure 1.3: Time series data: Japan, 2001:M3 - 2015:M12
Source: See Appendix A.1 for the detail.

Specification and Identification

The SVAR model is specified by the following reduced form:

$$A(L)X_t = \varepsilon_t \quad (1.1)$$

where $X_t \equiv [c_t, inv_t, \pi_t, mb_t, ex_t, mg_t, s_t, hp_t]'$ is the endogenous variable vector, $A(L) = A_0 - A_1L - \dots - A_pL^p$ is the p th polynomial matrix with the lag operator L , and ε_t is the structural shock vector.

My first objective is to investigate the effect of unconventional monetary policy on consumption, residential investment, inflation, and the housing market. Therefore, we encounter the usual reverse causation issue in macroeconomics: economic activities respond to monetary policy innovations, but monetary policy also reacts to macroeconomy changes. To identify unanticipated innovations in the monetary base, a shock series used for estimation

is required. There is a considerable amount of literature on how to identify monetary policy innovations. Traditional approaches relied on a recursive (i.e., Cholesky) structure (Christiano, Eichenbaum and Evans, 1999). However, this identification methodology may produce an underestimation of the shocks regarding Japan's case, leading to a weak effect on inflation (Michaelis and Watzka, 2017).

In this chapter, instead of the Cholesky, I identify the monetary policy shocks by imposing several sign restrictions (Uhlig, 2005). More specifically, I assume that household consumption, residential investment, and inflation can not simultaneously respond to unconventional monetary policy shocks. Furthermore, I assume that expansionary monetary policy shocks will not decrease the monetary base, mortgage loans, and stock prices (Musso, Neri and Stracca, 2011; Elenev, 2017; Paul, 2020). Additionally, expansionary monetary policy shocks will not increase the exchange rate. I place no restriction on those objective variables, specifically consumption, residential investment, inflation, and housing prices. Therefore, we can summarize sign restrictions for unconventional monetary policy shocks as in Table 1.1.

	c_t	inv_t	π_t	mb_t	ex_t	mg_t	s_t	hp_t
Sign	-	-	-	↑	↓	↑	↑	-

Table 1.1: Identify expansionary monetary policy shocks

Notes: The "-" indicates no restriction is imposed.

Source: Author's calculations.

To mitigate the partial identification issue of sign restrictions, I also build the endogenous variables into a recursive structure in addition to placing signs. I set the recursive block based on the rule that it is usually better to order slower-moving variables before fast-moving variables (Bruno and Shin, 2015). Consequently, the unconventional monetary policy shock series based on monetary base is shown in Figure 1.4.

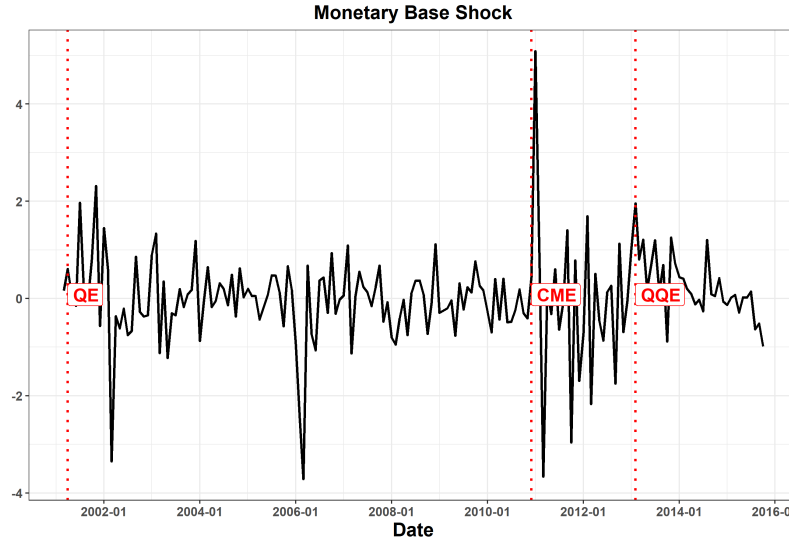


Figure 1.4: Unconventional monetary policy shocks: Japan, 2001:M3 - 2015:M12

Notes: Three vertical lines refer to the implementation time of QE, CME, and QQE, respectively.

Source: Author's calculations.

Impulse Responses

The empirical analysis is built on Japan's monthly time series spanning the period from 2001:M3 to 2015:M12. Based on the Akaike Information Criterion (AIC), the model's lag length is set to four. The sign restrictions are limited by one period.

Figure 1.5 plots the impulse response in household consumption, residential investment, inflation, mortgages, and real housing prices to expansionary monetary policy shocks. The responses are plotted with 68% confidence bands. The shock refers to one unit shock, which can be interpreted as one percentage point. The responses indicate that expansionary policy shocks have the typical impacts on consumption and inflation described in other literature: temporally increase consumption and inflation. Consumption increases by 0.04–0.06 percentage points for close to two years until the effects substantially perish. The effect on inflation increases by 0.04–0.1 percentage points for close to two years. Regarding housing market variables, the

residential investment increases by 0.26 percentage points at peak until the effects eventually perish after two years. On the other hand, both housing prices and housing loans show a persistent increase, especially for housing prices, which increase by a peak of 0.15 percentage points. Thus, unconventional monetary policy shows a comparatively potent and prolonged effect on housing prices, emphasizing the role of housing prices in transmitting monetary policy.

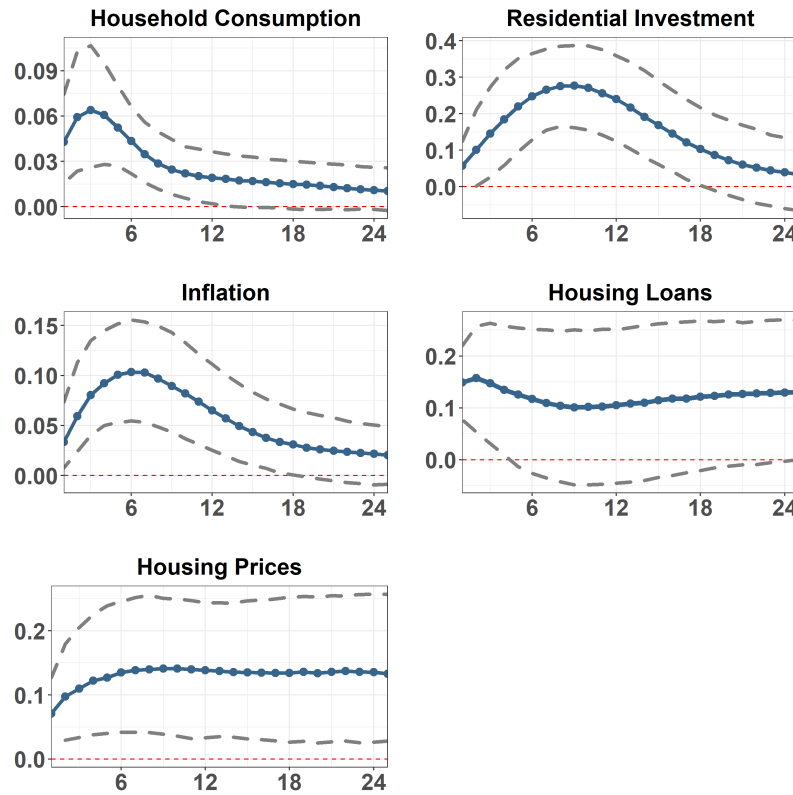


Figure 1.5: Impulse responses to expansionary monetary base shocks

Notes: Median responses with 68% confidence bands in dashed lines are reported. The vertical axes unit is one percentage point, and the unit of the horizon axes refers to one month.

Source: Author's calculations.

Next, I move to investigate impulse responses to housing price shocks. Figure 1.6 plots the impulse response in household consumption, residential investment, inflation, and mortgages to positive housing shocks. The responses indicate that positive housing price shocks also have a typical effect

on consumption, residential investment, and housing loan described in the literature on collateral effects: rising housing prices lead to higher collateral, more borrowing to finance consumption and residential investment. Consumption increases by 0.01–0.07 percentage points for close to nine months until the effects eventually perish. The residential investment increases by 0.08–0.22 percentage points for close to 18 months until the effects substantially disappear. The housing loans show persistently positive responses with a magnitude around 0.05 percentage points at peak. Notably, the effect of a positive shock to housing prices on inflation is also potentially positive, with the response of 0.08 percentage points at peak and lasts for two years. This can be interpreted as suggesting that housing price shock is a strong indicator for consumption (or output) growth and, therefore, project an increase in inflation. Thus, the role that housing prices play in transmitting the monetary policy is further enhanced.

Robustness

I further examine the robustness of the benchmark estimation results using an alternative policy variable, 10-year Japanese government bond yield, to replace the monetary base⁴. To identify the policy shock, which refers to the term spread shock, I use a similar method using sign restrictions with recursive structure. Here, I assume that household consumption, residential investment, and housing prices do not simultaneously react to term spread shocks. Moreover, I assume that expansionary monetary policy shocks will not increase the long-term government bond yield and the exchange rate (Krishnamurthy and Vissing-Jorgensen, 2011). Furthermore, the expansionary monetary policy shock will not decrease mortgage loans and stock

⁴There is a plenty of literature documenting the relationship between of the quantitative easing and long-term government bond yield, such as Krishnamurthy and Vissing-Jorgensen (2011), indicating the possibility of using long-term interest rate as an alternative policy indicator. Moreover, I also plot the time series of 10-year Japanese government bond yield and monetary base (see Figure A.1), which clearly reveals the correlation between these two policy variables.

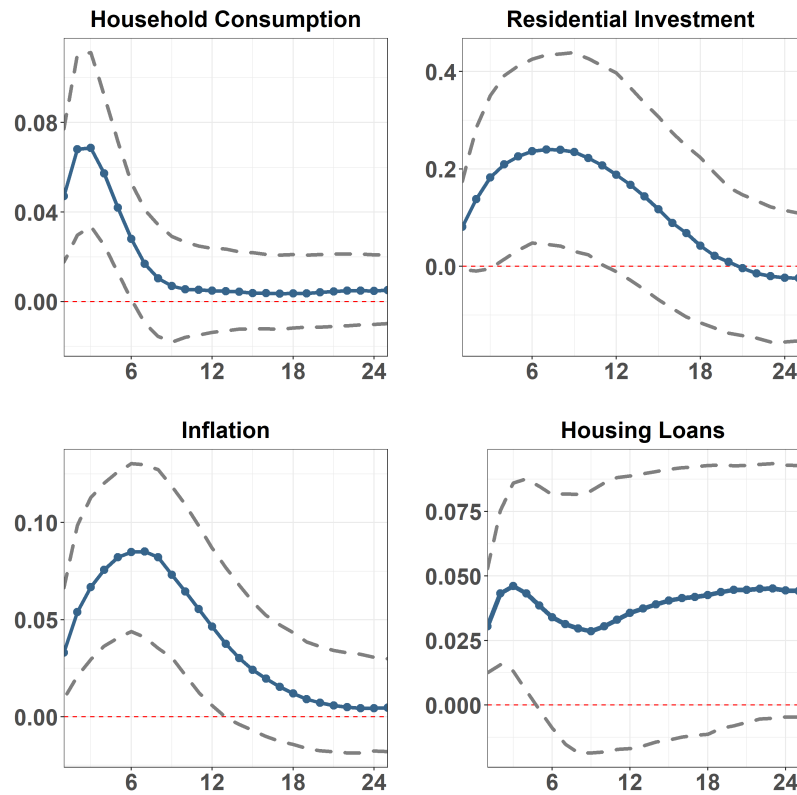


Figure 1.6: Impulse responses to positive housing price shocks

Notes: Median responses with 68% confidence bands in dashed lines are reported. The vertical axes unit is one percentage point, and the unit of the horizon axes refers to one month.

Source: Author's calculations.

prices. I put no restriction on those objective variables, specifically consumption, residential investment, inflation, and housing prices. Therefore, we can summarize sign restrictions for these term spread shocks as in Table 1.2.

	c_t	inv_t	π_t	$yield_t$	ex_t	mg_t	s_t	hp_t
Sign	-	-	-	↓	↓	↑	↑	-

Table 1.2: Identify expansionary term spread shocks

Notes: The "-" indicates no restriction is imposed.

Source: Author's calculations.

Figure 1.7 plots the impulse response in household consumption, residential investment, inflation, mortgages, and real housing prices to an expansionary term spread shock. The responses indicate that an expansionary term spread shock has consistent effects compared to the monetary base shock. Consumption increases by 0.02–0.06 percentage points for close to two years, and the effect on inflation increases by 0.04–0.13 percentage points for close to two years, and the results are very close to those from the monetary base shock. Regarding housing market variables, the residential investment increases by 0.3 percentage points at peak for close to two years. Consistently, housing prices also show a persistent increase with a magnitude of 0.12 percentage points. Thus, the finding that the unconventional monetary policy shows a comparatively potent and prolonged effect on housing prices is tested to be stable.

Further Evidence

To further assess housing price shocks' role in transmitting unconventional monetary policy, I historically decompose household consumption, residential investment, and inflation into the share of housing price shocks from the SVAR model, which are shown in Figure 1.8. Firstly, let us focus on the historical decomposition of household consumption. The share of housing shocks peaked around 2006 by 30% with the average share at about 15%

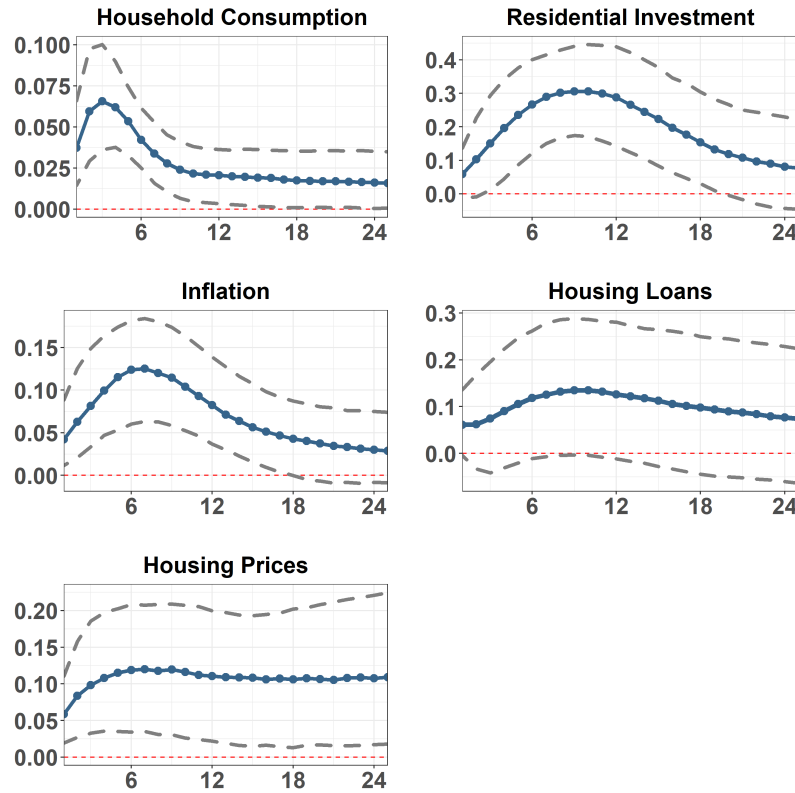


Figure 1.7: Impulse responses to expansionary term spread shocks

Notes: Median responses with 68% confidence bands in dashed lines are reported. The vertical axes unit is one percentage point, and the unit of the horizon axes refers to one month.

Source: Author's calculations.

across the whole period. Next, we look at the residential investment, where the housing shocks peaked around the first QE and QQE period by 35–40%, with an average share of about 22% across the whole period. Last, for inflation, the housing shocks peaked around the first QE and QQE period by 30% with an average share of about 18% across the whole period. Though varying across time, the contribution of housing price shocks is non-trivial but pronounced.

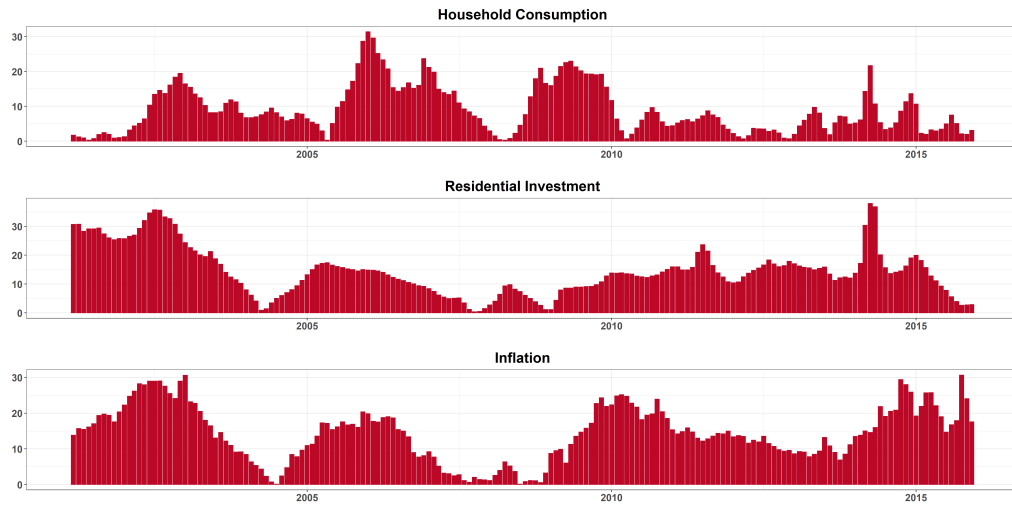


Figure 1.8: Historical decomposition: share of housing price shocks
Source: Author's calculations.

I also conduct a counterfactual analysis by comparing the magnitude of effects of expansionary monetary policy shocks on consumption, residential investment, and inflation for the economic system with and without housing market variables⁵ (see Figure 1.9). We can clearly observe that, at least in the short term, policy shocks have a stronger effect on the real economy if the housing market variables are accounted for. Therefore, we can conclude that this sizeable contribution of housing prices reflects that the housing market's development greatly matters for Japan's unconventional monetary policy.

⁵Here, the residential investment is treated as a core component of output instead of a housing market variable.

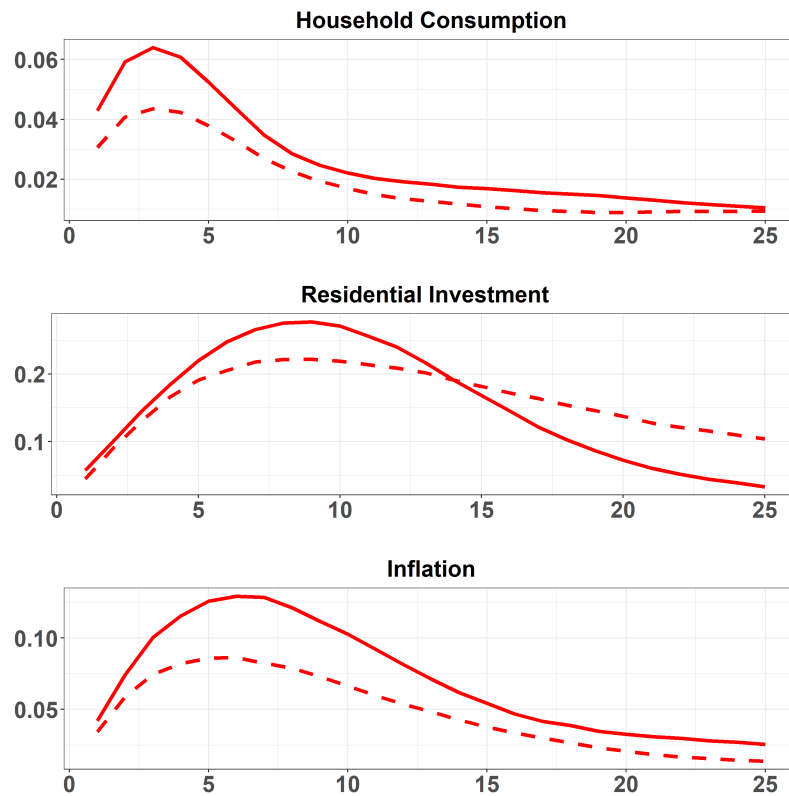


Figure 1.9: In the short term, unconventional monetary policy performs better when housing markets get involved

Notes: The red dashed line plots the median impulse responses to expansionary monetary base shocks when housing market variables are not controlled. The vertical axes unit is one percentage point, and the unit of the horizon axes refers to one month.

Source: Author's calculations.

1.2.2 Extension: Time-varying Effects

Specification

This subsection extends my benchmark SVAR model by updating it with time-varying parameters (TVP-SVAR). Besides the typical consideration of potential structural changes in the economy across time, my principal motivation for using TVP-SVAR is the reliance on housing price responses to the magnitude of the policy and real economic variables, which is likely to evolve over time.

Though concentrating on different objective variables, my TVP-SVAR model's setting follows the specification described in Primiceri (2005) and Nakajima (2011). The reduced form of the SVAR model with time-varying coefficients is given as

$$X_t = A_{0,t} + A_{1,t}X_{t-1} + \cdots + A_{p,t}X_{t-p} + u_t, \quad t = p+1, \dots, T \quad (1.2)$$

where the vector of time-varying intercepts is represented by $A_{0,t}$, and $A_{i,t}$ are time-varying parameter matrices for $i = 1, \dots, p$, and the disturbance vector u_t is the white noise. Furthermore, we can have a linearized dynamic model as

$$X_t = Z_t\beta_t + S_t^{-1}\Sigma_t\varepsilon_t \quad (1.3)$$

where β_t is the stacked form of the rows of $S_t^{-1}A_{i,t}$ for $i = 0, \dots, p$, and in $Z_t = I_6 \otimes (X'_{t-1}, \dots, X'_{t-p})$, the operator \otimes refers to the Kronecker product. S_t describes the strategy to identify structural shocks based on the sign

restrictions while with a recursive structure, which is the same in the SVAR setting, and is given in a time-varying lower-triangular matrix form:

$$S_t = \begin{bmatrix} 1 & 0 & \dots & 0 \\ s_{21,t} & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ s_{81,t} & \dots & s_{87,t} & 1 \end{bmatrix} \quad (1.4)$$

Time-varying covariance Ω_t can be decomposed as $\Omega_t = S_t^{-1} \Sigma_t \Sigma_t' (S_t^{-1})'$, and Σ_t is a diagonal time-varying covariance matrix:

$$\Sigma_t = \begin{bmatrix} \sigma_{1,t} & 0 & \dots & 0 \\ 0 & \sigma_{2,t} & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \dots & 0 & \sigma_{8,t} \end{bmatrix} \quad (1.5)$$

The process I build for the time-varying parameters follows Primiceri (2005). Let s_t be the assembled vector of the lower triangular coefficients of the matrix S_t , and define σ_t to be the assembled vector of the diagonal coefficients of the matrix Σ_t . Assume that β_t , S_t , and Σ_t in Equation 1.3 follow a random walk as follows:

$$\beta_{t+1} = \beta_t + \mu_t \quad (1.6)$$

$$s_{t+1} = a_t + \eta_t \quad (1.7)$$

$$\log \sigma_{t+1} = \log \sigma_t + \theta_t \quad (1.8)$$

for $t = p + 1, \dots, T$. The vectors of the disturbances are assumed to be in a joint normal distribution with a matrix of variance-covariance:

$$\begin{pmatrix} \varepsilon_t \\ \mu_t \\ \eta_t \\ \theta_t \end{pmatrix} \sim N \left(0, \begin{pmatrix} I_{8,t} & 0 & \dots & 0 \\ 0 & Q & \ddots & \vdots \\ \vdots & \ddots & U & 0 \\ 0 & \dots & 0 & V \end{pmatrix} \right) \quad (1.9)$$

In the TVP-SVAR framework, we typically have to set up the prior distribution of the initial state of the time-varying parameters; the purpose of the estimation is to specify the joint posterior distribution of the model parameters. To accomplish that, instead of following Primiceri (2005), in which the prior normal distribution whose mean and variance are determined by the estimation of a constant parameter SVAR model using time series in the pre-sample period, I choose a flat prior specification based on Nakajima (2011)⁶.

Time-varying Responses

Similarly, the empirical analysis is built on Japan's monthly data spanning the period from 2001:M3 to 2015:M12. Based on AIC, the lag length in the model is set to four.

Figure 1.10 plots the time-varying responses to unconventional monetary policy shocks based on my estimated TVP-SVAR. Impulse responses in Figure 1.10 are graphed as time series, showing the magnitude of the impulses over time for the 3, 6, and 12-month horizons. The estimated dynamic responses suggest that an expansionary monetary shock had significant time-varying effects over time at all horizons. Although, on average (which also can be somewhat captured by the benchmark SVAR model), the effect on household consumption, residential investment, inflation, housing loan, and housing prices has been positive, there is a considerable variation across the period.

First, look at household consumption and residential investment. Their responses to expansionary monetary policy shocks are pronounced in the crisis, CME, and the start of QQE periods and virtually vanish close to the end of QQE. Part of this finding can be explained by the improvement of private-

⁶As mentioned in Nakajima (2011), using flat priors for the initial state of time-varying parameters, Markov chain Monte Carlo (MCMC) methodology can efficiently compute the posterior estimation.

sector fundamentals during the pre-crisis period, as suggested by Miyao and Okimoto (2020), which greatly enhance the efficiency of monetary policy in promoting economic activities. Regarding the dropping magnitude of responses after the implementation of QQE, according to Eggertsson (2011) and Michaelis and Watzka (2017), people's optimism toward QQE changes into pessimism after the tax hike in April 2014, leading to a recession in the economy, which raises the concern that easing monetary policy might again be insufficient to boost the economy and, therefore, not have non-trivial real effects. My estimation might reflect these reversing expectation effects.

Regarding inflation, similar to the consumption and residential investment, its responses to policy shocks are also pronounced in the crisis, CME, and the starting of QQE periods and essentially diminish close to the end of QQE. Using the same story explained above, recovered and upgraded financial sectors provide an efficient environment for expansionary monetary policy to boost the economy, which raises the inflation expectation. However, when the economic activities face a slight recession around mid-2014, such increased expectations of inflation begin to come to a stop and turn to decline, which diminish inflation responses to the expansionary monetary policy. This can also be reflected in my estimates.

Regarding two housing market variables, their responses to policy shocks remain pronounced even until the end of QQE. Unlike the reversing expectation on growth and inflation, the low mortgage rate environment provided by the expansionary monetary policy raise the expectation of future housing prices and the demand for housing loans⁷. These findings show that the housing market can serve as an extra transmission channel even when policy shocks' real effects on consumption (output) and inflation diminish.

Another focus is the impact of housing price shocks in determining the role

⁷A large amount of literature has documented the important role of future housing price expectations, such as Case and Shiller (2003) and Piazzesi and Schneider (2009).

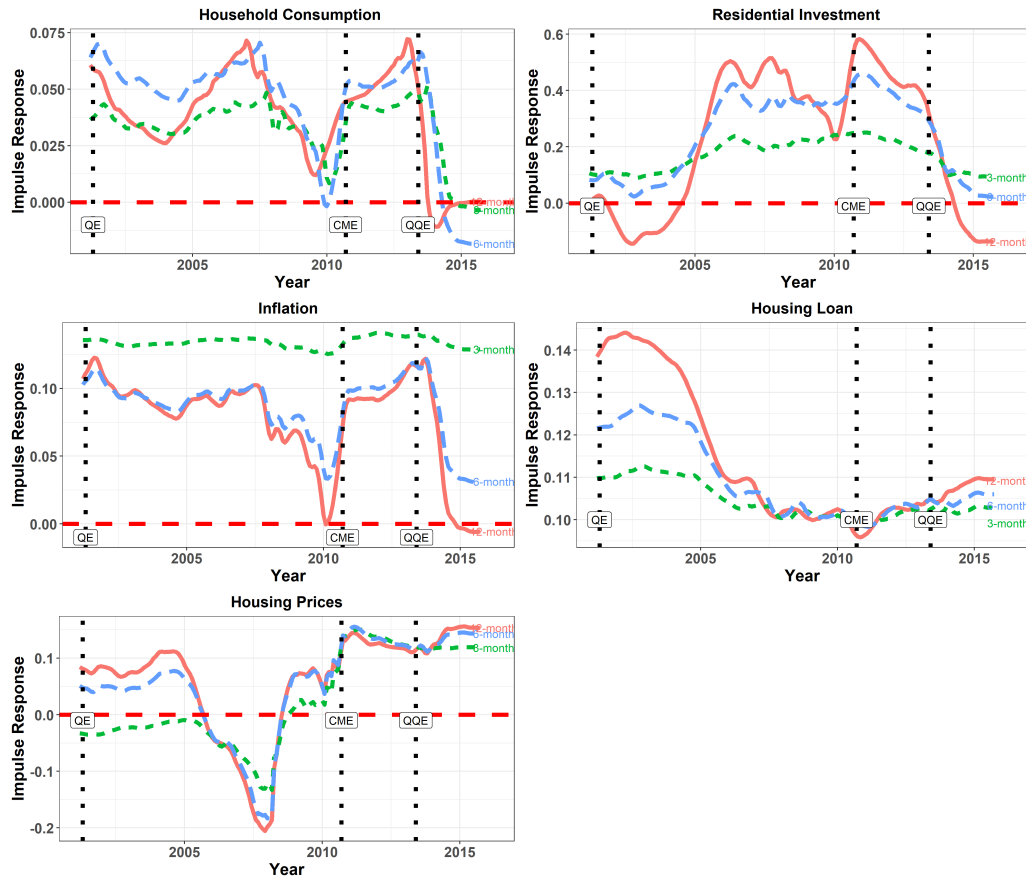


Figure 1.10: Time-varying impulse responses to expansionary monetary base shocks

Notes:

- 1) Three vertical lines refer to the implementation time of QE, CME, and QQE, respectively.
- 2) Time-varying responses for 3 (dotted green line), 6 (dashed blue line), and 12 months ahead (solid orange line) for the TVP-SVAR model.
- 3) The unit of the vertical axes is one percentage point.

Source: Author's calculations.

of housing prices in monetary policy transmission. Figure 1.11 shows time-varying responses to positive housing price shocks. Similar to the case of expansionary monetary policy shocks, though, on average (which also can be captured by the benchmark SVAR model), the effect on household consumption, residential investment, inflation, and housing loan have been positive, and there is a sizable variation across the period. For consumption, residential investment, and inflation, the peak responses are observed before the crisis, which is also when recovering housing prices peak. As explained in the previous subsection, housing price is a strong indicator, in the short term, for the growth expectation of the consumption (output) and future inflation, which again contributes to the quantitatively important role that housing prices play in transmitting the unconventional monetary policy.

1.3 Concluding Remarks

This chapter comprehensively documents the relationship between housing prices and the unconventional monetary policy in Japan. Quantitative impacts of unconventional monetary policy shocks are investigated using SVAR with the extension using TVP-SVAR. I show that expansionary monetary policy shocks increase household consumption, residential investment, inflation rate, housing loans, and housing prices. Regarding the effect of a positive housing price shock, I observe an increase in household consumption, residential investment, inflation, and housing loans. Combining these two results, an accelerator function of housing prices in policy transmission is confirmed. To further exploit the importance of housing prices, historical decomposition and counterfactual analysis are conducted, revealing the contribution of the housing market to the economy is non-trivial but pronounced.

On the other hand, as revealed by my proposed TVP-SVAR model, the magnitude of responses to shocks varies across different policy regimes. The

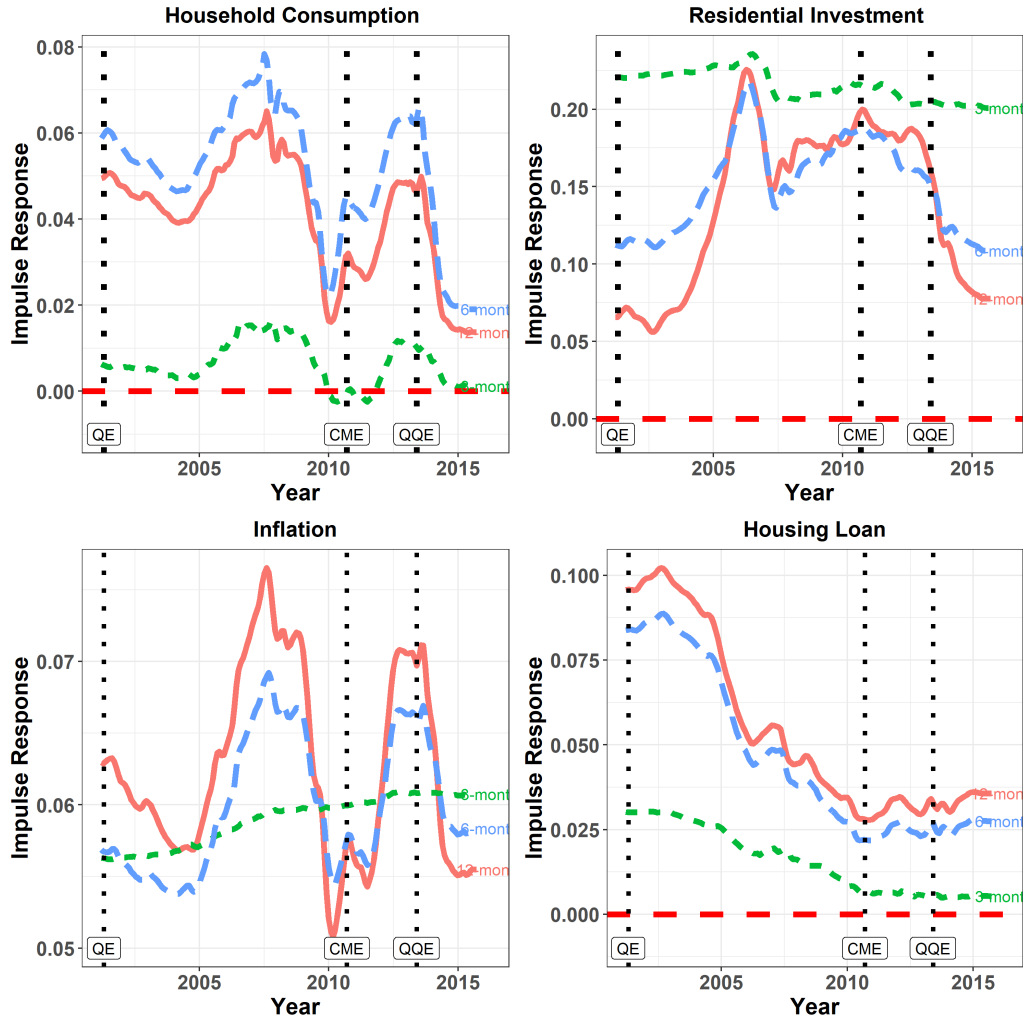


Figure 1.11: Time-varying impulse responses to positive housing price shocks

Notes:

- 1) Three vertical lines refer to the implementation time of QE, CME, and QQE, respectively.
- 2) Time-varying responses for 3 (dotted green line), 6 (dashed blue line), and 12 months ahead (solid orange line) for the TVP-SVAR model.
- 3) The unit of the vertical axes is one percentage point.

Source: Author's calculations.

effects of expansionary monetary policies on consumption, residential investment, and inflation during the QQE period diminish once people rate down the expectation on the policy effectiveness. However, a pronounced and persistent response of housing prices provides an extra transmission channel when the real effects of policy shocks on output and inflation vanish, further emphasizing the important role of housing prices for the unconventional monetary policy transmission in Japan.

Chapter 2

Household Balance Sheets and Unconventional Monetary Policy Transmission

2.1 Introduction

One of the most fundamental questions that macroeconomists try to answer is how monetary policy would affect real economic activities. In a typical New Keynesian model, the policy transmission mechanism works through the inter-temporal substitute channel (see Galí, [2015](#)). Following this mechanism, unexpected short-term interest rate changes will alter households' borrowing cost, leading to investment and saving changes and, thus, their aggregate consumption deviations. On the other hand, a surging number of theoretical studies have documented the relationship between household balance sheet positions and monetary policy transmission (Mitman, [2016](#); Kaplan, Moll and Violante, [2018](#); Auclert, [2019](#); Slacalek, Tristani and Violante, [2020](#); Luetticke, [2020](#)), showing that the policy effects are heterogeneous and significantly different from those predicted by a direct interest rate channel only, which indicates that there may be other channels that drive the monetary policy transmission. However, regardless of a growing body of empirical literature providing more empirical support for other transmis-

sion channels, it is still challenging to give a unified answer to explain which channel(s) can be the driving force.

One potential candidate that may explain such heterogeneity in monetary policy transmission is the cash-flow channel (Auclert, 2019; Cloyne et al., 2019; Slacalek, Tristani and Violante, 2020; Flodén et al., 2020)¹. This mechanism's key idea suggests that the unconventional monetary policy may directly affect household expenditure via household cash flow changes. If households' debt (e.g., the unpaid mortgage) is bundling with short-term interest rates, households' payment cost will drop when there is an expansionary monetary policy shock. Consequently, households' cash flows would increase. If households have many net financial assets or good financial market access, such cash flow variations may not generate significant expenditure reactions (Flodén et al., 2020)². However, if households are in a lower net saving position, such temporarily increased cash flows from expansionary monetary policy shocks will increase their expenditures³.

This chapter provides empirical support for this channel by using Japanese household survey data. The use of Japanese data has several significant advantages. First, as shown in the first chapter, Japan has been a front runner of unconventional monetary policy since the early 2000s with its enormous qualitative easing magnitude. Second, in Japan, households' indebtedness is comparatively high, and households commonly choose adjustable-rate mortgages (ARMs). Based on the recent national survey from the Ministry of Land, Infrastructure, Transport, and Tourism of Japan, ARMs took up around 50 to 60% of the mortgage loans' total contracts⁴. Third, Japan

¹In Auclert (2019) and Slacalek, Tristani and Violante (2020), the cash-flow channel works similarly to what they call the net interest rate exposure effect.

²On the other hand, in certain circumstances (e.g., households are not forward-looking), the interest-rate return may decrease if households are in the upper net saving position or with very low debt, which reduces the households' cash flows, leading to a drop in household consumption.

³This is very similar to the case of "poor hand-to-mouth" households documented in Kaplan, Violante and Weidner (2014).

⁴The share of ARMs may remain high due to the current environment of low long-

provides a relatively easy empirical setting using the household survey data with detailed information about household balance sheets and a relatively long sample period with high frequency. One big challenge in previous studies, mentioned by Flodén et al. (2020), is the limited number of survey data sets representing the population, both in terms of high-quality household expenditure measures and balance sheet information. I address this issue using Japan's administrative household survey data—The Family Income and Expenditure Survey (FIES). FIES offers me detailed information on household income, debt position, and demographic information as the household head's age. The details of FIES also allow me to attribute a measure of exact household expenditure. Furthermore, analyzing responses at the household level alleviates the typical macroeconomic issue when examining monetary policy shocks' impact on real economic activities, such as household expenditure, that monetary policy variations are endogenous to the economy's movement. According to my set-up, all households are assumed to be affected by the same monetary policy innovation, however, if the cash-flow channel is potent, the impact should vary between households depending on their net saving positions. Last, the long monthly survey data period also allows me to use standard time series estimation tools. In particular, I investigate how unconventional monetary policy would affect households' expenditure choices for those in lower net saving positions compared to those who are not, based on the structural vector autoregression (SVAR) framework⁵.

My results provide strong evidence for the importance of the cash-flow channel in driving unconventional monetary policy transmission. The empirical specification separates the aggregate consumption responses to unconventional monetary policy shocks, estimating heterogeneous responses across households with different indebtedness levels or net saving positions. I find

term interest rate as suggested by Campbell and Cocco (2003), who document a negative correlation between the long-term interest rate and fixed-term mortgages.

⁵I also provide empirical analyses using the local projections method as one robustness test.

that households in lower net saving position (with high debt levels) respond positively and substantially to expansionary monetary policy shocks. On the other hand, households in upper net saving position (with little or no debt) respond insignificantly. These estimates indicate the cash-flow channel. Additionally, by comparing with the estimates based on aggregate households, I conclude that the aggregate response of consumption to unconventional monetary policy masks the heterogeneous reactions among households and is mainly driven by households with outstanding debt. Furthermore, I find that such heterogeneity still holds even after controlling the life-cycle effects by restricting the sample to middle-aged households. Finally, I also show that neither income effects nor additional wealth effects, at least on their own, can explain this consumption heterogeneity, which further enhances the critical role played by the cash-flow channel in transmitting the unconventional monetary policy shocks.

The remainder of this chapter is structured as follows. In Section 2, I review related literature. Section 3 briefly outlines the cash-flow channel used to interpret the empirical findings. Section 4 describes the data and sets out the empirical design. Section 5 presents the baseline estimates with the several robustness tests and the extension. Section 6 concludes. Some supplementary materials appear in the Appendix.

2.2 Related Literature

This chapter complements the recent empirical contributions of Calza, Monacelli and Stracca (2013); Di Maggio et al. (2017); Jappelli and Scognamiglio (2018); Cloyne et al. (2019); Tzamourani (2019); and Flodén et al. (2020) that document the heterogeneous effects of monetary policy on household expenditures based on household balance sheet position. Cloyne et al. (2019) are the closest to my study, using the data of the United Kingdom and the United States, which also investigate household consumption responses to

monetary policy shocks. On the other hand, lacking detailed information on household balance sheets, they approximate the household debt position by using housing tenure status instead and find that consumption is significantly more responsive to temporary interest rate cuts if the household has an outstanding mortgage. Despite focusing on different monetary policy types and country choices, this chapter further sheds light on explaining the policy transmission, taking advantage of more detailed data on household debt positions instead of sacrifice to use the proxy.

This chapter also provides empirical evidence for the flourishing theoretical literature on heterogeneous effects of monetary policy. Kaplan, Moll and Violante (2018), by proposing a Heterogeneous Agent New Keynesian (HANK) model, revisit the monetary policy transmission mechanism, finding that the indirect channels weigh more than the traditional intertemporal substitution effect. Auclert (2019) and Slacalek, Tristani and Violante (2020) further evaluate monetary policy's redistribution effect on consumption by providing additional transmission channels, depending on household balance sheets.

Last, to the best of my knowledge, this is the first empirical study on the heterogeneous effects of unconventional monetary policy on household consumption in Japan. Previous literature using Japanese household survey data (e.g., Saiki and Frost, 2014; Inui, Sudou and Yamada, 2017) studies how unconventional monetary policies affect income inequality across households instead of heterogeneity in household consumption.

2.3 Cash-flow Channel

This section briefly describes how the cash-flow channel works in transmitting monetary policy changes to household consumption. The mechanism is summarized from Auclert (2019) and Slacalek, Tristani and Violante (2020),

who propose a tractable way of explaining the effects of monetary policy shocks, specifically a formula for the household cash flows.

2.3.1 Formula

From Auclert (2019) and Slacalek, Tristani and Violante (2020), a simplified formula of the cash-flow channel for each household i at each period can be given as

$$\Delta C_i = MPC \times (Y_i - C_i + \phi^A A_i - \phi^D D_i) \times \Delta R \quad (2.1)$$

where C denotes household consumption, Y denotes household disposable income, A represents long-term financial assets (e.g., stocks and bonds), and D refers to long-term household debts (e.g., ARMs). Furthermore, it is assumed that assets A and debts D mature every period with a fraction of ϕ^A and ϕ^D , respectively. ΔC refers to the one-period deviation of household consumption, and ΔR is the one-period short-term interest rate change that can be treated as a one-period monetary policy shock. MPC is the marginal propensity to consume, which is assumed to be constant across households⁶.

2.3.2 Interpretation

The above formula revealing the cash-flow channel captures the household net saving exposed to the interest rate changes. Supposing the household is a net saver (e.g., more assets than debts: $Y_i - C_i + \phi^A A_i - \phi^D D_i > 0$), an interest rate cut would lead to a smaller amount of cash flows, reducing household expenditures⁷. On the other hand, if the household owns more

⁶This is a strong assumption for the purpose of simplicity since there exists heterogeneity in MPC for different households, as documented by HANK literature (e.g., Kaplan, Moll and Violante, 2018).

⁷As mentioned in the previous sections, if the household is in an upper net saving position and forward-looking, such an interest rate cut may not generate significant consumption deviation (also see Flodén et al., 2020).

debt than assets ($Y_i - C_i + \phi^A A_i - \phi^D D_i < 0$), such an interest rate cut would instead induce a higher consumption expenditure as increased cash flows. Consequently, such a mechanism based on household balance sheets would drive the heterogeneity in consumption responses across households in different net saving positions.

2.4 Data and Empirical Framework

This section describes the household survey data used in this study. Next, I provide a strategy for grouping the households using their balance sheeting information—specifically, the household’s net saving position. Finally, I present my empirical design.

2.4.1 Household Survey Data

Since the primary aim of this chapter is to examine the heterogeneous consumption responses to innovations in unconventional monetary policy across different types of households in Japan, I use administrative household survey data—the Family Income and Expenditure Survey (FIES)—with rich coverage of monthly expenditure and income variables as well as the detailed information on household balance sheets. FIES is a survey conducted monthly by the Statistics Bureau designed to capture actual conditions of households’ income and expenditures. FIES covers a sample of households that are not single students⁸. Besides, FIES provides the demographics of the households—in particular, the age of the household head—which are essential in considering life-cycle effects on the debt positions of households. To obtain the real value, I deflate the expenditure and income variables in the survey using the consumer price index (CPI). The sample covers 2007:M7 to

⁸According to the 2015 Population Census of Japan, such kinds of households take 51.57 million households, which compose 96.5% of all households.

2015:M12 considering information availability⁹ and my focus on the period of unconventional monetary policy.

Then, based on the information on the debt positions of households—specifically, the net saving position—I group the households into two types: (1) those with high levels of debt (lower 20% of net saving position) and (2) those with little debt (upper 20% of net saving position). It is worth discussing one potential concern about this grouping strategy: that the net saving level may not capture the debt position. To address this issue, I show households’ share with outstanding unpaid mortgages among these two types of households. Figure 2.1 shows that about 80% of households with a net saving position in the lower 20% own unpaid mortgages. In comparison, only around 10% of households in the upper 20% own unpaid mortgage debts, which shows that most Japanese households with low net savings are indebted with mortgages.

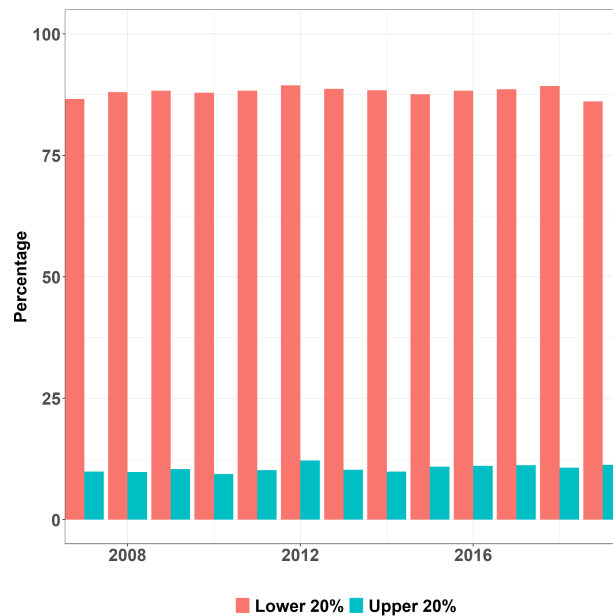


Figure 2.1: Share of households holding unpaid mortgages by net saving positions

Source: FIES

⁹Since the detailed debt position information is not available before the referred date

2.5 Empirical Analysis

2.5.1 Benchmark Framework

This research aims to document the heterogeneous impacts of unconventional monetary policy on the consumption expenditure across different types of households. In this section, I design an SVAR framework, where the choice of variables in the model reflects the setup of the identification of unconventional monetary policy and the estimation's purpose. Let the vector of endogenous variables be defined as

$$X_t \equiv [y_t, \pi_t, mb_t, ex_t, st_t, hp_t, inc_t, c_t]',$$

where y_t denotes the (log) real monthly GDP, π_t the year-on-year change of the CPI, mb_t the (log) monetary base, ex_t the (log) real effective exchange rate, st_t the (log) real stock price index, hp_t the (log) real housing price index, inc_t the (log) real household monthly disposable income, and c_t the (log) real household monthly expenditure. Real consumption and real income represent household-level data, and the rest are used to identify unconventional monetary policy shock.

Specification and Identification

The SVAR model is specified by the following reduced form:

$$A(L)X_t = \varepsilon_t \tag{2.2}$$

where $X_t \equiv [y_t, \pi_t, mb_t, ex_t, st_t, hp_t, inc_t, c_t]'$ is the vector of endogenous variables, $A(L) = A_0 - A_1L - \dots - A_pL^p$ is a matrix of p th polynomial in the lag operator L , and ε_t is a vector of structural shocks.

When considering the unconventional monetary policy, we consequently

encounter the usual reverse causation issue in macroeconomics: economic activities respond to monetary policy innovations, while monetary policy also reacts to macroeconomic changes. To identify unanticipated innovations in the monetary base, the policy variable chosen in this research, a shock series used for estimation is required. Previous literature has already provided many ways to identify monetary policy shocks. Traditional approaches use a recursive (i.e., Cholesky) structure (Christiano, Eichenbaum and Evans, 1999). However, this identification methodology may produce an underestimation of the shocks regarding Japan's case, which leads to a weak effect on economic activities (Michaelis and Watzka, 2017).

Instead of the Cholesky, this chapter identifies the monetary policy shocks by imposing several sign restrictions (Uhlig, 2005). More specifically, I assume that GDP, inflation, housing prices, and stock prices cannot simultaneously respond to unconventional monetary policy shocks. Furthermore, I assume that expansionary monetary policy shocks will not decrease the monetary base, GDP, inflation, household income, housing prices, and stock prices (Musso, Neri and Stracca, 2011; Elenev, 2017; Paul, 2020). Additionally, expansionary monetary policy shocks will not increase the exchange rate. For the objective variable, specifically household consumption, I put no restriction. Therefore, we can summarize the sign restriction for unconventional monetary policy shocks as Table 2.1.

Table 2.1: Identify expansionary monetary policy shocks

	y_t	π_t	mb_t	ex_t	s_t	hp_t	inc_t	c_t
Sign	↑	↑	↑	↓	↑	↑	↑	-

Notes: The "-" indicates no restriction is imposed.

Source: Author's calculations.

To mitigate the partial identification issue of sign restriction, I also build the endogenous variables into a recursive structure in addition to placing signs. I set the recursive block based on the rule that it is usually better to

order slower-moving variables before fast-moving variables (Bruno and Shin, 2015).

Impulse Responses

The empirical analysis is built on the monthly time series spanning the period from 2007:M7 to 2015:M12. The lag length in the model is set to two, based on the AIC. The sign restrictions are limited by one period.

Figure 2.2 plots the consumption responses with 68% confidence bands for two types of households to expansionary unconventional monetary policy shocks. The shock is measured by one unit shock, which can be interpreted as one percentage point change. We can observe clear evidence of heterogeneous effects across these two types of households. The consumption of households in a lower net saving position—in other words, with comparatively high levels of debt—increases by 0.01–0.03 percentage points and persists for more than two years. On the other hand, households in the upper net saving position—in other words, with little or no debt—exhibit no statistically positive response at all. As shown in the third panel of Figure 2.2, the point estimates suggest that household consumption aggregate responses are actually driven by the households in lower net saving positions or those with higher indebtedness.

As introduced previously, the cash-flow channel can be the potential driving force of this heterogeneity in household expenditure reaction. Following this mechanism, the unconventional monetary policy may directly affect household expenditure via household cash flow changes (see Equation 2.1). If households' debt is packed with short-term rates (e.g., ARMs), the payment cost would drop when there is an expansionary monetary policy shock. Consequently, households' cash flows would increase. If households have many net financial assets or good access to financial markets, such cash flows variations may not generate significant consumption reactions. However, if

households are in a low net saving position, such temporarily increased cash flows from expansionary monetary policy shocks will increase their expenditures.

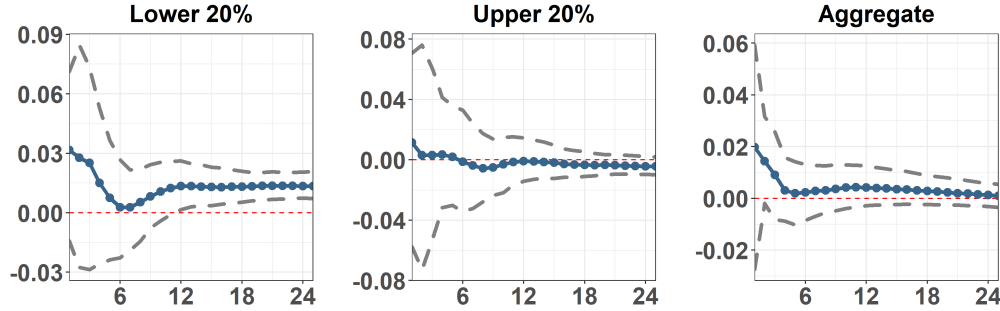


Figure 2.2: Consumption responses by household net saving position: 1% expansionary monetary base shock, SVAR

Notes: Median responses with 68% confidence bands in dashed lines are reported. The vertical axes unit is one percentage point, and the unit of the horizon axes refers to one month.

Source: Author's calculations.

2.5.2 Robustness

Term Spread Shocks

The first experiment to testify the robustness of household expenditure responses' heterogeneity uses an alternative unconventional monetary policy variable, which is the 10-year Japanese government bond yield, to replace the monetary base. To identify the policy shock, referring to the term spread shock, I use a similar method using sign restrictions with recursive structure. Here, I assume that GDP, inflation, housing prices, and stock prices do not simultaneously react to term spread shocks. On the other hand, I assume that expansionary monetary policy shocks will not increase the long-term government bond yield and the exchange rate (Krishnamurthy and Vissing-Jorgensen, 2011). Furthermore, the expansionary monetary policy shock will not decrease GDP, inflation, household income, housing prices, and stock prices. For the objective variable, specifically household expenditure,

I place no restriction. Therefore, we can summarize the sign restriction for these term spread shocks as Table 2.2.

Table 2.2: Identify expansionary term spread shocks

	y_t	π_t	$yield_t$	ex_t	s_t	hpt	inc_t	c_t
Sign	↑	↑	↓	↓	↑	↑	↑	-

Notes: The "-" indicates no restriction is imposed.

Source: Author's calculations.

Figure 2.3 plots the consumption responses of two types of households to an expansionary term spread shock based on SVAR. The shock is measured by one unit shock, which is interpreted as one percentage point changes in term spread. Similar to the baseline estimation, we can also observe clear evidence of heterogeneous effects across these two types of households. The consumption of households in a lower net saving position—in other words, with comparatively high levels of debt—increases by 0.01–0.03 percentage points and persists for more than two years. On the other hand, households in the upper net saving position—in other words, with little or no debt—exhibit no statistically positive response at all. As shown in the third panel of Figure 2.3, the point estimates indicate that the aggregate household consumption responses are mainly driven by the households in lower net saving position or those with higher indebtedness.

Local Projections Estimation

I further test the robustness of the consumption heterogeneity by adopting an alternative methodology, local projections (LPs) introduced by Jordà (2005), to estimate the impulse response functions. Figure 2.4 plots the consumption responses of two types of households to expansionary monetary base shocks based on LPs. The shock is measured by one unit shock, referring to one percentage point change. Similar to the baseline estimation presented previously, we can also observe clear evidence of heterogeneous effects across these two types of households. The consumption of house-

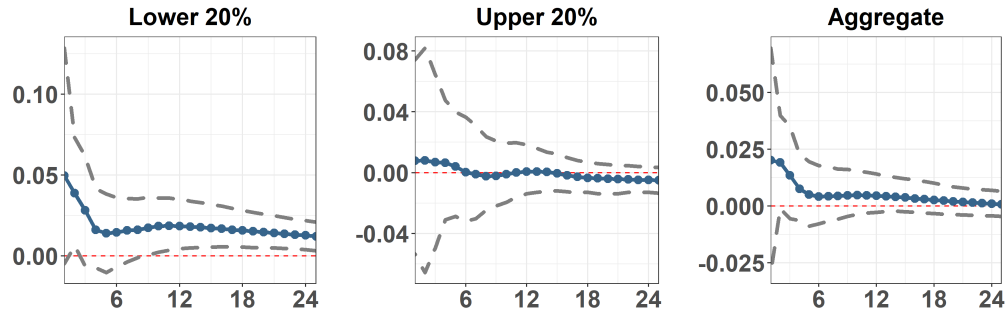


Figure 2.3: Consumption responses by household net saving position: 1% expansionary term spread shock, SVAR

Notes: Median responses with 68% confidence bands in dashed lines are reported. The vertical axes unit is one percentage point, and the unit of the horizon axes refers to one month.

Source: Author's calculations.

holds in lower net saving positions—in other words, with comparatively high levels of debt—peaks by 0.2 percentage points and persistently lasts for more than two years. On the other hand, households in the upper net saving position—in other words, with little or no debt—exhibit no statistically significant responses at all. As shown in the third panel of Figure 2.4, the point estimates indicate that the aggregate responses of household consumption count for half of the households in lower net saving positions or those with higher indebtedness.

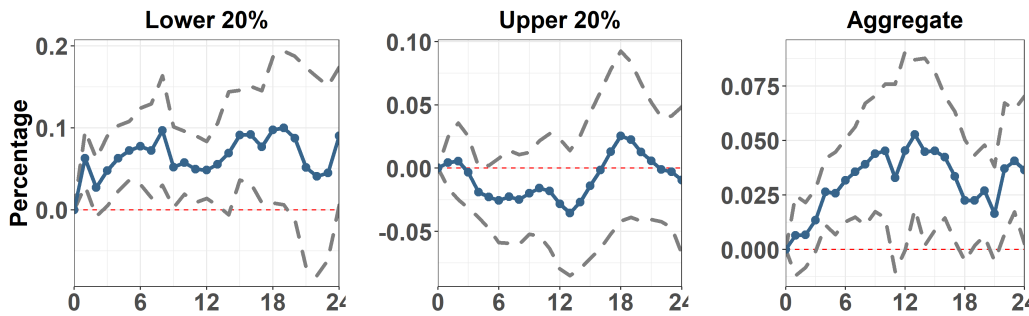


Figure 2.4: Consumption responses by household net saving position: 1% expansionary term spread shock, LPs

Notes: Median responses with 95% confidence bands in dashed lines are reported. The vertical axes unit is one percentage point, and the unit of the horizon axes refers to one month.

Source: Author's calculations.

In summary, in the case of expansionary unconventional monetary policy shocks, the household consumption responses are found to be large and positive for those in lower net saving positions. In contrast, for those in upper net saving positions, such responses are limited and insignificant. Since households in lower net savings or holding housing mortgages compose a relatively large proportion of Japan's population, their reactions towards the unconventional monetary policy shocks may play a vital role in the aggregate policy effects on expenditures. Furthermore, through two separate experiments, my findings on the household heterogeneity in consumption responses are revealed to be robust.

Demographic Controls

One possible concern is that the debt position (or net saving position) grouping is likely to be taken up by life-cycle effects. Given the common sense that younger households are more likely to hold debt than older households (e.g., Flavin and Yamashita, 2002), it is essential to select a more stable age group in comparing the heterogeneous consumption reactions to the monetary policy shock. In this additional experiment, I choose households with household heads aged from 40–49 (from now I call them middle-aged households) since this is the most stable group in our less-than-eight-year sample period, which will not be grouped into either young or old even considering the year effect. Figure 2.5 plots the consumption responses of two types of middle-aged households to expansionary monetary base shocks. We can still observe a clear difference in the responses of expenditures between the two types of households. The consumption of households in a lower net saving position—in other words, with comparatively high levels of debt—peaks by 0.08 percentage points, which is higher than the magnitude of the benchmark model's estimates, and persists for more than two years. On the other hand, similar to the baseline result, households in the upper net sav-

ing position—in other words, with little or no debt—exhibit no statistically positive response at all.

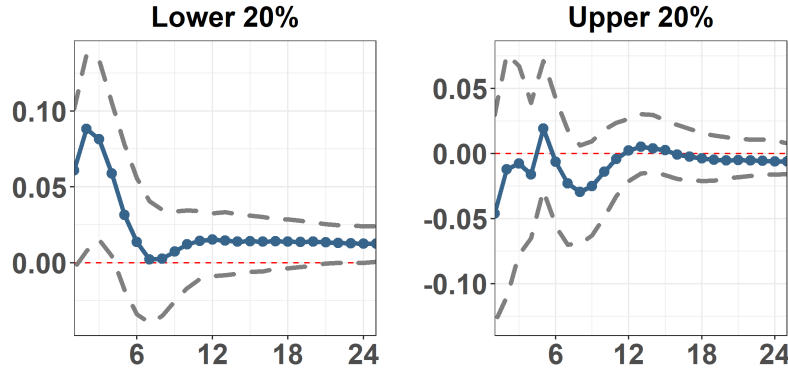


Figure 2.5: Consumption responses by household net saving position: 1% expansionary monetary base shock, household head age between 40 and 49, SVAR

Notes: Median responses with 68% confidence bands in dashed lines are reported. The vertical axes unit is one percentage point, and the unit of the horizon axes refers to one month.

Source: Author's calculations.

Additionally, I examine whether restricting the sample to those young households whose household head age is under 30 (from now I call these young-aged households) would challenge my findings of the consumption heterogeneity. Figure 2.6 plots the consumption responses of two types of households of the young-aged to expansionary monetary base shocks. Interestingly, we see that the clear evidence of the heterogeneity in expenditure responses disappears. Both two types of households respond positively to the expansionary policy changes with a larger magnitude peaking from 0.1 to 0.25 percentage points, compared to the baseline estimates. However, we can not judge that these results would violate my story in explaining the heterogeneity in household expenditures since those young-aged households in the upper net saving position are more likely to be renters or future home-buyers (see Figure B.1), which makes such a group behaves similarly to households in lower net saving position as they have minimal wealth (Campbell and Cocco, 2003; Cloyne et al., 2019).

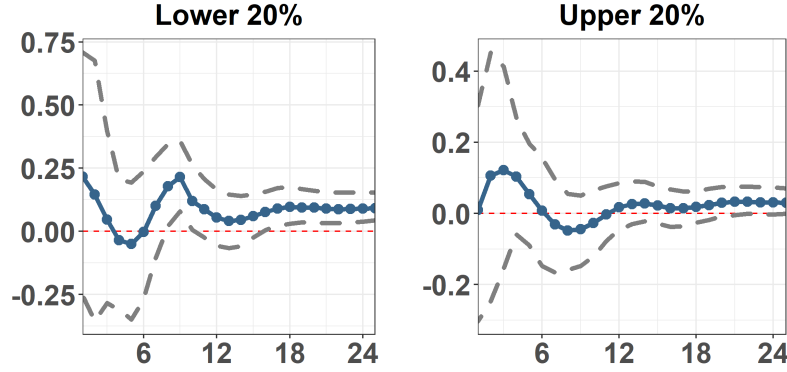


Figure 2.6: Consumption responses by household net saving position: 1% expansionary monetary base shock, household head age under 30, SVAR
 Notes: Median responses with 68% confidence bands in dashed lines are reported. The vertical axes unit is one percentage point, and the unit of the horizon axes refers to one month.

Source: Author's calculations.

On the other hand, if we look at the sample of old households, whose household head age is above 70 (from now I call these old-aged households), the situation becomes the opposite¹⁰. Figure 2.7 plots the consumption responses of two types of households of the old-aged to expansionary monetary base shocks. We find that the clear evidence of the heterogeneity in expenditure responses disappears again. Both types of households respond negatively but not significantly to the expansionary policy changes with a larger magnitude peaking from -0.1 to -0.2 percentage points, compared to the baseline estimates¹¹. These interesting results, similarly, are driven by the balance sheet position of the old-aged households. The old-aged households, for both types of households, own little unpaid mortgage (see Figure B.3), making their balance sheets purely composed of their savings (or with other financial assets). Consequently, the expansionary unconventional

¹⁰In this experiment, I choose the household head age group above 70 instead of 60 due to the concern that housing expenditure as well as mortgages may increase even after age 60 (Yang, 2009), which may violate the assumption that old-aged households hold little debt.

¹¹This can be partially explained by life-cycle effects on consumption (e.g., Ando and Modigliani, 1963).

monetary policy shocks lead to little adjustment in old-aged households' consumption.

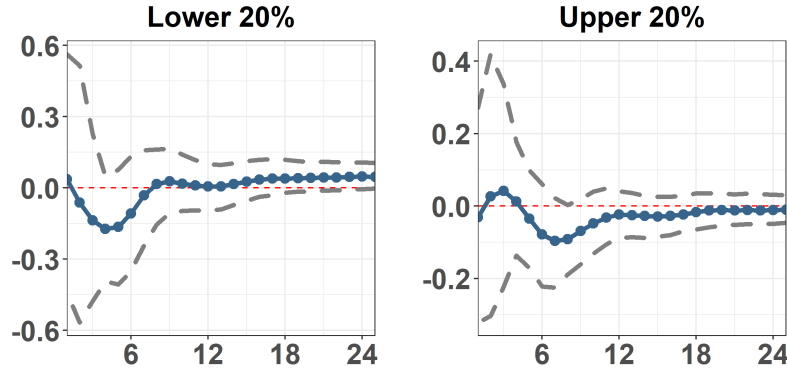


Figure 2.7: Consumption responses by household net saving position: 1% expansionary monetary base shock, household head age above 70, SVAR
Notes: Median responses with 68% confidence bands in dashed lines are reported. The vertical axes unit is one percentage point, and the unit of the horizon axes refers to one month.

Source: Author's calculations.

In summary, I find that the heterogeneity in household consumption responses still holds even after controlling the life-cycle effects by restricting the sample to middle-aged households. Furthermore, the loss of heterogeneous responses in consumption for the young-aged and old-aged groups does not necessarily violate my previous findings but provides alternative aspects to complete the main story of the monetary policy transmission mechanism.

2.5.3 Interpretation of Transition Mechanism

From the results shown in the previous section, I find that households with a different net saving position, regarding their monthly expenditures, respond heterogeneously to the shocks of unconventional monetary policy. Moreover, I also show that these heterogeneous reactions do not come from the demographic factors, specifically the age of household heads, but are driven by the heterogeneity in households' indebtedness, which can be interpreted as the cash-flow as well as net interest rate exposure channel. On the other hand,

some potential channels may drive this heterogeneity other than those mentioned above. To consider the concern that may weaken the importance of the channels I purpose, it is particularly necessary to examine the existence of other mechanisms, which is explored in this section.

I mainly explore two potential channels that may affect my interpretation of the findings. The first is the income effects: if the heterogeneous consumption responses across households are simply the results of heterogeneous reactions of their real income (e.g., expansionary monetary policy shocks only increase the income for households in lower net saving positions)¹². The second channel may come from the so-called wealth effects through the changes in asset prices, specifically stock prices, which may reflect the heterogeneity in consumption responses across different households¹³. However, the analyses shown below will tell how these two channels, at least by themselves, have difficulty fully explaining the heterogeneous reactions of the households' expenditures to the unconventional monetary policy shocks.

Income Effects

Figure 2.8 reports the impulse responses for household disposable income to an expansionary monetary policy shock¹⁴. The responses are plotted with 68% confidence bands. The shock refers to one unit shock, referring to one percentage point changes. The responses indicate that an expansionary monetary policy shock has the typical effects on income described in other literature: temporally increase income by increasing the aggregate demand. The income increases by 0.02–0.03 percentage points at peak for close to six months until the effects substantially perish. In essence, we can see that the income responses are generally similar across two types of households, which implies limited heterogeneity in income changes while households respond

¹²See Auclert (2019) and Slacalek, Tristani and Violante (2020) for details.

¹³See Auclert (2019) and Slacalek, Tristani and Violante (2020) for details.

¹⁴Since the objective variable is household disposable income, I put no sign restriction on it to identify the shock.

heterogeneously in their consumption to unconventional monetary policy innovations. This is important because it shows that the income heterogeneity of households does not drive the heterogeneous consumption responses¹⁵.

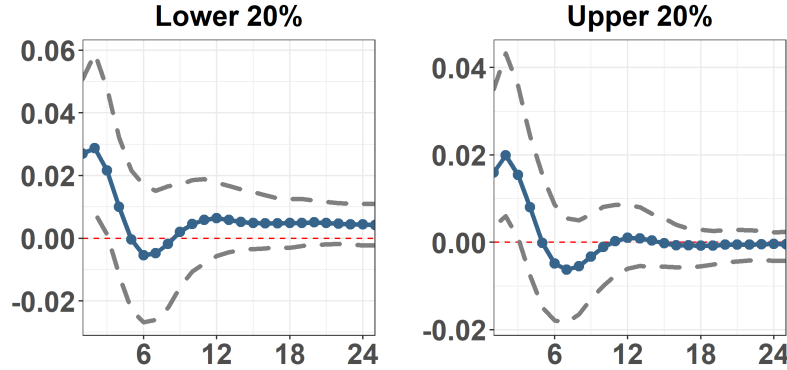


Figure 2.8: Income responses by household net saving position: 1% expansionary monetary base shock, SVAR

Notes: Median responses with 68% confidence bands in dashed lines are reported. The vertical axes unit is one percentage point, and the unit of the horizon axes refers to one month.

Source: Author's calculations.

Wealth Effects

Finally, I examine whether the variations in financial asset prices from unconventional monetary policy shocks generate heterogeneity in households' expenditures. Figure 2.9 plots the impulse responses with 68% confidence bands for household expenditure to a positive stock price shock. The shock is measured by one unit shock, referring to one percentage point changes. The point estimates suggest that the increase in stock prices has a typical wealth effect on household expenditure. The household consumption increases by 0.02–0.03 percentage points at peak for close to six to eight months, until the effects substantially disappear. Importantly, similar to the case of household disposable income, the consumption responses are

¹⁵There is also a concern that the responses of disposable income would also be affected by the tax changes following the monetary shocks (Cloyne et al., 2019). However, for Japan, the tax policies are stable, specifically during my sample period, which only generates a minimal difference between households' gross income responses. The impulse responses for households' gross income are available upon request.

generally similar across two types of households, which suggests that it is doubtful that this wealth effect can explain heterogeneity in household expenditure changes as presented in the previous subsection. This is because, if the wealth effects generated by the increase in stock prices work, there should be significantly larger responses from households with the upper net saving position, particularly for those holding a considerable amount of net financial assets. However, in Figure 2.9, the households with many net financial assets respond almost the same as those with the least amount of financial assets, which indicates that such wealth effects can not be, on their own, the driving factor to explain my estimation results.

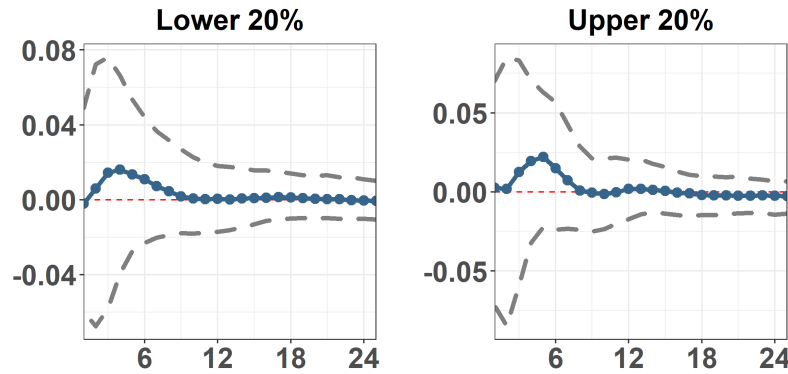


Figure 2.9: Consumption responses by household net saving position: 1% positive stock price shock, SVAR

Notes: Median responses with 68% confidence bands in dashed lines are reported. The vertical axes unit is one percentage point, and the unit of the horizon axes refers to one month.

Source: Author's calculations.

In summary, I find that neither income effects nor additional wealth effects, at least on their own, can explain what I have shown in previous subsections, which further enhances the critical role played by the cash-flow channel in transmitting the unconventional monetary policy shocks.

2.6 Concluding Remarks

Using Japanese household survey data on balance sheet positions and consumption, this chapter provides strong empirical support for the cash-flow channel's crucial role in unconventional monetary policy transmission. Those households in lower net saving positions (with higher debt levels) respond positively and significantly to expansionary monetary policy shocks. On the other hand, households in the upper net saving positions (with low levels of debt) respond insignificantly. This heterogeneity exists even if I control for households' life-cycle effects. Furthermore, I also exhibit that neither income effects nor additional wealth effects, at least on their own, can explain such heterogeneity in household consumption responses.

My findings also enhance the challenge of the prediction work in terms of the effects of unconventional monetary policy in Japan. The results shown in this chapter indicate that predicting the monetary policy's aggregate effect is no longer easy by relying on the conventional intertemporal substitution channel only. The heterogeneity in household balance sheets makes such aggregate effects complicated.

Chapter 3

Housing Wealth, Mortgage, and Self-employment Transitions: Evidence from China

3.1 Introduction

This chapter provides evidence that the growth in housing wealth may negatively impact homeowners' self-employment transitions based on the experiment in China. Previous literature suggests a significantly positive correlation between household assets and the probability of starting a business (Evans and Jovanovic, 1989; Holtz-Eakin, Joulfaian and Rosen, 1994; Paulson and Townsend, 2004). However, the mechanism of such a correlation between wealth and entrepreneurship remains undetermined. Those individuals who experience gains in their wealth have a higher propensity to start their businesses, but it could simply be that individuals feel rich rather than use the increase in collateral wealth to guarantee more loans to invest in businesses. This issue is also significantly important for those policymakers since many public programs that aim to subsidize small and informal firm lending are built on the belief that these firms are constrained in terms of collateral (Schmalz, Sraer and Thesmar, 2017).

Finding rising housing prices in China that covary with the self-employment rate (see Figure 3.1) further motivates me to explore whether this is just a correlation or indicates potential causality. To help shed light on this question, I use the 2010-2018 China Family Panel Studies data, which are nationwide individual-level data including detailed information on homeownership, housing wealth, employment status, and other demographic characteristics, to investigate the relationship between housing wealth gains and self-employment transitions.

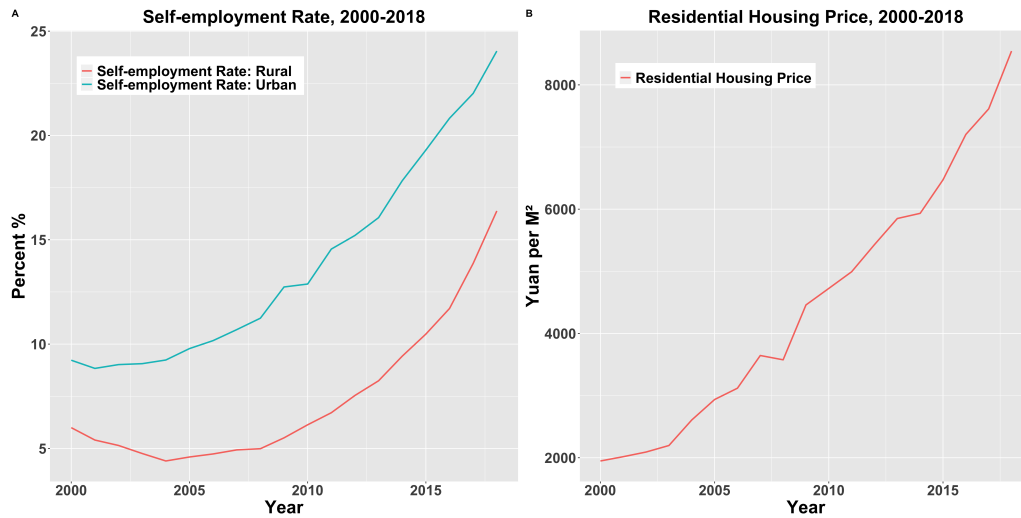


Figure 3.1: Aggregate self-employment rate and residential housing prices in China

Source: National Bureau of Statistics of China

My empirical strategy closely follows Schmalz, Sraer and Thesmar (2017)'s ideas, which compare the probability of becoming self-employed between homeowners and renters. Their idea is that, when there is a rise in housing prices, only those homeowners whose collateral wealth increases can start a business while renters cannot since renters cannot take out a mortgage. However, since renters in China are so different from those in France, as I will explain in later sections, I omit the sample of renters used as a control group in Schmalz, Sraer and Thesmar (2017) and restrict the sample to homeowners.

The initial OLS estimates a regression of housing wealth and past self-

employment status on current self-employment status. I discover that increased housing wealth is positively related to self-employment, as indicated by Figure 3.1. However, this is presumably because self-employed individuals tend to own larger housing properties as the sign reversed once we add other controls. Notably, the inconsistency of the self-employment status for household motivates my consideration of examining self-employment transitions other than current self-employment status. With this consideration and for the purpose of clarifying the mechanism, I add two major extensions: A) transform the self-employment status variable into a self-employment transition variable and B) add a dummy variable and interaction term to identify the potential channel(s) in self-employment transitions.

To better exploit the mechanism, I compare partial homeowners (homeowners with outstanding mortgages) and full homeowners (homeowners without outstanding mortgages) concerning the effect of housing wealth on their self-employment transitions by using the interaction term¹. When facing housing wealth gains, only full homeowners are able to obtain bank loans using their homes as collateral. As I will describe in Section 2, in China, it is almost impossible for partial homeowners to take out a mortgage using their houses. Therefore, we could expect significantly different estimates for full and partial homeowners, respectively, which may be an excellent tool to identify the potential channels.

To interpret the mechanism behind the empirical analysis, I propose four potential channels: A) *wealth effect channel*—For most Chinese households, housing also takes the largest fraction of their total wealth. An increase in housing value will create a wealth effect, which, in turn, raises the probability of choosing self-employment for all homeowners. B) *collateral lending channel*—Rising housing value should raise the probability of starting businesses

¹Schmalz, Sraer and Thesmar (2017) also split the homeowner groups into full and partial homeowners to see the difference when facing housing price inflation while using renters as the benchmark control group.

for full homeowners (homeowners without unpaid mortgages) as they can borrow more from banks. On the other hand, rising housing value may have ambiguous effects on partial homeowners (homeowners with unpaid mortgages) since they do not have access to the banking loan based on the Chinese institution. C) *crowd-out channel*—Facing the housing market boom, full homeowners may increase their borrowings from the banks against the increased housing wealth they have and use these extra borrowings to invest in the housing market, which will definitely decrease the chance of using banking borrowings to start a business. D) *portfolio choice channel*—Mortgage debt diminishes the likelihood of choosing self-employment for those partial homeowners by amplifying risk aversion.

Consistent with the *crowd-out channel*, I observe that increases in housing wealth lead to a lower propensity for homeowners to become self-employed. The point estimates suggest that a 10% increase in homeowners' housing value reduces their probability of choosing self-employment by 0.53–0.58 percentage points. Moreover, my estimates also show that a 10% increase in housing wealth further reduces the probability of choosing self-employment for partial homeowners by 0.38–0.49 percentage points, suggesting a *portfolio choice channel*. These estimates are proven to be stable and robust using various research designs, including instruments for housing wealth generated from average province housing prices and variation in housing supply elasticity.

This chapter contributes to the literature on housing wealth and self-employment. Previous literature focuses on the linkage between household wealth and business creation, development, or life-cycle, such as Hurst and Lusardi (2004); Li and Wu (2014); Adelino, Schoar and Severino (2015); Harding and Rosenthal (2017); Schmalz, Sraer and Thesmar (2017); and Bracke, Hilber and Silva (2018), which are close to my chapter. I complete these studies in three major aspects. First, the detailed individual-level homeownership

and housing wealth information from the CFPS data allow me to directly estimate how homeowners' housing wealth changes affect their propensity for self-employment, thus improving identification. Second, the comparison of full versus partial homeowners allows me to distinguish the potential channels from traditional wealth effects. Last, by using China as an experiment, this chapter also sheds light on rising concern about the potential adverse impact of surging housing prices on self-employment in developing economies.

The remainder of the chapter is structured as follows. Section 2 outlines the Chinese institutional background. Section 3 provides a set of potential channels for my empirical framework, illustrating how the rising housing value affects the individuals' self-employment decisions. Section 4 then provides details on the data I use in the analysis. Section 5 describes my empirical analysis. Section 6 concludes.

3.2 The Mortgage Market in China

The Chinese mortgage market is rapidly growing while comparatively elementary. According to Koss and Shi (2018), China's mortgage debts have been growing rapidly over the past ten years. Total mortgage debts guaranteed by the land rose from 2009 through 2015 with an average rate of 30.1% and reached 11.3 trillion yuan around 2015, which is about four times those mortgage debts in 2009. On the other hand, based on the statistic in 2016, the residential mortgage debt to GDP ratio in China stands at only 25% of GDP, which is low compared to the real estate finance sector in advanced economies.

The typical mortgage contract in China is an adjustable-rate loan designed with a maturity duration of 5 to 30 years². Notably, the Chinese mortgage

²5-year maturity for business purposes, 10-year maturity for personal consumption purposes, and 30-year maturity for residential purposes.

market gives a minimal chance of withdrawing home equity and obtaining second lien loans. Consequently, the collateral lending channel in China does not work through business owners financing their investment by receiving second mortgages: only those homeowners with no outstanding mortgage (here defined as full homeowners) can use their owned housings as collateral; those homeowners who still need to repay their remaining mortgage debts (here defined as partial homeowners) cannot. This unique background indicates that the collateral lending channel (if present) in China may only work for full homeowners.

Although not highly developed, the influence of housing wealth on the real economy has the potential to be potent in China. One important reason is that homeownership is widespread in China. In Figure 3.2, we can observe that, though experiencing a decline in the past eight years, the homeowner-ship rate is still at a high level around 80%³ compared to that in the United States (64.8% in 2017)⁴. Moreover, there is one huge difference between China and the United States; about 98%⁵ of Chinese homeowners fully own their houses while, in the United States, the number is only about 32% (Schmalz, Sraer and Thesmar, 2017).

3.3 Potential Channels

3.3.1 Portfolio Choice Channel

My analysis rests on recent models in occupation choice with housing, which examine how owner-occupied housing affects the household's risk-taking behaviors in their financial portfolios. The specification distinguishes between housing wealth and mortgage debts, stemming from Chetty, Sándor and

³According to the Survey and Research Center for China Household Finance, the homeownership rate is extremely high (e.g., 92.8% in 2017).

⁴Source: U.S. Census Bureau

⁵Averaged full homeownership rate during 2010 to 2018 is calculated by excluding the homeowners who have outstanding unpaid housing mortgages using the sample of China Family Panel Studies.

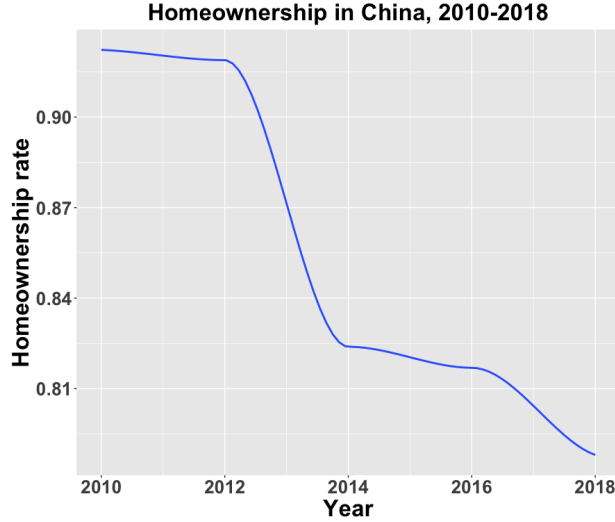


Figure 3.2: Average homeownership rate in China, 2010–2018
Source: China Family Panel Studies, 2010–2018

Szeidl (2017). Bracke, Hilber and Silva (2018) develop Chetty, Sándor and Szeidl (2017)’s framework considering the effect on an agent’s self-employment choice from the changes of its owned housing wealth and mortgage debt. According to their model’s assumption, an agent will become self-employed if the benefit of self-employment is above a certain threshold Φ^* , which can be summarized as⁶:

$$\Phi^* = Z\left(\frac{(1-\gamma)^2}{2}\alpha_Y[\alpha_Y\sigma_S^2 + 2(\alpha_H - \mu)\sigma_{SH}]\right) \quad (3.1)$$

where function $Z(\cdot)$ has a positive sign that guarantees the change of Φ^* is only determined by elements in $Z(\cdot)$, γ refers to the risk aversion, σ_S^2 is the variance of self-employment income, σ_{SH} is the covariance between housing prices and self-employment income, α_Y is the labor income share in total wealth, α_H is the housing value share in total wealth, and μ is the parameter representing the proportion of the income spent on housing consumption.

Regarding the intuition behind Equation 3.1, first, a rise in risk aversion γ results in a higher threshold Φ^* since, if self-employment income be-

⁶See Bracke, Hilber and Silva (2018) for details.

comes more volatile (larger σ_S^2), only the individuals who enjoy high-income premium will choose to start a business. Second, the threshold Φ^* also rises if labor income takes a larger proportion of wealth (higher α_Y), which results in a higher cost of self-employment income volatility. Instead, change in the housing price risk σ_{SH} has an ambiguous impact on the choice of self-employment. On one hand, larger σ_{SH} leads to a rise in the portfolio's general risk and, hence, reduces the propensity to be self-employed⁷. On the other hand, as individuals have to spend on housing consumption in the initial period ($\mu > 0$), self-employment may serve as security against the cost of housing with a hedging effect (Sinai and Souleles, 2005; Han, 2008)⁸.

Based on this setting, I now turn to the impact of exogenous increases in housing value in the initial period on the self-employment decision. More precisely, following Chetty, Sándor and Szeidl (2017) and Bracke, Hilber and Silva (2018), I focus on a positive change in housing value keeping liquid wealth constant, which corresponds to increases in the wealth contributed by housing. Additionally, it is crucial to investigate the effect of increases in housing value for homeowners with or without mortgages separately. As explained later, this mechanism predicts a strict negative effect of housing value increases for partial homeowners compared to an ambiguous effect for full homeowners.

For full homeowners, as shown in Equation 3.1, an increase in housing value, on one hand, decreases α_Y , reducing the risk correlated with labor income. On the other hand, it promotes a rise in the housing share of wealth α_H , leading to a riskier overall portfolio position. This makes the predictive effect on self-employment ambiguously signed (Bracke, Hilber and Silva, 2018). For partial homeowners who own unpaid mortgages, an increase in

⁷Davidoff (2006) documents that people should own less property if their incomes positively correlate with housing prices.

⁸Sinai and Souleles (2005) document that people tend to buy houses when rent becomes volatile. On the other hand, Han (2008) shows that housing can be treated as a hedge for future housing prices.

housing value in the beginning will also increase the amount of mortgage they need to pay⁹. Since the mortgage is paid with a higher mortgage rate instead of the risk-free interest rate, a rise in initial mortgage debt reduces lifetime wealth. With lower wealth levels, the variability of self-employment income becomes higher as the share of labor income in total wealth increases, which generates a negatively signed prediction for the likelihood of being self-employed. These two different responses from full and partial homeowners give rise to the idea of a **portfolio choice channel**.

Portfolio choice channel: *Past housing wealth gains negatively affect self-employment choice for partial homeowners while ambiguously affecting full homeowners.*

3.3.2 Other Channels

If we consider the traditional setting with housing as collateral without portfolio consideration, rising housing value should raise the probability of starting businesses for full homeowners as they can borrow more from banks. On the other hand, rising housing value may have ambiguous effects on partial homeowners since they do not have access to a bank loan. These two different responses from full and partial homeowners give rise to the **collateral lending channel**.

Collateral lending channel: *Past housing wealth gains positively affect self-employment choice for full homeowners while not affecting partial homeowners.*

For most Chinese households, housing also takes the largest fraction of their total wealth. An increase in housing value will create a wealth effect, which, in turn, raises the probability of choosing self-employment for both full and partial homeowners.

⁹Though consistent with the setting of Bracke, Hilber and Silva (2018) that the mortgage is predetermined, I further assume that the amount of mortgage debt is tied to housing value.

Wealth effect channel: *Past housing wealth gains positively affect self-employment choice for both full homeowners and partial homeowners.*

The last potential channel I propose is motivated by recent research from Chen and Wen (2017). Their model indicates that rapid growth in housing prices may crowd out investment in the capital since the return from investment in real estate markets is higher than in the non-real-estate sector. They also point out that many non-real estate firms in China invest in housing markets unrelated to their primary business. Furthermore, they document that the growth rate of real estate investment covaries positively with housing prices while the investment in non-real estate sectors indicates the opposite. Moreover, they state that fast-growing housing prices can be a potent indicator of future investment decreases in those non-real-estate sectors. Consequently, this crowd-out effect may also exist among full homeowners since optimal individuals will choose to invest in the high-return sector, lowering their incentive to start their own business. Facing the housing market boom, full homeowners may increase their borrowings from the banks against the increased housing wealth they have and use these extra borrowings to invest in the housing market, which will definitely decrease the chance to use banking borrowings to start the businesses. On the other hand, since partial homeowners with the tighter balance sheet do not have access to the banking loan, this crowd-out effect may be less than for full homeowners. This gives rise to the **crowd-out channel**.

Crowd-out channel: *Past housing wealth gains negatively affect self-employment choice for full homeowners while weakly affecting partial homeowners.*

Therefore, we can summarize potential channels with the following table:

Channels	Housing value \times full homeowners	Housing value \times partial homeowners
Portfolio choice	ambiguous	\downarrow
Collateral lending	\uparrow	no
Wealth effect	\uparrow	\uparrow
Crowd-out	\downarrow	weak

Table 3.1: Identification of channels: based on the effects of past housing wealth gains on full and partial homeowners

Source: Author's calculations

3.4 Data and Descriptive Statistics

3.4.1 Data

To examine the effect of housing wealth on the self-employment transition, I use consecutive yearly waves (a two-year gap between each survey) of the China Family Panel Studies (CFPS) from 2010 to 2018, which, in several aspects, is similar to the Panel Study of Income Dynamics. The CFPS presents nationwide (covering 25 provinces of China) individual-level panel survey data, which allows me to observe self-employment transitions. The CFPS data contain a detailed set of demographic information about survey respondents such as gender, marriage, education, employment status, and personal income and family information like homeownership, liquid assets, housing assets, and mortgage debt, which are critical for my empirical analysis. To give further information to show the representativeness of CFPS data for China's economy, using the CFPS from 2010–2018, I plot the time series of the average self-employment rate and the average housing wealth ¹⁰ (see Figure 3.3), which can be compared with Figure 3.1, where nationally aggregate data are used. Though the magnitude is different from the national aggregate data, CFPS still reports a similar trend of rising self-employment and housing wealth (prices), which gives confidence that this research may provide policy implications from a more aggregate perspective.

¹⁰The average housing wealth is the wealth of the family's current living house.

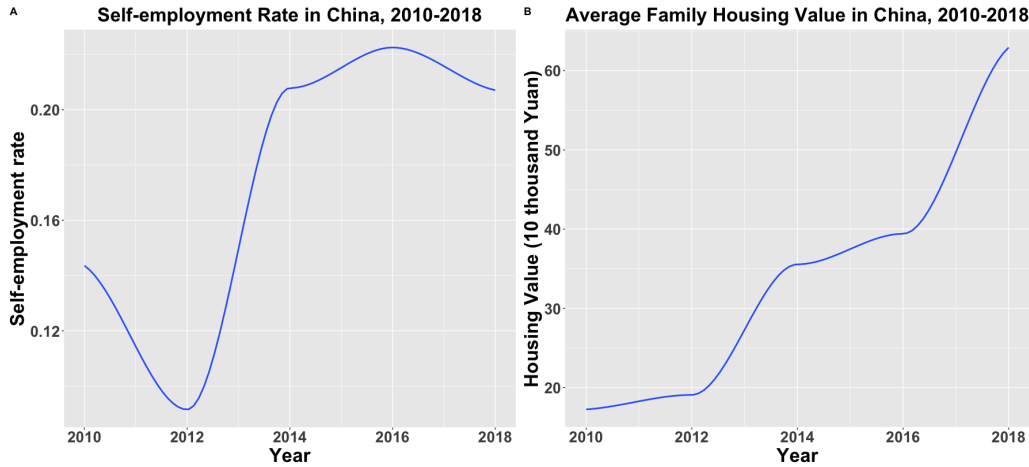


Figure 3.3: Average homeownership rate and average housing wealth in China, 2010–2018

Source: China Family Panel Studies, 2010–2018

I restrict the sample to individuals who are currently working with ages ranging from 18 to 64 since I am only interested in the transition into and out of being self-employed. Another reason is that, in China, only individuals who are currently employed or have a stable income with ages ranging from 18 to 64 can take out mortgages from banks. For this chapter, as explained in the Introduction section, I only keep the sample of individuals with homeownership.

I also restrict the sample to household heads. However, CFPS data do not provide specified information to identify which individual is the household head (except the data for 2010). Instead, I choose the individual who is most familiar with the family’s economic condition as the household head. Though this may generate bias in the definition of household head, those who know the most about the family economic condition should be the primary decision-makers regarding whether to be self-employed or not. The characteristics of household heads will be summarized in the next subsection.

3.4.2 Descriptive Statistics

Table 3.2 shows descriptive statistics on homeowners' characteristics as well as their housing wealth and self-employment status. The sample contains 23,156 observations, which correspond to the homeowners surveyed between 2010 and 2018. Of the sample respondents, only 10.4% have unpaid housing mortgages, partly reflecting the underdeveloped mortgage market situation in China. The current housing wealth is based on the current living housing wealth owned by household heads, and its average wealth is 212,235 Yuan (deflated based on constant price in 2010). On the other hand, there is also a substantial heterogeneity between households' housing wealth. The standard deviations of reported variables are large, which further indicates the heterogeneity across households.

The average age of household heads is about 44 years old, 64.2% are male, 89.1% are married, and the average number of family members is about four. The average liquid wealth, mainly composed of deposits, is about 31,890 Yuan. Also, 12.1% of household heads have a diploma above the high school degree, and the average personal income of the household head is about 51,080 Yuan. Finally, the primary outcome variable I focus on is the self-employment status of household heads. The average current year self-employment rate is about 15.2%. The reported self-employment rate in China is higher than that in advanced economies such as the United States (e.g., 6% in 2018), Japan (e.g., 10% in 2018), and Germany (e.g., 9.9% in 2018)¹¹, which again indicates the potential importance of studying the relationship between housing wealth and self-employment in China.

¹¹Source: OECD Database

Table 3.2: Descriptive statistics for homeowners

Variable	Obs.	Mean	Std.Dev.
Real housing value (current year, 10,000 RMB)	23,156	21.235	49.744
Self-employment (dummy)	23,156	0.152	0.359
Mortgage (dummy)	23,156	0.104	0.306
Liquid wealth (10,000 RMB)	23,156	3.189	9.127
Individual income (household head, previous year, 10,000 RMB)	23,156	5.108	3.922
Marriage (household head, dummy)	23,156	0.891	0.311
Male (household head, dummy)	23,156	0.642	0.479
Age (household head)	23,156	44.12	10.250
Family size	23,156	3.893	1.689
Higher education (household head, dummy)	23,156	0.121	0.326

Notes: Variables of real housing value, liquid wealth, and individual income are deflated based on constant price in 2010.

Source: Authors' calculations.

3.5 Empirical Analysis

This section outlines my empirical design for addressing issues that have challenged the literature to date and spotlight the assumptions that affect how to interpret my estimation results. I mainly estimate three sets of regressions for self-employment transitions, addressing each practice's issues and advantages.

What we must address again is that these models are estimated only over homeowners. Like Schmalz, Sraer and Thesmar (2017), previous work tries to identify the housing collateral channel by comparing the different responses between homeowners and renters when facing housing price inflation as renters cannot engage in the mortgage market. However, such an identification approach needs a solid assumption that renters are not affected by housing price inflation. Though Schmalz, Sraer and Thesmar (2017) argue that housing rents in France are relatively stable compared to housing prices, this is certainly not the case in China. In China, monthly housing rents typically increase with housing prices. Consequently, a rise in housing

prices is likely to increase homeowners' wealth while raising rental costs for non-homeowners. Also, in China, renters tend to save for down payments when preparing a future home purchase, which is mostly correlated with the housing price movement. As suggested by previous work such as Li and Wu (2014), China's rising housing prices discourage renters from starting a business. Another reason is that, compared to renters, homeowners are more likely to be exposed to housing price volatility (Harding and Rosenthal, 2017; Bracke, Hilber and Silva (2018)). Therefore, considering the above issues, instead of using renters as the control group as is traditional, I only focus on the estimation based on homeowners.

3.5.1 Basic Model

Based on the setting described above, my initial model examines the relationship between housing wealth and individuals' self-employment, which is described as follows:

$$\begin{aligned} SelfEmp_{i,j,t} = & \alpha_1 HousingWealth_{i,j,t} + \alpha_2 SelfEmp_{i,j,t-1} \\ & + \alpha_3 Control_{i,j,t} + \theta_t + \gamma_j + \epsilon_{i,j,t} \end{aligned} \quad (3.2)$$

where $SelfEmp_{i,j,t}$ is a dummy variable equal to 1 if the household head i living within province j is self-employed at surveyed year t , $HousingWealth_{i,j,t}$ is the logged housing wealth at year t owned by household head i living within province j , $SelfEmp_{i,j,t-1}$ is the one-survey lagged dummy variable equal to 1 if household head i living within province j is self-employed, and $Control_{i,j,t}$ contains the demographic information of household head i living within province j at surveyed year t , which includes logged liquid wealth, logged personal income, age, age squared, gender, marital status, high education dummy, and the family size. Finally, the time effects and province fixed effects, which are included to control the unobserved variables within

a province the individual lives in as well as national variation, are captured by the vector measured by θ_t and γ_j , respectively.

In column (1) of Table 3.3, I report estimates based on the OLS regression of the housing wealth and past self-employment status on current self-employment status without any control. Consistent with the co-movement shown in Figures 3.1 and 3.3, I found an increase in housing wealth is positively associated with self-employment. This is presumably because self-employed individuals tend to own larger housing properties. Additionally, we can see that current self-employment has a significantly positive correlation with past self-employment. If household heads were self-employed two years ago, they have a 53% higher probability of becoming self-employed than those who were not.

In column (2), I try to somehow consider those omitting factors by including controls including liquid wealth, personal income, age, gender, marital status, high education dummy, and family size as well as the time effects and province fixed effects¹². The inclusion of these controls significantly reduces the coefficient of housing wealth and makes the sign negative. Moreover, instead of the previous positive sign, the coefficient on past self-employment reverses to -37% , which indicates that past self-employed people have a lower propensity to be self-employed in the future.

Notably, the inconsistency of the self-employment status for household motivates my consideration of self-employment transitions instead of current self-employment status. With this consideration, as well as the purpose of clarifying the mechanism, I add two major extensions of the model in Equation 3.2: A) transform the self-employment status variable into a self-employment transition variable and B) add a dummy variable and interaction term to identify the potential channel(s) in self-employment transitions.

The new framework studies those household heads who may transition into

¹²These controls are standard and are also used in later analyses.

Table 3.3: Housing wealth and self-employment

	Self-employment	
	(1)	(2)
Real housing value (log)	0.072*** (0.018)	−0.032*** (0.009)
Past self-employment	0.527*** (0.018)	−0.367*** (0.073)
Controls	No	Yes
Province Fixed Effects	No	Yes
Time Fixed Effects	No	Yes
Observations	23,156	23,156
R-squared	0.799	0.193

Robust standard errors in parentheses.

***Significant at the 1% level.

**Significant at the 5% level.

*Significant at the 10% level.

Source: Authors' calculations.

and out of self-employment from time $t - 1$ to t . I also add a dummy variable for the partial homeowners, which refers to those household heads who hold unpaid mortgage debt. Using this partial-homeowner dummy, I build an interaction term with housing wealth to identify whether this is a significant difference between partial and full homeowners (homeowners without outstanding mortgages) regarding the effect of increased housing wealth on self-employment transition. Such extension is critical as we may not be able to distinguish the potential channels by simply looking at the estimation results over the whole sample of homeowners. For example, even if homeowners observe positive effects of housing wealth gains on the probability of becoming self-employed, the potential channels may be concealed by aggregate effects. Using the partial-homeowner interaction term, I can provide an additional tool consistent with a particular channel but difficult to reconcile with other interpretations.

One of the concerns in using partial homeowners as a comparison group is whether partial and full homeowners witness similar housing wealth growth

trends. If the trends are different, the comparison of the interaction term may no longer be able to identify the mechanism while biased by other factors unrelated to potential channels. However, from the time series of housing wealth owned by full and partial homeowners in Figure 3.4, we can find that both groups face a paralleled growth trend in housing wealth.

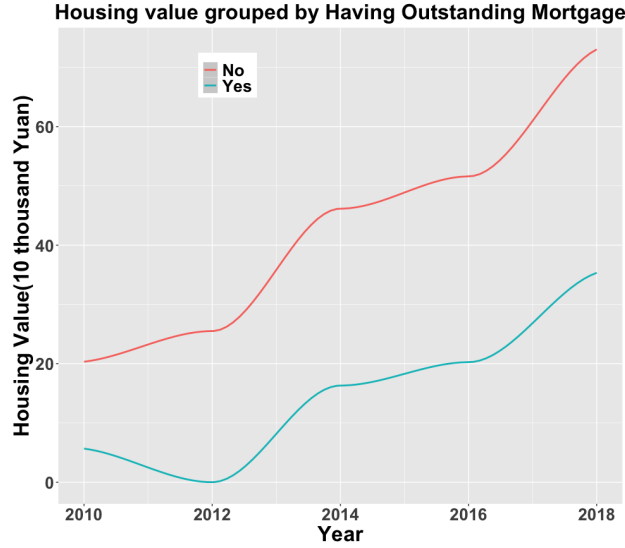


Figure 3.4: Average housing wealth: full vs. partial homeowners, 2010–2018
Source: China Family Panel Studies, 2010–2018

Following the above discussion, the extended model can be given as Equation 3.3 below.

$$\begin{aligned}
 Enter_{i,j,t} = & \beta_1 HousingWealth_{i,j,t} + \beta_3 Partial + \beta_4 Partial \times HousingWealth_{i,j,t} \\
 & + \beta_5 Control_{i,j,t} + \theta_t + \gamma_j + \epsilon_{i,j,t}
 \end{aligned}
 \tag{3.3}$$

where $Enter_{i,j,t}$ is a dummy variable that equals 1 if an employee i living within province j and surveyed in time $t - 1$ becomes self-employed at time t ; $Partial_{i,j,t}$ is a dummy variable, which equals 1 when the household head has an outstanding unpaid mortgage; $Partial \times Housingwealth_{i,j,t}$ is an interaction term to capture the difference in the effects of increased housing wealth on self-employment transition between partial and full homeowners;

and the rest of the variables remain the same as those mentioned in Equation 3.2.

Column (1) in Table 3.4 presents the estimates of the effect of housing wealth gains on the likelihood of transition into self-employment from the status of being an employee. We can see that housing wealth gains significantly decrease the probability of the household head becoming self-employed. A 10% increase in housing wealth will decrease the probability of becoming self-employed by 0.38% at a 5% level. Also, the dummy variable of partial homeowners does not show any significant estimation, which indicates that there is no significant difference in the propensity to become self-employed between partial and full homeowners. Last, the interaction term tells us that the homeowners who have an outstanding mortgage have a 0.27% smaller probability of becoming self-employed than those without an outstanding mortgage even if they face the same 10% increase in housing wealth. Therefore, the results in column (1) are inconsistent with interpretations from the *wealth effect channel* or *collateral lending channel* of housing wealth gains, instead representing the *portfolio choice channel* and *crowd-out channel*. Mortgage debt diminishes the likelihood of choosing self-employment for those partial homeowners by amplifying risk aversion. On the other hand, full homeowners will choose to invest in high-return sectors such as housing markets, lowering their incentive to start their own business. These results are not entirely inconsistent with the conclusion suggested by Mian and Sufi (2011) that more leveraged households are more likely to borrow because of different institutional backgrounds between the United States and China.

To capture the unobserved individual factors that may simultaneously determine occupational choice and tenure status, column (2) reports the estimates with extra control of individual fixed effects. The coefficients on housing wealth and the interaction term become larger, and the signs remain consistent.

Table 3.4: OLS estimates

	Transition to self-employment	
	(1)	(2)
Real housing value (log)	-0.038** (0.016)	-0.068** (0.036)
Partial homeowner	0.002 (0.071)	0.007 (0.031)
Partial homeowner × Real housing value (log)	-0.027*** (0.008)	-0.037*** (0.011)
Controls	Yes	Yes
Province Fixed Effects	Yes	Yes
Time Fixed Effects	Yes	Yes
Individual Fixed Effects	No	Yes
Observations	23,156	23,156

Robust standard errors in parentheses.

***Significant at the 1% level.

**Significant at the 5% level.

*Significant at the 10% level.

Source: Authors' calculations.

However, even if I observe consistent results concerning the effects of housing wealth on the transition to self-employment, I still cannot solve the potential endogenous issue that housing tends to bias such effect. To isolate the exogenous variation in housing wealth, following Chetty, Sándor and Szeidl (2017), I propose the instrumental variable approach in the next subsection.

3.5.2 Instrument Variable

Provincial Housing Prices

To generate exogenous variation in housing wealth, I first propose the instrument: the individual's living province's average housing prices during the current year. An important identification requirement of this instrument is that deviations in average provincial housing prices are not correlated with unobserved factors determining self-employment decisions, conditional on other controls. In assessing this hypothesis's validity, it is crucial to know

that those fixed effects incorporated in the estimation have excluded some bias from omitted variables. In particular, variations in policy rates (at the national level) may directly affect both provincial housing prices and self-employment decisions. Including time (current year) fixed effects may allow me to mitigate such concerns. Correspondingly, by incorporating province fixed effects, those potential biases coming from provincial differences across local housing markets may be accounted for.

Column (1) of Table 3.5 reports first-stage regressions of housing wealth on the instrument (average provincial housing prices). This specification controls for province and time fixed effects. The first-stage estimation shows that higher provincial housing prices strongly indicate higher individual housing wealth. Column (2) in Table 3.5 reports 2SLS estimates of Equation 3.3, where housing wealth is instrumented using the province housing prices. Similarly, I control for all fixed effects, including individual effects. The estimated coefficient of the housing wealth indicates that a 10% increase in the individual's housing value decreases the probability of choosing self-employment by 0.53 percentage points. The estimated coefficient of the interaction term predicts that a 10% increase in housing wealth decreases the probability of choosing self-employment for partial homeowners by 0.49 percentage points more. The estimates using this instrument report a consistent result with previous OLS estimates, which shows that the story interprets these results as sound.

Housing Supply Elasticity

Although fixed effects control the most plausible confounding factors, there is still a potential threat to the instrument's validity using average provincial housing prices. Variations in provincial housing markets can be related to other factors, such as the local labor market's performance (Chetty, Sándor and Szeidl, 2017), directly affecting self-employment decisions. To mitigate such concerns, I attempt to use the instrument built by housing prices at

Table 3.5: IV estimates: average provincial housing prices

	Transition to self-employment	
	(1)	(2)
Real housing value (log)		-0.053*** (0.008)
Partial homeowner		0.005 (0.004)
Partial homeowner \times Real housing value (log)		-0.049*** (0.013)
Provincial housing price (log)	1.995*** (0.059)	
Controls	No	Yes
Province Fixed Effects	Yes	Yes
Time Fixed Effects	Yes	Yes
Individual Fixed Effects	No	Yes
Observations	23,156	23,156

Robust standard errors in parentheses.

***Significant at the 1% level.

**Significant at the 5% level.

*Significant at the 10% level.

Source: Authors' calculations.

the national level, interacted with provincial housing supply elasticity, and produce housing wealth changes. To better understand the intuition behind this strategy, we can consider the case of Beijing, a city with an inelastic housing supply. Suppose there is a national housing demand shock; while only a little housing supply adjustment can be implemented in Beijing, local (provincial) housing prices will vary potentially with housing prices at the national level. More generally, national housing demand shocks, measured by national house prices, have more potent influences on housing prices in those provinces where the elasticity of housing supply is low, which produce differential changes in housing prices across provinces. This strategy's main advantage is that it excludes possible omitted variable bias from provincial economic shocks since provincial housing price deviations are purely driven by the housing demand shocks at the national level, and my time fixed effects control the direct impacts from such shocks.

To achieve this strategy, I interact the national housing prices with provincial housing supply elasticity to build the housing wealth instrument. The index of housing supply elasticity is taken from Wang, Chan and Xu (2012), who construct estimated elasticity based on the idea from Saiz (2010) and Glaeser, Gyourko and Saiz (2008), capturing local geographic constraints as well as policy restrictions in China¹³.

The first column of Table 3.6 reports first-stage regressions of housing wealth on the instrument (housing supply elasticity). This specification controls for province and time fixed effects. Column (1) of Table 3.6 indicates that the increase in national housing prices has significantly smaller impact on housing wealth in provinces where the housing supply elasticity is high.

¹³Since Wang, Chan and Xu (2012) only document the housing supply elasticity in China using the data of 35 major cities, I approximate this city-level elasticity into province-level by assuming the provincial housing market is driven by the market of its capital city as well as its major city (or cities). Though this approach may create a weak instrument issue, my first-step estimation result indicates the IV's validity. Another reason for using this approximation approach is the difficulty of looking at city-level or county-level information of CFPS for confidentiality.

Table 3.6: IV estimates: national housing prices \times housing supply elasticity

	Transition to self-employment	
	(1)	(2)
Real housing value (log)		-0.058** (0.026)
Partial homeowner		0.001 (0.031)
Partial homeowner \times Real housing value (log)		-0.038*** (0.010)
National housing prices \times Housing supply elasticity	-1.206*** (0.018)	
Controls	No	Yes
Province Fixed Effects	Yes	Yes
Time Fixed Effects	Yes	Yes
Individual Fixed Effects	No	Yes
Observations	23,156	23,156

Robust standard errors in parentheses.

***Significant at the 1% level.

**Significant at the 5% level.

*Significant at the 10% level.

Source: Authors' calculations.

Columns (2) of Table 3.6 reports 2SLS estimates of Equation 3.3, where housing wealth is instrumented using national housing prices interacted with the provincial housing supply elasticity. Similarly, I control for all fixed effects, including individual fixed effects. The estimated coefficient of the housing wealth suggests that a 10% increase in an individual's housing value lowers the probability of choosing self-employment by 0.58 percentage points. The estimated coefficient of the interaction term shows that a 10% increase in housing wealth reduces the probability of choosing self-employment for partial homeowners by 0.38 percentage points more. The estimates using this instrument report a consistent result with previous estimates, which again indicates that the story interpreting these results is sound.

3.6 Concluding Remarks

Using the 2010–2018 CFPS data, this chapter characterizes housing wealth’s causal effect on the homeowner’s self-employment transition. I provide robust evidence that an increase in housing wealth reduces homeowners’ propensity to start a business. The point estimates indicate that a 10% increase in housing value reduces the homeowner’s probability of choosing self-employment by 0.53–0.58 percentage points. On the other hand, my estimates show that a 10% housing wealth growth reduces the probability of choosing self-employment for partial homeowners (homeowners with outstanding unpaid mortgage debt) by 0.38–0.49 percentage points more.

My estimates hold in a set of research designs exploiting the exogenous variation in housing wealth from the average provincial housing prices as well as national housing prices interacted with the elasticity of provincial housing supply, the stability of the estimates in the different exercises makes the results quite robust.

My findings suggest that the impacts of housing wealth change on homeowners’ self-employment choice are driven by *portfolio choice channel*—mortgage debt diminishes the likelihood of choosing self-employment for those partial homeowners by amplifying risk aversion—as well as *crowd-out channel*—homeowners will choose to invest high-return sector such as housing markets, lowering their incentive to start their own business.

Finally, this chapter further raises the concern on the negative side of rising housing prices in terms of discouraging self-employment, especially in developing countries with booming housing markets.

References

- Adelino, Manuel, Antoinette Schoar and Felipe Severino (2015). ‘House prices, collateral, and self-employment’. In: *Journal of Financial Economics* 117.2, pp. 288–306 (cit. on p. [51](#)).
- Ando, Albert and Franco Modigliani (1963). ‘The" life cycle" hypothesis of saving: Aggregate implications and tests’. In: *The American economic review* 53.1, pp. 55–84 (cit. on p. [42](#)).
- Aoki, Kousuke, James Proudman and Gertjan Vlieghe (2004). ‘House prices, consumption, and monetary policy: a financial accelerator approach’. In: *Journal of financial intermediation* 13.4, pp. 414–435 (cit. on p. [1](#)).
- Aron, Janine et al. (2012). ‘Credit, housing collateral, and consumption: evidence from Japan, the UK, and the US’. In: *Review of Income and Wealth* 58.3, pp. 397–423 (cit. on p. [3](#)).
- Auclert, Adrien (2019). ‘Monetary policy and the redistribution channel’. In: *American Economic Review* 109.6, pp. 2333–67 (cit. on pp. [26](#), [27](#), [30](#), [31](#), [44](#)).
- Bjørnland, Hilde C and Dag Henning Jacobsen (2010). ‘The role of house prices in the monetary policy transmission mechanism in small open economies’. In: *Journal of financial stability* 6.4, pp. 218–229 (cit. on p. [2](#)).
- Bowman, David et al. (2015). ‘Quantitative easing and bank lending: Evidence from Japan’. In: *Journal of International Money and Finance* 57, pp. 15–30 (cit. on pp. [2](#), [5](#), [6](#)).
- Bracke, Philippe, Christian AL Hilber and Olmo Silva (2018). ‘Mortgage debt and entrepreneurship’. In: *Journal of Urban Economics* 103, pp. 52–66 (cit. on pp. [51](#), [54–56](#), [62](#)).
- Bruno, Valentina and Hyun Song Shin (2015). ‘Capital flows and the risk-taking channel of monetary policy’. In: *Journal of Monetary Economics* 71, pp. 119–132 (cit. on pp. [9](#), [36](#)).
- Calza, Alessandro, Tommaso Monacelli and Livio Stracca (2013). ‘Housing finance and monetary policy’. In: *Journal of the European Economic Association* 11.suppl_1, pp. 101–122 (cit. on p. [29](#)).

- Campbell, John Y and Joao F Cocco (2003). ‘Household risk management and optimal mortgage choice’. In: *The Quarterly Journal of Economics* 118.4, pp. 1449–1494 (cit. on pp. 28, 41).
- Case, Karl E and Robert J Shiller (2003). ‘Is there a bubble in the housing market?’ In: *Brookings papers on economic activity* 2003.2, pp. 299–362 (cit. on p. 21).
- Chen, Kaiji and Yi Wen (2017). ‘The great housing boom of China’. In: *American Economic Journal: Macroeconomics* 9.2, pp. 73–114 (cit. on p. 57).
- Chetty, Raj, László Sándor and Adam Szeidl (2017). ‘The effect of housing on portfolio choice’. In: *The Journal of Finance* 72.3, pp. 1171–1212 (cit. on pp. 53–55, 67, 68).
- Christiano, Lawrence J, Martin Eichenbaum and Charles L Evans (1999). ‘Monetary policy shocks: What have we learned and to what end?’ In: *Handbook of macroeconomics* 1, pp. 65–148 (cit. on pp. 9, 35).
- Cloyne, James et al. (2019). ‘The effect of house prices on household borrowing: a new approach’. In: *American Economic Review* 109.6, pp. 2104–36 (cit. on pp. 27, 29, 41, 45).
- Damjanovic, Tatiana and Sarunas Girdėnas (2014). ‘Quantitative easing and the loan to collateral value ratio’. In: *Journal of Economic Dynamics and Control* 45.Supplement C, pp. 146 –164 (cit. on pp. 6, 7).
- Davidoff, Thomas (2006). ‘Labor income, housing prices, and homeownership’. In: *Journal of urban Economics* 59.2, pp. 209–235 (cit. on p. 55).
- Di Maggio, Marco et al. (2017). ‘Interest rate pass-through: Mortgage rates, household consumption, and voluntary deleveraging’. In: *American Economic Review* 107.11, pp. 3550–88 (cit. on p. 29).
- Eggertsson, Gauti B (2011). ‘What fiscal policy is effective at zero interest rates?’ In: *NBER Macroeconomics Annual* 25.1, pp. 59–112 (cit. on p. 21).
- Eleney, Vadim (2017). ‘Mortgage credit, aggregate demand, and unconventional monetary policy’. In: *Aggregate Demand, and Unconventional Monetary Policy (February 13, 2017)* (cit. on pp. 7, 9, 35).
- Evans, David S and Boyan Jovanovic (1989). ‘An estimated model of entrepreneurial choice under liquidity constraints’. In: *Journal of political economy* 97.4, pp. 808–827 (cit. on p. 48).

- Flavin, Marjorie and Takashi Yamashita (2002). ‘Owner-occupied housing and the composition of the household portfolio’. In: *American Economic Review* 92.1, pp. 345–362 (cit. on p. 40).
- Flodén, Martin et al. (2020). ‘Household Debt and Monetary Policy: Revealing the Cash-Flow Channel*’. In: *The Economic Journal* (cit. on pp. 27–29, 31).
- Galí, Jordi (2015). *Monetary policy, inflation, and the business cycle: an introduction to the new Keynesian framework and its applications*. Princeton University Press (cit. on p. 26).
- Glaeser, Edward L, Joseph Gyourko and Albert Saiz (2008). ‘Housing supply and housing bubbles’. In: *Journal of urban Economics* 64.2, pp. 198–217 (cit. on p. 70).
- Han, Lu (2008). ‘Hedging house price risk in the presence of lumpy transaction costs’. In: *Journal of Urban Economics* 64.2, pp. 270–287 (cit. on p. 55).
- Harding, John P and Stuart S Rosenthal (2017). ‘Homeownership, housing capital gains and self-employment’. In: *Journal of Urban Economics* 99, pp. 120–135 (cit. on pp. 51, 62).
- Holtz-Eakin, Douglas, David Joulfaian and Harvey S Rosen (1994). ‘Sticking it out: Entrepreneurial survival and liquidity constraints’. In: *Journal of Political economy* 102.1, pp. 53–75 (cit. on p. 48).
- Huber, Florian and Maria Teresa Punzi (2020). ‘International Housing Markets, Unconventional Monetary Policy, And The Zero Lower Bound’. In: *Macroeconomic Dynamics* 24.4, pp. 774–806 (cit. on p. 6).
- Hurst, Erik and Annamaria Lusardi (2004). ‘Liquidity constraints, household wealth, and entrepreneurship’. In: *Journal of political Economy* 112.2, pp. 319–347 (cit. on p. 51).
- Iacoviello, Matteo (2005). ‘House prices, borrowing constraints, and monetary policy in the business cycle’. In: *American economic review* 95.3, pp. 739–764 (cit. on pp. 1, 2, 5).
- Iacoviello, Matteo and Stefano Neri (2010). ‘Housing market spillovers: evidence from an estimated DSGE model’. In: *American Economic Journal: Macroeconomics* 2.2, pp. 125–64 (cit. on p. 5).
- Inui, Masayuki, Nao Sudou and Tomoaki Yamada (2017). ‘The effects of monetary policy shocks on inequality in Japan’. In: (cit. on p. 30).

- Jappelli, Tullio and Annalisa Scognamiglio (2018). ‘Interest rate changes, mortgages, and consumption: evidence from Italy’. In: *Economic Policy* 33.94, pp. 183–224 (cit. on p. 29).
- Jordà, Òscar (2005). ‘Estimation and inference of impulse responses by local projections’. In: *American economic review* 95.1, pp. 161–182 (cit. on p. 38).
- Kaplan, Greg, Benjamin Moll and Giovanni L Violante (2018). ‘Monetary policy according to HANK’. In: *American Economic Review* 108.3, pp. 697–743 (cit. on pp. 26, 30, 31).
- Kaplan, Greg, Giovanni L Violante and Justin Weidner (2014). *The wealthy hand-to-mouth*. Tech. rep. National Bureau of Economic Research (cit. on p. 27).
- Kimura, Takeshi and Jouchi Nakajima (2016). ‘Identifying conventional and unconventional monetary policy shocks: a latent threshold approach’. In: *The BE Journal of Macroeconomics* 16.1, pp. 277–300 (cit. on pp. 2, 5, 6).
- Koeda, Junko (2019). ‘Macroeconomic effects of quantitative and qualitative monetary easing measures’. In: *Journal of the Japanese and International Economies* 52, pp. 121–141 (cit. on p. 6).
- Koss, Richard and Xinrui Shi (2018). ‘Stabilizing China’s Housing Market’. In: *IMF Working Paper* (cit. on p. 52).
- Krishnamurthy, Arvind and Annette Vissing-Jorgensen (2011). *The effects of quantitative easing on interest rates: channels and implications for policy*. Tech. rep. National Bureau of Economic Research (cit. on pp. 12, 37).
- Li, Lixing and Xiaoyu Wu (2014). ‘Housing price and entrepreneurship in China’. In: *Journal of Comparative Economics* 42.2, pp. 436–449 (cit. on pp. 51, 62).
- Luetticke, R (2020). ‘Transmission of Monetary Policy with Heterogeneity in Household Portfolios’. In: *American Economic Journal: Macroeconomics* (cit. on p. 26).
- Mian, Atif and Amir Sufi (2011). ‘House prices, home equity-based borrowing, and the US household leverage crisis’. In: *American Economic Review* 101.5, pp. 2132–56 (cit. on p. 66).
- Michaelis, Henrike and Sebastian Watzka (2017). ‘Are there differences in the effectiveness of quantitative easing at the zero-lower-bound in Japan over time?’ In: *Journal of International Money and Finance* 70, pp. 204–233 (cit. on pp. 2, 5, 6, 9, 21, 35).

- Mitman, Kurt (2016). ‘Macroeconomic effects of bankruptcy and foreclosure policies’. In: *American Economic Review* 106.8, pp. 2219–55 (cit. on p. 26).
- Miyao, Ryuzo (2016). *Unconventional Monetary Policies*. Yuhikaku Publishing Co., Ltd (cit. on p. 4).
- Miyao, Ryuzo and Tatsuyoshi Okimoto (2020). ‘Regime shifts in the effects of Japan’s unconventional monetary policies’. In: *The Manchester School* 88.6, pp. 749–772 (cit. on pp. 2, 5, 6, 21).
- Musso, Alberto, Stefano Neri and Livio Stracca (2011). ‘Housing, consumption and monetary policy: How different are the US and the euro area?’ In: *Journal of Banking & Finance* 35.11, pp. 3019–3041 (cit. on pp. 2, 3, 9, 35).
- Nakajima, Jouchi (2011). ‘Time-Varying Parameter VAR Model with Stochastic Volatility: An Overview of Methodology and Empirical Applications’. In: *Monetary and Economic Studies* 29 (cit. on pp. 18, 20).
- Paul, Pascal (2020). ‘The time-varying effect of monetary policy on asset prices’. In: *Review of Economics and Statistics* 102.4, pp. 690–704 (cit. on pp. 5, 6, 9, 35).
- Paulson, Anna L and Robert Townsend (2004). ‘Entrepreneurship and financial constraints in Thailand’. In: *Journal of Corporate Finance* 10.2, pp. 229–262 (cit. on p. 48).
- Piazzesi, Monika and Martin Schneider (2009). ‘Momentum traders in the housing market: Survey evidence and a search model’. In: *American Economic Review* 99.2, pp. 406–11 (cit. on p. 21).
- (2016). ‘Housing and macroeconomics’. In: *Handbook of macroeconomics* 2, pp. 1547–1640 (cit. on p. 1).
- Primiceri, Giorgio E (2005). ‘Time varying structural vector autoregressions and monetary policy’. In: *The Review of Economic Studies* 72.3, pp. 821–852 (cit. on pp. 5, 18–20).
- Saiki, Ayako and Jon Frost (2014). ‘Does unconventional monetary policy affect inequality? Evidence from Japan’. In: *Applied Economics* 46.36, pp. 4445–4454 (cit. on p. 30).
- Saiz, Albert (2010). ‘The geographic determinants of housing supply’. In: *The Quarterly Journal of Economics* 125.3, pp. 1253–1296 (cit. on p. 70).
- Schmalz, Martin C, David A Sraer and David Thesmar (2017). ‘Housing collateral and entrepreneurship’. In: *The Journal of Finance* 72.1, pp. 99–132 (cit. on pp. 48–51, 53, 61).

- Sinai, Todd and Nicholas S Souleles (2005). ‘Owner-occupied housing as a hedge against rent risk’. In: *The Quarterly Journal of Economics* 120.2, pp. 763–789 (cit. on p. 55).
- Slacalek, Jiri, Oreste Tristani and Giovanni L Violante (2020). ‘Household balance sheet channels of monetary policy: A back of the envelope calculation for the Euro Area’. In: *Journal of Economic Dynamics and Control*, p. 103879 (cit. on pp. 26, 27, 30, 31, 44).
- Tzamourani, Panagiota (2019). ‘The interest rate exposure of euro area households’. In: *European Economic Review*, p. 103643 (cit. on p. 29).
- Uhlig, Harald (2005). ‘What are the effects of monetary policy on output? Results from an agnostic identification procedure’. In: *Journal of Monetary Economics* 52.2, pp. 381–419 (cit. on pp. 9, 35).
- Wang, Songtao, Su Han Chan and Bohua Xu (2012). ‘The estimation and determinants of the price elasticity of housing supply: Evidence from China’. In: *Journal of Real Estate Research* 34.3, pp. 311–344 (cit. on p. 70).
- Wu, Jing Cynthia and Fan Dora Xia (2016). ‘Measuring the macroeconomic impact of monetary policy at the zero lower bound’. In: *Journal of Money, Credit and Banking* 48.2-3, pp. 253–291 (cit. on p. 6).
- Yang, Fang (2009). ‘Consumption over the life cycle: How different is housing?’ In: *Review of Economic Dynamics* 12.3, pp. 423–443 (cit. on p. 42).

Appendix A

Appendix for Chapter 1

A.1 Data Sources

Consumption: Quarterly real private consumption time series with seasonally adjusted from Economic and Social Research Institute. Cubic interpolation is implemented to generate monthly time series.

Residential Investment: Quarterly real private consumption time series with seasonally adjusted from Economic and Social Research Institute. Cubic interpolation is implemented to generate monthly time series.

Inflation Rate: Monthly time series from the Bank of Japan Consumer Price Index database, which excludes food and imputed rent. Changes in consumption tax rates have been adjusted.

Monetary Base: Monthly average time series with seasonally adjusted from the Bank of Japan.

Effective Exchange Rate: Monthly real effective exchange rate index from Bank for International Settlements (BIS).

Housing Prices: Monthly time series of the residential property index from Ministry of Land, Infrastructure, Transport and Tourism. Variation from the inflation changes is adjusted.

Housing Loan: Quarterly time series of household housing loan from Bank of Japan. Cubic interpolation is implemented to generate monthly time series. Variation from the inflation changes is adjusted.

10-year Japanese Government Bond Yield: Monthly 10-year government bond yield from the Bank of Japan.

Stock Prices: Monthly time series of the Tokyo Stock Price Index (TOPIX) from Japan Exchange Group. Variation from the inflation changes is adjusted.

A.2 Supplementary Figures

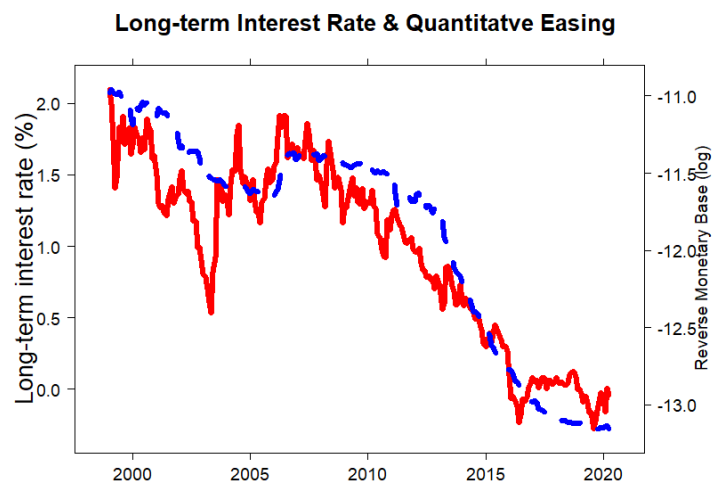


Figure A.1: Long-term interest rate and quantitative easing

Notes: Long-term interest rate refers to the 10-year Japanese government bond yield (red line, left axis), and quantitative easing refers to the reversed (log) monetary base (blue line, right axis).

Appendix B

Appendix for Chapter 2

B.1 Data Sources of Macro-level Variables

GDP: Monthly real GDP time series with seasonally adjusted from Nikkei Needs.

Inflation Rate: Monthly time series from the Bank of Japan Consumer Price Index database, which excludes the food and imputed rent. Changes in consumption tax rates have been adjusted.

Monetary Base: Monthly average time series with seasonally adjusted from the Bank of Japan.

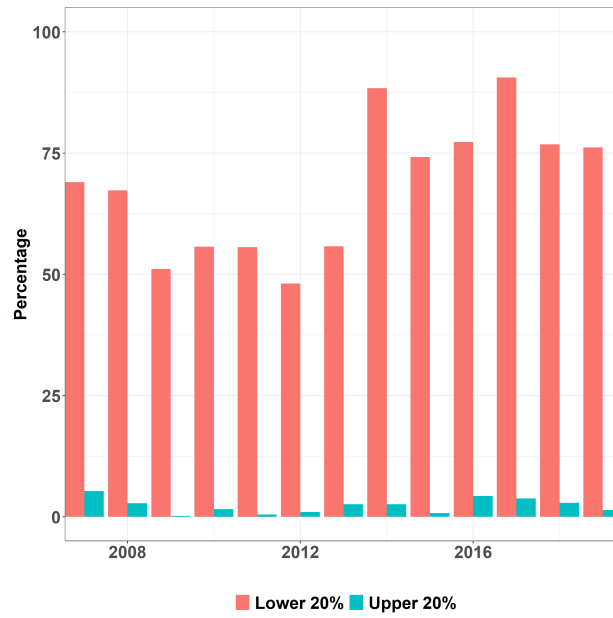
Effective Exchange Rate: Monthly real effective exchange rate index from Bank for International Settlements (BIS).

Housing Prices: Monthly time series of the residential property index from Ministry of Land, Infrastructure, Transport and Tourism. Variation from the inflation changes is adjusted.

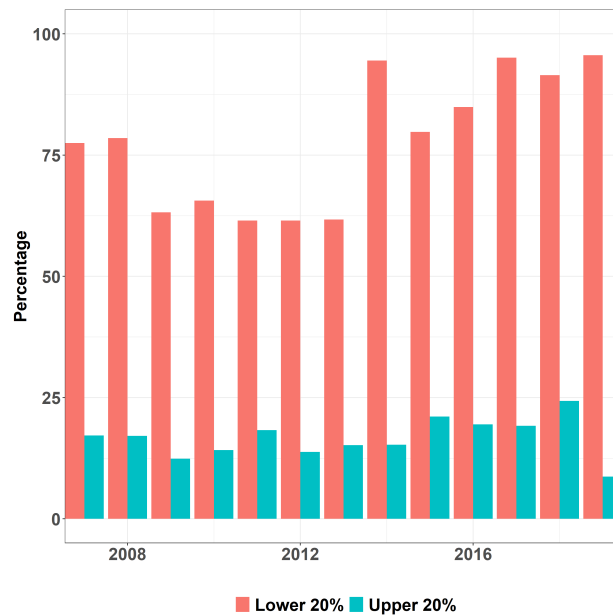
10-Year Japanese Government Bond Yield: Monthly 10-year government bond yield time series from the Bank of Japan.

Stock Prices: Monthly time series of the Tokyo Stock Price Index (TOPIX) from Japan Exchange Group. Variation from the inflation changes is adjusted.

B.2 Supplementary Figures

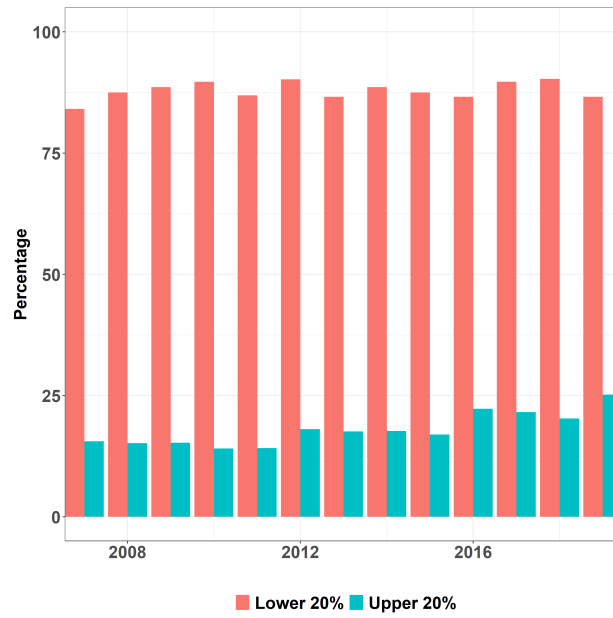


(a) Share of households holding unpaid mortgages



(b) Homeownership rate of households

Figure B.1: Young-aged households by net saving positions
Source: FIES

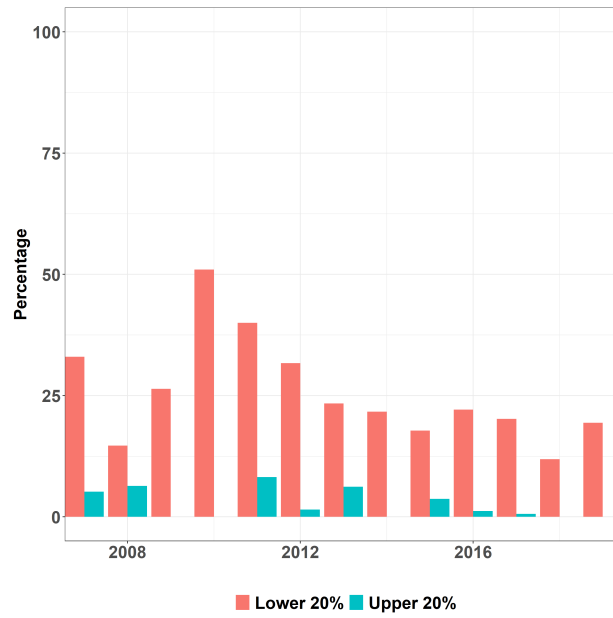


(a) Share of households holding unpaid mortgages



(b) Homeownership rate of households

Figure B.2: Mid-aged households by net saving positions
Source: FIES



(a) Share of households holding unpaid mortgages



(b) Homeownership rate of households

Figure B.3: Old-aged households by net saving positions
Source: FIES