University of Reading

New evidence on housing wealth and consumption channels

Article

Accepted Version

Zhu, B., Li, L., Downs, D. H. and Sebastian, S. (2019) New evidence on housing wealth and consumption channels. Journal of Real Estate Finance and Economics, 58 (1). pp. 51-79. ISSN 1573-045X doi: https://doi.org/10.1007/s11146-017-9638-8 Available at http://centaur.reading.ac.uk/72855/

To link to this article DOI: http://dx.doi.org/10.1007/s11146-017-9638-8

Publisher: Springer

New Evidence on Housing Wealth and Consumption Channels*

Bing Zhu
Real Estate and Planning, Henley Business School
University of Reading
Whiteknights,Reading RG6 6UD
Email: B.Zhu@henley.reading.ac.uk

Lingxiao Li
Department of Finance
Mihaylo College of Business and Economics
California State University, Fullerton
800 N State College Blvd
Fullerton, CA 92834
Email: lingli@fullerton.edu

David H. Downs
The Kornblau Institute & FIRE Department
Virginia Commonwealth University
301 W. Main Street
Richmond, VA 23284
Email: dhdowns@vcu.edu

Steffen Sebastian
IREBS International Real Estate Business School
University of Regensburg
Universitätsstraße 31
93053 Regensburg, Germany
Email: steffen.sebastian@wiwi.uni-regensburg.de

Manuscript version: July 17, 2017.

Acknowledgments: The authors thank Lutz Arnold, Michael LaCour-Little, Gabriel Lee, Andreas Lehnert, Alvaro Mezza, Stanimira Milcheva, Daniel Ringo, Rolf Tschernig, and participants in the Lunch Seminar at the University of Regensburg, the University of Reading, the 7th ReCapNet Conference, the European Real Estate Society Annual Meeting, and the American Real Estate and Urban Economics National Meeting for useful suggestions on previous versions of the paper. Downs acknowledges The Kornblau Institute for support. The authors alone are responsible for any errors.

New Evidence on Housing Wealth and Consumption Channels

Abstract

This paper provides new evidence on the effect of housing wealth on consumption by focusing on the impact of home-equity extraction. We develop a household consumption decision model to illustrate the differential effect of home-equity extraction, relative to net home equity, on consumption. The home-equity extraction channel is also shown to vary with household-level borrowing constraints. Based on U.S. household survey data and an instrumental-variables approach, our empirical results validate model predictions. We find that the marginal propensity to consume is two times higher for the home-equity extraction channel relative to the conventional housing wealth effect. The consumption effect of home-equity extraction is more than 2.5 times greater for liquidity-constrained households than for unconstrained households. These results are even more pronounced in the case of durable goods consumption for constrained borrowers.

JEL codes: E21, R22, G21

Keywords: Consumption; housing wealth; home-equity credit; liquidity constraint

1. Introduction

Housing wealth and its impact on consumption has recently garnered widespread attention in the literature. Two channels that underlie the co-movement between home values and consumption have been studied: the conventional housing wealth effect and the collateral effect. The housing wealth effect suggests that households may feel wealthier as a result of their rapidly appreciating home values and, consequently, spend more on consumption. In contrast, the collateral effect focuses on the role of home equity as loan collateral: Rising home values can impact a household's spending by allowing them to borrow against their home's value via home-equity credit or cash-out refinancing. The goal of our study is to use micro-level data and examine, more explicitly than previous studies, the channels through which housing wealth impacts consumption. In doing so, we present innovative theoretical and empirical evidence. The results of our study enable us to better understand the channels through which housing wealth impacts consumption, as well as the effect of borrowing constraints on these channels.

The literature demonstrates general agreement that fluctuations in house values significantly impact consumption; however, the effect of home-equity extraction is largely unknown. Empirical evidence regarding the housing wealth effect on consumer spending—and the collateral effect in particular—varies significantly, and ranges from virtually no impact to overly large. For example, using Danish household data, Leth-Petersen (2010) studies the impact of an exogenous increase in credit access on total household expenditures using a difference-in-difference method. He finds a statistically significant, yet only moderate, economic impact of the 1992 credit reform that enabled Danish households to use housing as collateral. In contrast, Cooper (2010) examines the influence of households' home-equity extraction on the spending and saving behaviors of U.S. households over the period 1999–2009, and finds that a one-dollar increase in equity extraction increases household expenditures by up to 54 cents.

One challenge with these studies is the endogeneity between home-equity extraction and consumption. Endogeneity can arise from common macroeconomic shocks, financial planning, or both. For instance, good news about the future could lead to a higher level of both equity extraction and consumption and, as a result, appear to have a positive relationship with each other. To address this issue, the difference-in-difference (Leth-Petersen 2010) and Heckman two-stage regression (Hurst and Stafford, 2004) methods have been used in prior studies. In contrast, we use an instrumental-variables (IV) approach to study the impact of extracted home equity on consumption. State-level aggregate refinancing loan supply serves as an IV in the first-stage analysis. Our approach has certain advantages, which we discuss in the next section. We also conduct various robustness checks for instrument validity, including a falsification test. Consequently, our study contributes to the literature by more carefully investigating the relationship between extracted home equity and consumption.

Another issue at stake is identifying to what degree households can extract from their home equity. Previous literature uses both extracted home equity (see, e.g., Hurst and Stafford (2004); Cooper (2010); and Fan and Yavas (2017)) and extractable home equity (see, e.g., Leth-Petersen 2010 and Browning et al. (2013)) as the measurements. Net home equity, which is the home value net of all mortgage indebtedness, provides an estimate of housing equity that can be, but has not been, converted into cash for expenditure. This is the extractable home equity, and it affects consumption by the *perceived* convertibility of home equity into cash. The underlying channel represents the conventional housing wealth effect. On the other hand, extracted home equity is the *realized* home-equity extraction through loan refinancing or other forms of home-equity credit. Extracted home equity is the increase in mortgage indebtedness since the first mortgage, and the expenditure stimulated as a result of this channel represents the collateral effect of home equity. In this paper, we provide new evidence on each of these housing wealth consumption effects (i.e., extracted home equity and extractable home equity). Our analysis is based on a household-level consumption decision model, and our predictions are validated by empirical results.

Our study also seeks to address divergent findings in the literature that may be due to the different borrowing constraints households face. Specifically, we examine how housing wealth effects vary with household-level borrowing constraints. We do this from both theoretical and empirical perspectives. Since the early 2000s, the associated tax benefits of and low interest rates for home-equity loans and lines of credit have contributed to the low cost of home-equity credit, which offers a feasible option for households seeking to smooth consumption during income shortfalls. In contrast, households without borrowing constraints can rely on liquid assets or other forms of credit for consumption. Although home-equity credit rates may appear low, accessing home-equity credit may incur significant costs, such as repayment penalties, closing costs, and lender search costs. For households that have limited access to unsecured loans, consumption is more likely to be financed through home-equity extraction.

Our results, based on household survey data from the Panel Study of Income Dynamics (PSID) for the period 1999–2013, show that extracted home equity significantly increases the marginal propensity to consume (MPC) housing wealth. This effect—i.e., the collateral effect of realized extracted home equity—goes above and beyond the conventional housing wealth effect reflected by the extractable-home-equity-to-consumption channel. For instance, one dollar of extracted home equity is related to about an 8-cent increase in consumption, on average, while a one-dollar increase in extractable home equity is associated with only a 4-cent increase in consumption. The economic intuition is clear: There is a larger consumption effect for exercising the ability to increase debt than by simply having the option. We also provide evidence that liquidity constraints affect the channels between housing wealth and consumption. For liquidity-constrained households—which we define as having a lower proportion of liquid financial wealth, higher debt-to-income ratio, or higher loan-to-value ratio—a one-dollar increase in extracted home equity is associated with an up to 30-cent increase in consumption. For unconstrained households, extracted home equity plays a limited role in stimulating consumption. This conclusion is further confirmed when we analyze durable and nondurable goods consumption separately. Durable goods consumption, which is typically financed by borrowing, is more sensitive to the amount of extracted home equity than nondurable goods consumption. This effect is even more prominent for liquidity-constrained households.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 presents a household consumption decision model to analyze the effects of housing wealth on consumption and to differentiate the effects across channels. Section 4 describes the econometric setting and data. Section 5 reports estimation results and discusses their implications, and Section 6 concludes.

2. Measuring and Testing Extracted Home Equity—Related Literature

The impact of housing wealth on household consumption has attracted extensive attention.[1] However, there is no consensus among researchers regarding the underlying channel for the co-movement between home values and consumption. One strand of literature posits that similar to financial wealth, housing wealth affects consumption spending through the conventional housing wealth effect.[2] Another strand suggests that home prices impact total expenditures through improved collateral, rather than directly through wealth.[3]

Several studies examine the empirical impact of home-equity extraction on consumption using aggregate data, and attribute the increased co-movement between home prices and consumption to financial liberalization (see, e.g., Greenspan and Kennedy (2008); Case et al. (2008); and Duca et al. (2012)). However, using aggregate consumption and wealth data may fail to capture (1) wealth distribution skewness and (2) spending-pattern differences across households. For instance, Guo and Hardin (2014) show that household wealth is related to differences in consumption patterns. Wealthier households—those with a potentially greater percentage of net worth in

[1] For example, see Belsky and Prakken (2004); Kishor (2007); Case et al. (2008); Benjamin and Chinloy (2008); Bostic et al. (2009); Tsai et al. (2012); Abdallah and Lastrapes (2013); Guo and Hardin (2014); and others.

[2] For example, see Kishor (2007); Simo-Kengne et al. (2015); and Bostic et al. (2009).

[3] For example, see Muellbauer and Murphy (1990); Iacoviello (2004); Aoki et al. (2004); Leth-Petersen (2010); Browning et al. (2013).

financial assets—are less likely to finance consumption through loans using housing as collateral.

As a result of these issues, more recent studies tend to use household-level data to examine the collateral effect. A key issue at stake in this approach is identifying the degree to which households can extract wealth from their home equity. Some studies focus on the extractable portion of home equity, and do this with alternative measures of extractable home equity. For example, Browning et al. (2013) measure extractable home equity as unexpected innovations in house prices. Those authors find that total expenditures by Danish households were uncorrelated with unexpected innovations in house prices, indicating an insignificant consumption effect for extractable home equity. Leth-Petersen (2010) measures the impact of home-equity extractability on consumption by studying the effect of an exogenous increase in credit access on total household expenditures. He finds a statistically significant but economically moderate impact from using housing as collateral.

Relative to extractable home equity, the realization aspect of extracted home equity provides a more straightforward measure of that portion of housing wealth that may directly affect consumption. As such, extracted home equity is the home-equity credit or mortgage that is potentially applied most directly to smooth consumption. Although extracted home equity is conditional on the actual net equity in the property, extracted home equity also reflects other factors, such as credit supply, household credit constraints, and the opportunity costs of—and, therefore, the willingness to—extract home equity. Consequently, some studies use total mortgage balance or mortgage payment to measure extracted home equity. For instance, using U.S. household data, Guo and Hardin (2014) find that the mortgage balance has a larger impact on consumption than net home equity. Based on Chinese household-level data over the period 2001–2009, Fan and Yavas (2017) use mortgage payment to measure the extraction from home equity. That work shows that households with a mortgage consume a higher portion of their income than households without a mortgage. Other studies measure extracted home equity as the increase in debt since the first mortgage. For example, Hurst and Stafford (2004) find a significantly negative relationship between refinance loans and household wealth for those households with a high loan-to-value ratio, implying that liquidity-constrained households may use refinance loans to smooth consumption. Following Greenspan and Kennedy (2008), Cooper (2010) defines extracted home equity as the increase in household mortgage balance for non-movers or the decrease in home equity for movers. The results show a significant effect from extracted home equity on consumption. We follow Cooper’s definition in this study.

Arguably, the various approaches to measuring home-equity extraction found in the literature have contributed to different conclusions regarding this channel. An additional concern is randomization. The extraction of home equity can be endogenous to a household’s consumption decision, which may be due to common macroeconomic shocks or a household’s financial planning. Consequently, the treatment of home-equity extraction may fail to randomly assign to households. So, for example, Leth-Petersen (2010) employs a difference-in-difference method to study consumption change related to an exogenous increase in credit access to home-equity extraction due to the 1992 Danish credit market reform. However, there is no such regulatory change in the U.S. that enables quasi-experimental analysis. Hurst and Stafford (2004) use a Heckman correction to address selection bias. However, selection bias is only one form of endogeneity, and a Heckman correction may not be sufficient to address the potential endogeneity we describe. Therefore, in this paper, we adopt an IV estimation approach and rigorously address the instrument's validity.

3. Theoretical Framework

In this section, we present a theoretical framework for understanding how housing wealth channels—and specifically the extracted home-equity channel—affect consumption. Our objective is to provide testable implications, which we will examine through our empirical analysis.

We illustrate how extracted home equity affects consumption based on a two-period model. In addition, we follow Ogawa and Wan (2007) and incorporate the concept of cash-equivalent wealth (Guo and Hardin, 2014, Benjamin and Chinloy, 2008) and home-equity credit into the theoretical model. The two-period model sets up as follows. Initially, the household has an outstanding mortgage balance (D_0), existing housing stock (H), and stock holding (S_0).[4] In period 1, the household incurs labor income and consumption denoted by Y_1 and C_1, respectively. The house

[4] We only consider homeowners, as home-equity credit is only available to homeowner. Thus, we do not include house-purchasing decisions for the households in this paper, and assume that the housing stock remains constant before the household sells the property at the final stage.

price in period 1 is P_0, which is determined by the supply and demand in the housing market. The household obtains a secondary debt (D_1), which can be used to pay previous loan interest expense, consume, invest, or any combination. Alternatively, D_1 can be used to replace the previous mortgage with a refinancing loan.[5] We assume that all debts have interest-only payments. That is, the household pays the interest expense in each period and pays off the principal by the end of the next period.[6]

In period 2, labor income Y_2 with cash equivalent wealth is entirely spent on consuming and paying off the outstanding debt.[7] Our aim is to illustrate the channel through which the given amount of debt affects consumption expenditure. Consequently, and for simplicity, we follow Ogawa and Wan (2007) and assume that there is no uncertainty about future prices and interest rates.

The budget constraint in the current period (period 1) for the household is given by:

$$Y_1 + \lambda^S S_0 + \lambda^H (HP_0 - D_0 - D_1) + D_1 = C_1 + \lambda^S S_1 + \lambda^H (HP_0 - D_0 - D_1) + r_{d0} D_0, \quad (1)$$

where r_{d0} is the effective interest rate for the initial mortgage D_0, which includes origination fees

---

[5] When D_1 stands for a refinancing loan, the payoff diagram is slightly different from the home-equity loan. In this case, D_0 is replaced by D_1 in the beginning of period 1, at a refinancing mortgage rate of r_{d1}. r_{d1} is normally lower than the mortgage rate for the original loan; however, origination fees, prepayment penalties, or closing costs can trigger additional costs. By the end of period 1 there is no longer any D_0; instead, the household pays the interest expense and principal related to D_1. Such a change in the payment arrangement does not qualitatively change the results; the estimated partial derivative of C_1 with respect to D_1 is similar. A detailed derivation is available from the authors upon request. I think the above change helps to clarify this issue.

[6] Other payment strategies do not qualitatively change the conclusion.

[7] We do not consider default in this study, and assume that households are able to repay all debts.

and other fees ($0 < r_{d0} < 1$). D_1 comes from the opportunity to borrow against home equity. r_1 is the effective interest rate for D_1 ($0 < r_{d1} < 1$), which includes origination fees, prepayment penalties, closing costs, and other fees and expenses. With extracted home equity, the household may immediately consume (C_1), pay the mortgage expenses ($r_{d0}D_0$), or reinvest in stock (S_1). The effect of the secondary mortgage, D_1, yields a consumption effect of extracted home equity, which is the part of home equity that has been replaced by cash.

λ^S and λ^H are cash-equivalent coefficients for stock holdings and home equity, respectively. Both have a value between 0 and 1 (Benjamin and Chinloy, 2008). A higher cash-equivalent coefficient for housing assets implies that the household perceives a higher level of cash-equivalent wealth from home equity due to its convertibility to cash (Guo and Hardin, 2014). If market liquidity increases (e.g., transaction costs decrease or turnover increases), households will perceive a higher level of wealth. Both λ^H and λ^S will increase. If stock assets are fully liquid, $\lambda^S = 1$. For housing assets, λ^H is usually less than 1. Home equity netting all debts ($HP_0 - D_0 - D_1$) reflects the amount of extractable home equity.

At period 2, the household sells the house and stock to pay back the debt and consumes the rest. The household is subject to the following budget constraint:

$$Y_2 + \lambda^S(1 + r_s)S_1 + \lambda^H(1 + g_h)HP_0 = C_2 + (1 + r_{d0})D_0 + (1 + r_{d1})D_1, \quad (2)$$

where labor income Y_2, cash-equivalent wealth, and investment return are entirely spent on consumption and the payoff of all outstanding debt. r_s is the stock return at period 2, and g_h is the percent appreciation (or depreciation) of the house price at the second period. As we assume that there is no uncertainty about future prices and interest rates, r_s and g_h are taken as givens.

The household makes a lifetime consumption plan to maximize its intertemporal utility from consumption during the two periods. The utility function of the household is defined as:

$$\max \quad U(C_1) + \beta U(C_2) \tag{3}$$

where $U'() > 0$ and $U"() < 0$. β denotes the discount factor. The household determines the consumption level in each period to maximize its utility, subject to budget and debt constraints. To maximize Equation (3), we have

$$\frac{\partial C_1}{\partial S_1} + \beta \frac{\partial C_2}{\partial S_1} = 0, \tag{4}$$

For the purpose of deriving the optimal consumption rule, we assume that the utility function of the household exhibits constant relative risk aversion

$$U(C) = \frac{1}{1-\gamma} C^{1-\gamma}. \tag{5}$$

where γ is the degree of relative risk aversion.

By optimization, it can be shown that optimal consumption in period 1 is given by:

$$C_1 = \frac{1}{1+\Psi(1+r_s)} \{\Psi Y_2 + \Psi(1 + r_s)Y_1 + \Psi(1 + r_s)\lambda^S S_0 + \Psi(1 + g_h)\lambda^H HP_0 + \Psi(r_s - r_{d1})D_1 -$$

$$\Psi[1 + r_{d0} + (1 + r_s)r_{d0}]D_0\} \tag{6}$$

with $\Psi = (1 + r_S)^{-\frac{1}{\gamma}}\beta^{-\frac{1}{\gamma}}$.

Equation (6) demonstrates that for liquidity-unconstrained households, current consumption is determined by the household's cash-equivalent wealth, income, and extracted home equity. From

Equation (6), we observe that extracted home equity can affect consumption, which is defined as the collateral effect. The intensity of the collateral effect can be measured as follows:

$$\frac{\partial C_1^{unconstrained}}{\partial D_1} = \frac{\Psi(r_s - r_{d1})}{1+\Psi(1+r_s)}. \tag{7}$$

For liquidity-unconstrained households, as long as $r_s > r_{d1}$, consumption (C_1) is positively related to extracted home equity (D_1). From Equation (7), it can be shown that the sensitivity of consumption to home-equity borrowing $(\frac{\partial C_1^{unconstrained}}{\partial D_1})$ depends on the interest rate for the home-equity loan (r_{d1}). With a decrease in the cost of home-equity credit, borrowing against home equity becomes an important method for households seeking to finance consumption.

Home equity can also affect consumption through perceived extractable home equity, defined as the conventional housing wealth effect. The partial derivative of C_1 with respect to $HP_0 - D_0 - D_1$ measures the intensity of the conventional housing wealth effect:

$$\frac{\partial C_1^{unconstrained}}{\partial (HP_0 - D_0 - D_1)} = \frac{1}{\frac{1}{\Xi^{\mathrm{H}}} - \frac{1}{\Xi^{\mathrm{D}_0}} - \frac{1}{\Xi^{\mathrm{D}_1}}}. \tag{8}$$

with $\Xi^{\mathrm{H}} = \frac{\Psi(1+g_h)\lambda^H}{1+\Psi(1+r_s)}$, $\Xi^{\mathrm{D}_0} = -\frac{\Psi[1+r_{d0}+(1+r_s)r_{d0}]}{1+\Psi(1+r_s)}$ and $\Xi^{\mathrm{D}_1} = \frac{\Psi(r_s - r_{d1})}{1+\Psi(1+r_s)}$.

As shown in Equation (8), the sensitivity of consumption (C_1) to the home value netting debt depends on the extracted home-equity loan rate (r_{d1}), initial mortgage rate (r_{d0}), and housing price change (g_h). It can be shown that with a decrease in r_{d1} and r_{d0}, consumption is more sensitive to net home equity. The sensitivity of consumption to home equity is also positively related to the housing-price growth rate (g_h).

When the household faces a borrowing constraint $(D_1 = \bar{L}HP_0 - D_0)$, with $\bar{L}$ as the maximum loan to value ratio ($0 < \bar{L} < 1$), D_1 is a linear function of D_0. So Equation (6) becomes

$$C_1 = \frac{1}{1+\Psi(1+r_s)}\{\Psi Y_2 + \Psi(1+r_s)Y_1 + \Psi(1+r_s)\lambda^S S_1 + \Psi(1+g_h)\lambda^H HP_1 + \Psi(r_s - r_{d1})D_1 - \Psi[1 + r_{d0} + (1+r_s)r_{d0}](\bar{L}HP_1 - D_1)\} \quad (9)$$

Thus, for a liquidity-constrained household:

$$\frac{\partial C_1^{constrained}}{\partial D_1} = \frac{\Psi(r_s - r_{d1})}{1+\Psi(1+r_s)} + \frac{\Psi[1+r_{d0}+(1+r_s)r_{d0}]}{1+\Psi(1+r_s)},$$

$$\frac{\partial C_1^{constrained}}{\partial(1-\bar{L})HP_0} = (1-\bar{L})[\frac{\Psi(1+g_h)\lambda^H}{1+\Psi(1+r_s)} - \bar{L}\frac{\Psi[1+r_{d0}+(1+r_s)r_{d0}]}{1+\Psi(1+r_s)}]$$

For liquidity-constrained households, the sensitivity of consumption to a home-equity loan decreases with the home-equity loan interest rate (r_{d1}), but increases with the first-mortgage interest rate (r_{d0}). Regarding the conventional housing wealth effect, in addition to the initial mortgage rate (r_{d0}) and the housing-price growth rate (g_h), the sensitivity of consumption (C_1) to home value netting debt also depends on maximum loan to value ratio ($\bar{L}$). It can be shown that with the increase in $\bar{L}$, consumption would be less sensitive to net home equity. From the optimal decision rules of the household, we derive the following propositions.

Proposition 1: *The elasticity of consumption to extracted home equity is larger for liquidity-constrained households than for liquidity-unconstrained households.*

Appendix 1 provides the proof.

Proposition 2: *The elasticity of consumption to extractable home equity is smaller for liquidity-constrained households than for liquidity-unconstrained households, given that the elasticity of* *consumption to extractable home equity and the elasticity of consumption to extracted home equity are both positive for liquidity-unconstrained households, which means that* $r_s > r_{d1}$*, and* $\frac{\partial C_1^{unconstrained}}{\partial(HP_0 - D_0 - D_1)} > 0$.

Appendix 1 provides the proof.

4 Empirical Design and Data

4.1 Empirical Identification

Consumption can be affected by four factors: income; financial assets (stocks, bonds, etc.); home equity; and the amount of extracted home equity. We estimate the effect of these variables on total consumption in logarithmic form. As previously discussed, we following Cooper (2010) and define extracted home equity for each household as (1) the increase in total mortgage balance for a non-mover or (2) the decrease in home equity for a mover:

$$HEE_{i,s,t} = \begin{cases} M_{i,s,t} - M_{i,s,t-1} & if \;\; M_{i,s,t-1} > 0 \;\; and \; M_{i,s,t} - M_{i,s,t-1} > 0 \;\; and \; move_{i,s,t} = 0 \\ H_{i,s,t-1}^{equity} - H_{i,s,t}^{equity} & if \; H_{i,s,t}^{equity} - H_{i,s,t-1}^{equity} < 0 \quad and \quad move_{i,s,t} = 1 \\ 0 & otherwise \end{cases}, \quad (15)$$

where $HEE_{i,s,t}$ is the (dollar) amount of extracted home equity for household i in state s at period t,[8] $M_{i,s,t}$ is the mortgage balance for household i in state s at period t, and $H_{i,s,t}^{equity}$ represents home equity netting all debts for household i in state s at period t. $move_{i,s,t}$ is a binary indicator with a

[8] Origination fees, prepayment penalties, and closing costs can affect the amount of cash extracted by refinancing loans. However, as these data are not available in PSID or HMDA, extracted home equity in our empirical estimation is measured as the increase in the mortgage balance for non-movers and decrease in net home equity for movers. We acknowledge that these additional costs can systematically overestimate the cash available for extraction. The result could be a downward bias, such that the actual consumption effect of extracted home equity may be even larger than our estimation.

value of 1 when the household moves in the previous year, and 0 when the household does not move.

One concern is that the co-movement between extracted home equity and consumption may be driven by common macroeconomic shocks, which are not necessarily related to changes in the credit constraints of households. We use an IV approach to correct for any link between extracted home equity and consumption. Furthermore, as the home-equity loan amount is left-censored, we use a Tobit model in our first-stage estimation:

$$h_{i,s,t}^{HEE} = \begin{cases} Z_{s,t-1}\delta + W_{i,s,t}\psi + \xi_{i,s,t} & for\ HEE_{i,s,t} > 0 \\ 0 & otherwise \end{cases}, \tag{16}$$

where $h_{i,s,t}^{HEE}$ stands for the log value of extracted home equity for household *i* in state *s* at period *t*. Given that the amount of extracted home equity can be zero, we define $h_{i,s,t}^{HEE} = \ln(HEE_{i,s,t} + 1)$. $W_{i,s,t}$ is a vector of control variables for household *i* in state *s* at period *t*, including each household's income, financial wealth, home equity, mortgage payment, age, marital status, and number of children. The control variables ensure the IV's conditional exogeneity. ψ is a vector of coefficients. The IV, $Z_{s,t-1}$, is selected to reflect the aggregate credit supply of financial institutions to refinance loan applicants in state *s* at period *t-1*. δ is the associated coefficient. We consider three proxies for the IV: (1) the proportion of refinance loan amounts to total loan amounts for each state and each period; (2) the state-level refinancing-loan denial ratio; and (3) the difference in the state-level denial ratio between refinance loans and home purchase loans. As these IVs measure the credit supply in past periods (period t-1), they are exogenous to individual household consumption decisions in the next period (period t). In addition, as the IVs are aggregate state-level variables, they are unlikely to be correlated with the financial decisions or financial plans of individual households. However, concerns may still arise that macroeconomic shocks may affect household credit demand. This can lead to endogenous co-movement between the loan supply and household consumption decisions. Therefore, we include the difference in the refinance-loan denial ratio and home purchase-loan denial ratio as an instrument. We argue that the difference in the denial ratio is independent of macro shocks, as the loan-denial ratio for both refinance loans and home purchase loans will be subject to the same shock and will likely respond similarly. Therefore, we argue that the instrument based on the state-level aggregate credit supply in the last period—and especially the difference in the loan-denial ratio—satisfies the conditional exogeneity requirement for a valid instrument.

In the second stage, we include the predicted level of extracted home equity from the first-stage model in the following equation[9]:

$$c_{i,s,t} = \alpha_y y_{i,s,t} + \alpha_f f_{i,s,t} + \alpha_h h_{i,s,t}^{equity} + \alpha_{hee} \hat{h}_{i,s,t}^{HEE} + X_{i,s,t}\varphi + u_{i,s,t}, \tag{17}$$

where $c_{i,s,t}$ stands for the logged consumption for household i in state s at period t. $y_{i,s,t}$, $f_{i,s,t}$, $h_{i,s,t}^{equity}$ and $\hat{h}_{i,s,t}^{HEE}$ are the log-transformed income, financial wealth, extractable home equity, and

[9] Wooldridge (2002) introduces a two-stage IV estimator that is suitable for IV estimation with a nonlinear regression in the first stage, as is the case with our model. Standard errors of the regression coefficients are corrected according to Wooldridge (2002).

the instrumented version of extracted home equity for household i at period t, respectively. The extractable home equity is measured as the net home equity excluding all mortgage debt outstanding, and the instrumented extracted home equity[10] is based on the first-stage regression predicted value. The coefficient α_h quantifies the conventional housing wealth—that is, how the perception of extractable home equity affects consumption. The coefficient α_{hee} is the *marginal effect* of extracted home equity on consumption, which reflects the collateral effect of housing wealth. $X_{i,s,t}$ includes household-level total debt payment, age, marital status, and number of children.

4.2 Data

Our cross-sectional samples come from the PSID database, which is an ongoing, nationally representative sample of more than 5,000 U.S. households since1968. Family survey data were published annually before 2000, and have been published every two years since.[11] Our sample covers the period 1999–2013. We concentrate on those households that own a house, have positive income and stock holdings, and whose nondurable consumption is 500–500,000 USD, annually.

---

[10] Empirical results are based on the instrumented extracted home equity. For expositional simplicity, we will use "extracted home equity" going forward.

[11] The two-year lag may lead to underestimation of the consumption effect of home-equity extraction. With the two-year lag, extracted home equity is defined as the increase in mortgage indebtedness since the first mortgage over the last two years for non-movers, or the decrease in home equity over the last two years for movers. However, household consumption is only for the past year. If, over the two-year period, a household extracts home equity in the first year and also consumes the converted cash in the first year, the extracted home equity is counted but the consumption is not observed. In other words, the two-year lag means that any impact of extracted home equity on consumption would be stronger if part of the extracted home equity is consumed in the first year.

These selection criteria are also used in previous literature (Guo and Hardin, 2014). Consumption includes durable goods, nondurable goods, and services. Durable goods consist of vehicles, home repairs, furnishings, and vacations; nondurable goods include such items as food and clothes. Services cover expenses on energy, medical care, insurance, education, childcare, and others. Income is the household's labor income plus transfer payments from the previous year. Because labor income reflects the previous year, we argue that the income endogeneity problem discussed by Cooper (2010) will not lead to biased results in our study. Financial wealth is defined as net stock value. Housing wealth is calculated as household home value, excluding mortgage balances. Consumption, income, wealth, and mortgage data are deflated using the consumption price index, with 1982–84 as the base period.

Data on state-level refinance-loan denial ratio and refinance loan amount come from the Home Mortgage Disclosure Act (HMDA) database, which reports the dollar amount of denied loan applications and total approved applications for counties in more than 300 MSAs. We aggregate denied and approved loan amounts in counties for each state and calculate the average state-level loan-denial ratio.

Table 1 presents summary statistics for the data. As can be seen, consumption rose by 35% from 1999 to 2013 and peaked in 2007. Compared to income and stock, which show a more stable increase, home equity has a stronger fluctuation in value during this period. Average home equity nearly doubled from 1999 to 2007, but decreased in the following period. The amount of home-equity extraction shows a pattern similar to that of home equity. In 2001, around 32.9% of homeowners extracted home equity, with an average amount of 10,024 USD. By 2005, the percentage of homeowners with home equity loans increased to 39.5%, and the average amount rose to nearly 15,908 USD. After 2005, lenders started to reduce their exposure to the housing market, so the percentage of households with home-equity extraction dropped. In 2013, only 23% of homeowners extracted equity from their home, and the average amount dropped to 5,800 USD. The increase in home-equity extraction may be related to the relaxed credit supply for refinance loans, as we can see that the proportion of refinance loans peaked at 72% in 2003. In 2003, the loan-denial ratio was also very low; only 14% of home purchase loans and 23% of refinance loans were rejected. In 2009, however, the home purchase-loan denial ratio rose to 26% and the refinance-loan denial ratio to 78%.

<< Table 1 about here>>

5 Empirical Results

5.1 Baseline Results

Table 2 reports results of the first-stage Tobit regression for the outcome home-equity extraction with alternative IVs. The state-level proportion of refinance loans to total loans is statistically significant and positively related to the amount of extracted home equity. This result is consistent with the view that a relaxed credit supply for refinance loans allows for more home-equity extraction (Model i, Table 2). Loan-denial ratios are also a widely used IV to proxy for credit supply. As shown in the next column of Table 2, extraction of home equity is statistically significant and negatively related to the state-level refinance-loan denial ratio (Model ii, Table 2). In Model iii, we use the difference in the denial ratio between refinance loans and home purchase loans as the IV to remove the impact of common macroeconomic factors on the supply of refinance loans. The coefficient remains significant (Model iii, Table 2), but is smaller in magnitude than the coefficient for the refinance-loan denial ratio.

<< Table 2 about here >>

Table 3 reports the second-stage regression results for the log of total consumption. The three columns correspond to the alternative estimations from the Tobit first-stage models in Table 2. In all specifications, consumption is statistically significant and positively related to income, stock, and home equity, which is consistent with previous literature. In addition to this consistency with prior studies, we observe a significant and positive impact on consumption for age, number of children, and the marriage indicator. The coefficient on age squared is significant and negative, implying a nonlinear relationship between age and consumption. The parameter of interest—the coefficient on extracted home equity—is significant and positively related to consumption. This confirms a significant and positive consumption channel for extracted home equity. If we compare the size of the coefficients of home equity and extracted home equity, we see that the elasticity of consumption to home equity is larger than that for extracted home equity.[12] Specifically, a 1%

[12] As our paper focuses on the collateral effect, the IV approach is applied to extracted home equity. As home value may also be endogenous to consumption, the impact of home equity on consumption could be overestimated.

increase in home equity is associated with a more than 12% increase in consumption, while a 1% increase in extracted home equity is related to an approximately 3% increase in consumption.

<< Table 3 about here >>

As income, home equity, stocks, and extracted home equity are log-transformed variables, we convert the estimated coefficients to the marginal propensity to consume (MPC) by multiplying the coefficient by the respective average consumption wealth ratio.[13] While the estimated coefficients measure the relative percentage change in consumption, MPC measures the absolute dollar change. This is partially reflective of the starting levels of the consumption wealth ratio used as a reference. These results are reported in Table 4. Consistent with previous studies, financial wealth has a smaller MPC than housing wealth. On average, a one-dollar increase in stock wealth is associated with about a 0.8-cent increase in consumption, which is much lower than the housing wealth MPC. Income also has a strong impact on consumption. The estimated income MPC is around 4 cents, which is smaller than estimates reported in studies using aggregate data (for example, Lettau and Ludvigson 2001; Duca et al. 2010). However, it is similar to results based on household survey data, as reported by Guo and Hardin (2014) and Cooper (2010).

[13] For example, the MPC for home equity is calculated as the respective coefficient multiplied by the ratio of average consumption to average home equity, and the MPC for extracted home equity is calculated as the respective coefficient multiplied by the ratio of average consumption to average extracted home equity.

Although the estimated coefficients imply a larger impact for home equity on consumption at the relative level, the converted MPC of an extra dollar of extracted home equity is more than twice the increase in home equity. As shown in Table 4, a one-dollar increase in housing wealth (i.e., home equity) is associated with an approximately 4-cent increase in consumption. In contrast, an extra dollar of extraction from home equity is related to an increase in consumption of between 8 and 12 cents. Economically, the collateral effect due to extracted home equity plays a larger role in stimulating consumption than the conventional housing wealth effect. However, the estimated MPC is still smaller in size than what has been reported in previous studies. For example, using a similar database, Cooper (2010) finds that a one-dollar increase in equity extraction leads to as much as a 54-cent increase in household expenditures. Based on survey data, Greenspan and Kennedy (2008) show that around 32 cents out of one dollar of extracted home equity was used for consumption over the period 1991–2005. Belsky and Prakken (2004) report that around 16 to 18 cents out of a dollar of extracted home equity was used for personal consumption during the period 1998–2002.

There are two possible explanations for the magnitude differences found for the collateral effect. First, we use IVs to address the potential endogeneity in using extracted home equity and consumption. Our estimated MPC is the causal effect of home-equity extraction on consumption. Second, we use a log-transformed measure of extracted home equity rather than the dollar amount in the regression. The converted MPC, therefore, can be affected by the reference level of the consumption and extracted home-equity ratios used in the conversion. Interestingly, by using the

2013 ratio as the reference—instead of the average ratio between 2001 and 2013—the MPC for extracted home equity is around 20 cents.

<< Table 4 about here >>

5.2 Liquidity-constrained and unconstrained households

As shown in our theoretical model, liquidity-constrained and unconstrained households may differ in terms of their consumption behavior. We examine this issue empirically by segmenting households into groups according to (1) total wealth, (2) proportion of liquid wealth to total wealth, (3) debt-to-income ratio, and (4) loan-to-value ratio. Liquidity-constrained households presumably possess less liquid wealth, higher debt-to-income ratios, and higher loan-to-value ratios. They may also have less total wealth. Due to the skewed distribution of wealth in the U.S., such segmentation also enables us to take a closer look at spending patterns and consumption channels across consumers.

Table 5 reports the results when we segment the entire sample into liquidity-constrained and unconstrained households according to their total wealth. We use three thresholds to define liquidity-constrained households: the bottom 50%, 25%, and 10% of all households ranked by their net wealth. After identifying constrained households based on the thresholds, the remaining households are considered unconstrained. All estimations are based on the third specification in the Tobit regression shown in Table 2 (Model iii), in which we use the difference in the denial ratio between refinance and home-purchase loans as the IV. Results based on the other two specifications in Table 2 are remarkably robust.[14]

As shown in Table 5, elasticity of consumption to income is relatively consistent across the three threshold cases. However, we observe that the effect on financial and housing wealth differs between wealthier and less wealthy households. For all alternative wealth thresholds, the elasticity of consumption to financial wealth and extractable home equity are much larger for wealthier households. For the 10% least wealthy households, the coefficients for financial wealth and extractable housing wealth are only around half that for unconstrained households. In contrast, a significant impact of extracted home equity only appears for the 10% least wealthy households. A 1% increase in extracted home equity is associated with a 0.10% increase in consumption, which implies a 30-cent MPC.

<< Table 5 about here>>

In Table 6, we focus on liquid wealth and find similar results as compared to the segmentation by total wealth. Liquid wealth includes savings, cash, and checking account balances. Liquidity-constrained households tend to possess a smaller proportion of liquid wealth in their total wealth. As shown in Table 6, the home-equity coefficient for unconstrained households is larger than for

[14] Results based on the other specifications are available from the authors upon request.

liquidity-constrained households. For households with less than 0.6% of liquid wealth (the bottom 10th percentile), a 1% increase in extractable home equity is associated with a 0.13% increase in consumption, implying an MPC of 4.5 cents. Meanwhile, for the rest of the households, a 1% increase in extractable home equity is related to a 0.89% increase in consumption, which is around 2.3 cents of MPC. Regarding the coefficient for extracted home equity, liquidity-constrained households exhibit a larger elasticity. For households with less than 0.6% of liquid wealth (10th percentile of least liquid wealth), the elasticity of consumption to extracted home equity is around three times larger than for the rest of the households, while the MPC of extracted home equity is more than two times higher.

<< Table 6 about here >>

We further examine the issue of liquidity with two widely used metrics for underwriting household borrowing capacity: debt-to-income ratio (DTI) and loan-to-value ratio (LTV). The former is calculated as the household's monthly debt payments divided by income.[15] The latter is estimated as the outstanding mortgage balance divided by total home value (Hurst and Stafford (2004). Higher values of DTI or LTV imply that a household faces borrowing constraints that, in turn, impact consumption. Analogous to the thresholds we used previously, we define liquidity-

[15] In the PSID database, household payments to credit cards or student loans are not available. Our debt payment, therefore, only includes mortgage and car payments. We acknowledge that this debt-payment measure may underestimate the actual payment by households.

constrained households as those with DTIs or LTVs higher than the 50th, 75th, and 90th percentiles. Results are reported in Tables 7 and 8.

The coefficient on extracted home equity is higher for households with higher DTI and LTV (the top 50%, 25%, and 10% of the sample ranked by DTI or LTV) as compared to all less-constrained households. For example, when household DTI is above 47%, the elasticity of extracted home equity on consumption is 0.100, which is more than three times larger than for households with DTI below 47%, where the coefficient is only 0.031. A similar finding is evident in the results based on LTV segmentation, in which the impact of home-equity extraction is insignificant for households with LTV higher than 80% LTV (i.e., higher than the 90th percentile). When we consider the cohort of households with the highest DTI (from the top 10% to the top 50% of households), we see that the coefficient of home-equity extraction decreases from 0.100 to 0.041. When we look at the cohort of households with the LTV rising from 0.4 to 0.8, the coefficient of home-equity extraction rises from 0.024 to 0.134; meanwhile, the impact of a percentage increase in home equity drops from 0.090 to 0.026.

<< Table 7 about here >>

<< Table 8 about here >>

Our empirical results confirm the prediction of Proposition 1: Extracted home equity is more important for liquidity-constrained households. As liquidity-constrained households may have only limited access to uncollateralized borrowing, they often choose to tap into their home equity when they want to increase consumption. When the LTV is more than 80%, the home equity or conventional wealth effect of housing is statistically insignificant, whereas the home-equity extraction or collateral effect is highly significant, both statistically and economically. For example, a percentage increase in extracted home equity results in a 13.4% increase in consumption, which implies a 25-cent growth in consumption triggered by a one-dollar increase in extracted home equity.

Consistent with the prediction of Proposition 2, the elasticity of consumption to home equity (i.e., housing wealth effect) for unconstrained households is larger than the effect of home-equity extraction. When the LTV is below 40%, home-equity extraction is not statistically significant. For unconstrained households, housing affects their consumption mainly through the conventional wealth effect. Households that are unconstrained by liquidity, apart from secured loans such as home-equity loans, can draw on more liquid assets or rely on uncollateralized borrowing, such as credit cards, for consumption.

5.3 Additional Results and Robustness Tests

In this section, we provide additional results for robustness and to check the validity of our instrument. In addition, we seek to further support our findings by reporting the results of a falsification test based on renters. First, we investigate whether wealth effects and consumption channels differ between durable and nondurable consumption. To do this, we segment households by LTV as a proxy for constraints and report results for durable and nondurable consumption separately. Table 9 reports the results for durable goods, nondurable goods, and services. We observe variations among the three types of consumption by dividing the sample into households with LTV higher or lower than 80%. Consistent with findings based on total consumption, the impact of home equity decreases with an increase in household leverage. For households with LTV higher than 80%, home equity has an insignificant impact on durable consumption. This result is consistent with Bostic et al. (2009), who show that for credit-constrained households, fluctuations in house values are not significant in determining durable consumption.

Regarding the collateral effect, extracted home equity clearly contributes to the consumption of durable goods by liquidity-constrained households. As purchases of durable goods, such as cars and household appliances, are more likely to be financed by borrowing, extracted home equity plays a more important role for durable consumption than for nondurable consumption, as seen in the MPCs reported in Table 9. This effect is especially evident for extracted home equity. For households with LTV higher than 80%, one dollar extracted from home equity is related to a 34.6-cent increase in consumption of durable goods.

<< Table 9 about here >>

As households may use extracted home equity to consolidate other debts, we include the household's first mortgage as a control variable in both the first- and second-stage regressions.

The second and third columns in Table 10 report results for the second-stage regression, which, in general, remain robust for home equity and extracted home equity. First mortgage has an insignificant impact on households' consumption.

In addition, we also control for household income shocks. Households that received a negative income shock and have few liquid assets to buffer the shock are more likely to refinance and extract home equity for consumption purposes, all else equal. We follow Hurst and Stafford (2014) and use unemployment spells as our measure of income shocks. We construct a dummy variable that takes the value of 1 if either the household head or the spouse experiences an unemployment spell between 1999 and 2013. Results are report in Table 10. The consumption effect of extracted home equity remains robust for constrained households.

Lastly, we acknowledge that concerns may arise regarding the endoegeneity between our instruments and consumption. This may arise from the coincidence of market booms and busts or changes in credit limits. To address this concern, we conduct a falsification check using renters as our sample to investigate our instrument's validity.[16] As renters cannot borrow against home equity, the instrument (i.e., state-level refinancing loan supply) should not be a useful instrument for predicting the consumption of renters. If the instrumented extracted home equity can also explain renter consumption, this will imply that the instrument of state-level refinancing loan

---

[16] We gratefully acknowledge an anonymous reviewer for suggesting this approach.

supply is not valid, as it overestimates the true relationship.

In the falsification test, we first calculate the instrumented extracted home equity for renters. Next, we regress renter consumption on the instrumented extracted home equity. As home equity is necessary for the calculation of home-equity extraction, we simulate a counterfactual home-equity value for renters by assuming that they are able to purchase their rented home by borrowing. The counterfactual home equity is calculated as the annual rent payment divided by the 30-year mortgage rate in that year.

Once the home-equity value is set for renters, we simulate a counterfactual extracted home equity for renters, using the IV—state-level refinancing loan credit supply—and other variables for renters using Equation (16). The coefficient for the simulation is from the first-stage regression for homeowners. In the second stage, we regress the actual consumption of renters on the counterfactual extracted home equity and counterfactual home equity. Other variables, such as income and stock wealth, are based on their actual values. Regression results are reported in Table 10. The elasticity of consumption to income and stock wealth remains relatively robust; however—and importantly—the elasticities for counterfactual home equity and extracted home equity are insignificant. The consumption of renters is indeed uncorrelated to the instrumented extracted home equity.

<< Table 10 about here >>

6 Conclusion

The recent economic boom and bust have raised important questions about the relationship between housing wealth and consumption. Prior studies find that, since the mid-1990s, consumption has become more sensitive to housing wealth. However, significant disagreements persist regarding the causes of this increased sensitivity. Identifying the channels through which housing wealth affects consumption is essential in order to understand the economic implications of home-price fluctuations and a household's ability to borrow against its home.

Our paper develops a household-consumption decision model that predicts different consumption effects of extracted and extractable home equity. Based on household survey data from the PSID database from 1999 to 2013, our empirical results suggest that the collateral effect of home-equity extraction is economically relevant to co-movement between housing wealth and consumption. On average, a one-dollar increase in housing equity is associated with a 4-cent increase in consumption, while the marginal propensity to consume for home-equity credit is around 8 cents.

The contributions of this study are further extended by our theoretical and empirical results on consumption patterns across liquidity-constrained and unconstrained households. The conventional housing wealth effect remains an important channel by which housing wealth affects consumption. However, this is primarily the case for unconstrained households: The increase in home values allows them to feel more confident about their financial status, and they spend more.

In contrast, for households that have limited access to uncollateralized credit, home-equity credit offers an alternative way to finance consumption. For liquidity-constrained households, which typically have higher debt-to-income or loan-to-value ratios, a one-dollar increase in extracted home equity is associated with an increase of up to 30 cents in consumption.

This new evidence regarding the home-equity extraction channel for consumption, especially in the case of constrained households, contributes to our understanding of the role housing wealth has played in recent economic cycles. The impact of home-equity extraction, along with exceptionally low rates for home-equity credit, is clearly an important driver in the marginal propensity to consume—and, for some consumers, to abruptly curtail consuming.

Reference

ABDALLAH, C. S. & LASTRAPES, W. D. (2013). Evidence on the Relationship between Housing and Consumption in the United States: A State-Level Analysis. Journal of Money Credit and Banking, 45, 559-589.

AOKI, K., PROUDMAN, J. & VLIEGHE, G. (2004). House prices, consumption, and monetary policy: a financial accelerator approach. Journal of Financial Intermediation, 13, 414-435.

BELSKY, E. & PRAKKEN, J. (2004). Housing Wealth Effects: Housing's Impact on Wealth Accumulation, Wealth Distribution and Consumer Spending. Joint Centre on Housing Studies Working Paper, W04-13.

BENJAMIN, J. D. & CHINLOY, P. (2008). Home equity, household savings and consumption. Journal of Real Estate Finance and Economics, 37, 21-32.

BOSTIC, R., GABRIEL, S. & PAINTER, G. (2009). Housing wealth, financial wealth, and consumption: New evidence from micro data. Regional Science and Urban Economics, 39, 79-89.

BROWNING, M., GORTZ, M. & LETH-PETERSEN, S. (2013). Housing Wealth and Consumption: A Micro Panel Study. Economic Journal, 123, 401-428.

CAMPBELL, J. Y. & COCCO, J. F. (2003). Household risk management and optimal mortgage choice. Quarterly Journal of Economics, 118, 1449-1494.

CASE, K., QUIGLEY, J. & SHILLER, R. J. (2008). Comparing Wealth Effects: the stock market versus the housing market. Advances in Macroeconomics 5.

COOPER, B. D. (2010). Did Easy Credit Lend to Overspending? Home Equity Borrowing and Household Behavior in the Early 2000s. Federal Reserve Bank of Boston Discussion Paper.

DUCA, J. V., MUELLBAUER, J. & MURPHY, A. (2012). How Financial Innovations and Accelerators Drive Booms and Busts in U.S. Consumption. Working Paper.

FAN, Y. & YAVAS, A. (2017). How Does Mortgage Debt Affect Household Consumption? Micro Evidence from China. Working Paper.

GUO, S. & HARDIN, W. G. (2014). Wealth, Composition, Housing, Income and Consumption. Journal of Real Estate Finance and Economics, 48, 221-243.

HURST, E. & STAFFORD, F. (2004). Home is where the equity is: Mortgage refinancing and household consumption. Journal of Money Credit and Banking, 36, 985-1014.

IACOVIELLO, M. (2004). Consumption, house prices, and collateral constraints: a structural econometric analysis. Journal of Housing Economics, 13, 304-320.

KISHOR, N. K. (2007). Does consumption respond more to housing wealth than to financial market wealth? If so, why? Journal of Real Estate Finance and Economics, 35, 427-448.

LETH-PETERSEN, S. (2010). Intertemporal Consumption and Credit Constraints: Does Total Expenditure Respond to an Exogenous Shock to Credit? American Economic Review, 100, 1080-1103.

OGAWA, K. & WAN, J. (2007). Household debt and consumption: A quantitative analysis based on household micro data for Japan. Journal of Housing Economics, 16, 127-142.

SIMO-KENGNE, B. D., MILLER, S. M., GUPTA, R. & AYE, G. C. (2015). Time-Varying Effects of Housing and Stock Returns on US Consumption. Journal of Real Estate Finance and Economics, 50, 339-354.

TSAI, I. C., LEE, C. F. & CHIANG, M. C. (2012). The Asymmetric Wealth Effect in the US Housing and Stock Markets: Evidence from the Threshold Cointegration Model. Journal of Real Estate Finance and Economics, 45, 1005-1020.

Table 1 Statistics summary

	All years	1999	2001	2003	2005	2007	2009	2011	2013
Mean									
	35,130	27,279	28,415	36,367	36,972	37,655	35,965	35,373	36,827
	16,442	14,235	14,032	13,554	18,506	16,914	17,472	18,233	18,170
	8,171	7,006	6,815	6,912	8,200	10,494	8,850	7,623	8,587
	21,084	10,023	13,394	29,259	20,018	21,212	20,635	21,316	23,362
Income	58,865	56,111	58,216	55,947	57,318	58,325	58,624	61,873	65,227
Home equity	102,193	68,620	80,034	92,336	114,450	124,239	103,609	99,010	105,090
Stock	95,909	92,307	93,131	95,571	95,152	87,636	79,336	104,489	128,687
Total mortgage balance	61,150	49,926	52,617	58,723	66,347	65,397	64,075	61,262	61,345
Extracted home equity	10,506	-	10,024	11,495	15,908	11,594	8,822	6,590	5,806
% households	32.2%	-	32.9%	39.6%	39.5%	32.7%	26.4%	23.0%	23.2%
Debt payment	6,669	6,203	7,064	6,599	7,035	6,977	6,544	6,072	5,808
Age	50	47	48	49	50	51	52	53	54
No. of children	0.989	1.164	1.179	1.006	1.024	0.936	0.952	0.883	0.804
Marriage	0.880	0.891	0.880	0.870	0.878	0.882	0.882	0.886	0.884
Income shock	4%	5%	3%	6%	5%	3%	5%	6%	4%
% ref. loan	60%	60%	61%	72%	48%	48%	69%	65%	59%
Loan denial ratio	17%	17%	13%	14%	20%	26%	17%	16%	15%
Ref. loan denial ratio	41%	38%	26%	23%	52%	78%	35%	34%	30%
Standard Deviation									
Consumption	40,071	23,901	21,867	74,409	26,095	28,473	39,229	27,870	28,144
Durable	17,109	17,488	14,308	13,156	16,426	16,413	22,528	19,339	17,480
Nondurable	14,533	13,091	12,735	13,818	12,736	15,065	19,302	11,290	15,366
Services	55,450	9,666	12,464	130,005	17,327	17,773	21,586	21,390	23,703
Income	85,956	57,258	62,141	88,373	89,092	65,030	65,761	79,218	148,395
Home equity	126,947	81,026	96,799	107,920	142,520	159,809	136,874	105,918	116,121
Stock	577,922	539,964	791,919	730,850	639,774	248,284	323,214	414,063	516,775
Total mortgage balance	73,575	56,707	62,351	68,743	78,134	82,133	75,677	69,683	77,438
Extracted home equity	32,658	-	37,668	27,704	39,619	32,545	34,003	24,782	19,867
% households	0.47	-	0.47	0.49	0.49	0.47	0.44	0.42	0.42
Debt payment	7,631	6,341	9,062	6,886	8,350	8,339	6,696	6,164	5,888
Age	13	13	12	13	13	13	14	13	14
No. of children	1.151	1.217	1.275	1.102	1.127	1.084	1.170	1.133	1.080
Married	0.325	0.312	0.325	0.337	0.327	0.323	0.323	0.318	0.320
Income shock	21%	21%	16%	24%	22%	17%	21%	24%	20%
% ref. loan	11.8%	10%	8.9%	6.2%	7.8%	8.4%	6.7%	6.9%	6.4%
Loan denial ratio	7.2%	5.5%	3.6%	3.4%	5.2%	10.2%	5.3%	4.1%	3.6%
Ref. loan denial ratio	21.6%	9.7%	8.2%	5.7%	14.6%	14.4%	10.5%	8.0%	6.3%

Notes: Consumption is the total consumption in USD Durable, nondurable, and services are consumption in durable goods, nondurable goods, and services, respectively. Income stands for household income. Home equity is the home value excluding all debts, and stock stands for net stock wealth. Extracted home equity stands for the dollar amount of extracted home equity. Mortgage stands for the household total mortgage balance, including first mortgage and other home equity credits. All variables are deflated using the consumption price index (with 1982–84 as the base period). % households denotes the percentage of households using extracted home equity. Debt payment is the total payment for all debts. Age stands for the age of household head. No. of children denotes the number of children in the household. Married is a dummy variable with 1 for married and 0 otherwise. Income shock is an indicator variable *taking the value of 1 if either the household head or the spouse experienced an unemployment spell in the past year, and zero otherwise. % ref. loan stands for the refinance loan amounts to total mortgage loans percentage. Loan denial ratio denotes the state-level denial ratio of home-purchase loans, and Ref. loan denial ratio denotes the state-level denial ratio of refinance loans. % ref. loan, Loan denial ratio, and Ref. loan denial ratio, which are at state aggregate levels, are from HMDA data. All other variables, including home equity, extracted home equity, and total mortgage balance, are at the household level and from the PSID database.*

Table 2 First-stage regression of extracted home equity

	Tobit		
	(i)	(ii)	(iii)
	6.956***		
	(1.480)		
		-5.711***	
		(1.171)	
			-2.960***
			(1.222)
	0.327***	0.321***	0.316***
	(0.144)	(0.141)	(0.143)
	-0.059	-0.072	-0.051
	(0.120)	(0.119)	(0.121)
	0.126***	0.124***	0.122***
	(0.050)	(0.050)	(0.050)
Log of Payment	1.445***	1.447***	1.447***
	(0.043)	(0.043)	(0.042)
Log of Age	-0.569***	-0.558***	-0.567***
	(0.072)	(0.071)	(0.071)
	0.004***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)
	-0.158*	-0.180**	-0.176*
	(0.091)	(0.092)	(0.091)
Married	-0.123	-0.116	-0.103
	(0.325)	(0.326)	(0.325)
Const	7.026***	5.360***	6.956***
	(2.300)	(2.210)	(2.174)
State Dummy	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes
No. of Obs.	19132	19132	19132
LL	-28861	-28862	-28859

Notes: This table reports the results of the first-stage regression for the IV estimator (Wooldridge, 2002). The dependent variable is defined as $\ln(HEE_{it} + 1)$*. HEE is the home equity that has been extracted by individual households and is defined by Equation (15). Home Equity stands for home value net of all debts. Standard deviations are in parentheses. ***, **, and * denote significance at the1%, 5%, and 10% level, respectively.*

Table 3 Second-stage regression of total consumption for all observations

	2SLS		
	(i)	(ii)	(iii)
	0.133***	0.133***	0.133***
	(0.005)	(0.005)	(0.005)
	0.120***	0.120***	0.120***
	(0.005)	(0.005)	(0.005)
	0.044***	0.044***	0.044***
	(0.002)	(0.002)	(0.002)
	0.036***	0.023*	0.027*
	(0.013)	(0.012)	(0.014)
	-0.010*	-0.005	-0.006
	(0.005)	(0.006)	(0.005)
	0.026***	0.024***	0.025***
	(0.003)	(0.003)	(0.003)
Log of Age Squared	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)
No. of Children	0.022***	0.022***	0.022***
	(0.004)	(0.004)	(0.004)
Married	0.273***	0.272***	0.272***
	(0.013)	(0.013)	(0.013)
Const	6.034***	6.000***	5.985***
	(0.077)	(0.095)	(0.092)
State Dummy	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes
No. of Obs.	19132	19132	19132
Adjusted R2	0.2883	0.2881	0.2882

*Notes: This table reports the results of the second-stage regression for the IV regression (Wooldridge 2002). It examines the impact of extracted home equity on consumption. Dependent variable is logged total consumption in every two years from 2001 to 2013. Income, stock, home equity, and payment stand for households' income, net stock value, home value net of all debt, and annual payment to all debts, respectively. Instrumented extracted home equity is the predicted extracted home equity from the first-stage Tobit regression using the instrument of state-level aggregate refinancing loan supply. Standard deviations are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.*

Table 4 MPC for all observations

	(i)	(ii)	(iii)
Income	0.039	0.039	0.039
Home Equity	0.041	0.041	0.041
Stock	0.008	0.008	0.008
Instrumented Extracted Home Equity	0.119	0.078	0.089

Notes: This table reports the marginal propensity to consume (MPC) of income, home equity, stocks, and extracted home equity from Table 3 and the three models with different IVs. Income, stock, home equity, and extracted home equity stand for household income, net stock value, home value net of all debt, and home equity that has already been extracted by households, respectively. MPCs are calculated by multiplying the respective coefficient by the corresponding average consumption wealth ratio over the period 2001–2013.

Table 5 Regression of Total Consumption for Households Segmented by Proportion of Net Wealth

	50th Percentile		25th Percentile		10th Percentile	
	Below <198,664	Above ≥198,664	Below <87,923	Above ≥87,923	Below <39,953	Above ≥39,953
Coef.						
Log of Income	0.132***	0.115***	0.178***	0.126***	0.159***	0.134***
	(0.008)	(0.007)	(0.014)	(0.006)	(0.021)	(0.006)
Log of Home Equity	0.051***	0.137***	0.041***	0.125***	0.060***	0.122***
	(0.006)	(0.008)	(0.009)	(0.006)	(0.013)	(0.005)
Log of Stock	0.030***	0.036***	0.021***	0.044***	0.025***	0.045***
	(0.003)	(0.003)	(0.004)	(0.003)	(0.006)	(0.002)
	0.004	0.023	0.028	0.001	0.100***	0.007
	(0.020)	(0.019)	(0.027)	(0.022)	(0.044)	(0.019)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
State Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes
MPC						
Income	0.041	0.033	0.053	0.037	0.046	0.040
Home Equity	0.031	0.037	0.042	0.038	0.089	0.040
Stock	0.027	0.004	0.037	0.007	0.078	0.008
Instrumented Extracted Home Equity	0.014	0.079	0.086	0.003	0.307	0.025
No. of Obs.	9567	9565	4307	14825	1911	17221
Adjusted R2	0.2033	0.2383	0.2300	0.2477	0.2424	0.2578

*Notes: This table reports IV regression results (Wooldridge 2002) for liquidity-constrained households (in gray columns) and unconstrained households (in white columns). Liquidity-constrained households are defined as households with net wealth less than 198,644 USD (50th percentile), 87,923 USD (25th percentile) and 39,953 USD (10th percentile). Households above the threshold are defined as unconstrained households. Variables are as defined in Tables 3 and 4. Standard deviations are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.*

Table 6 Regression of Total Consumption for Households Segmented by Proportion of Liquid Wealth

	50th Percentile		25th Percentile		10th Percentile	
	Below <6.2%	Above ≥6.2%	Below <2%	Above ≥2%	Below <0.6%	Above ≥0.6%
Coef.						
Log of Income	0.133***	0.124***	0.142***	0.129***	0.164***	0.128***
	(0.008)	(0.008)	(0.011)	(0.006)	(0.016)	(0.006)
Log of Home Equity	0.108***	0.135***	0.107***	0.125***	0.089***	0.126***
	(0.006)	(0.007)	(0.009)	(0.005)	(0.012)	(0.005)
Log of Stock	0.044***	0.042***	0.040***	0.046***	0.050***	0.043***
	(0.003)	(0.003)	(0.004)	(0.003)	(0.005)	(0.002)
	0.092***	0.022	0.104***	0.017	0.104*	0.033**
	(0.028)	(0.018)	(0.034)	(0.018)	(0.057)	(0.016)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
State Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes
MPC						
Income	0.043	0.034	0.047	0.037	0.049	0.038
Home Equity	0.034	0.052	0.031	0.046	0.023	0.045
Stock	0.006	0.011	0.005	0.010	0.004	0.009
Instrumented Extracted Home Equity	0.297	0.077	0.317	0.057	0.288	0.111
No. of Obs.	9561	9571	4783	14349	1976	17156
Adjusted R2	0.2891	0.2978	0.3147	0.2845	0.4053	0.2789

*Notes: This table reports IV regression results (Wooldridge 2002) for liquidity-constrained households (in gray columns) and unconstrained households (in white columns). Liquidity-constrained households are defined as households with liquid wealth less than 6.2% of net wealth (50th percentile), 2.0% of net wealth (25th percentile) and 0.6% of net wealth (10th percentile). Households above the threshold are defined as unconstrained households. Variables are as defined in Tables 3 and 4. Standard deviations are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.*

Table 7 Regression of Total Consumption for Households Segmented by Debt to Income

	50th Percentile		75th Percentile		90th Percentile	
	Above ≥0.17	Below <0.17	Above ≥0.30	Below <0.30	Above ≥0.47	Below <0.47
Coef.						
Log of Income	0.158***	0.109***	0.055***	0.189***	0.008	0.189***
	(0.007)	(0.008)	(0.011)	(0.007)	(0.015)	(0.006)
Log of Home Equity	0.144***	0.106***	0.110***	0.119***	0.099***	0.111***
	(0.007)	(0.006)	(0.008)	(0.005)	(0.015)	(0.005)
Log of Stock	0.034***	0.053***	0.062***	0.037***	0.074***	0.039***
	(0.003)	(0.003)	(0.004)	(0.002)	(0.007)	(0.002)
	0.041***	0.030*	0.073***	0.026*	0.100***	0.031***
	(0.018)	(0.016)	(0.023)	(0.014)	(0.042)	(0.012)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
State Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes
MPC						
Income	0.040	0.040	0.026	0.050	0.005	0.053
Home Equity	0.043	0.044	0.048	0.038	0.047	0.037
Stock	0.004	0.018	0.022	0.006	0.022	0.007
Instrumented Extracted Home Equity	0.204	0.073	0.155	0.106	0.258	0.108
No. of Obs.	9566	9566	4776	14356	1939	17193
Adjusted R2	0.3256	0.2500	0.2571	0.3074	0.2692	0.3002

*Notes: This table reports IV regression results (Wooldridge 2002) for liquidity-constrained households (in gray columns) and unconstrained households (in white columns). Liquidity-constrained households are defined as households with debt to income ratio higher than 0.17 (50th percentile), 0.30 (75th percentile) and 0.47 (90th percentile). Households below the threshold are defined as unconstrained households. Variables are as defined in Tables 3 and 4. Standard deviations are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.*

Table 8 Regression of Total Consumption for Households Segmented by LTV

	50th Percentile		75th Percentile		90th Percentile	
	Above ≥0.4	Below <0.4	Above ≥0.6	Below <0.6	Above ≥0.8	Below <0.8
Coef.						
Log of Income	0.182***	0.085***	0.188***	0.110***	0.197***	0.119***
	(0.009)	(0.007)	(0.013)	(0.006)	(0.022)	(0.006)
Log of Home Equity	0.090***	0.191***	0.090***	0.175***	0.026**	0.167***
	(0.006)	(0.008)	(0.009)	(0.007)	(0.013)	(0.006)
Log of Stock	0.042***	0.042***	0.039***	0.042***	0.030***	0.042***
	(0.003)	(0.003)	(0.004)	(0.002)	(0.006)	(0.002)
	0.024*	0.012	0.057***	0.035**	0.134***	0.024
	(0.015)	(0.032)	(0.020)	(0.017)	(0.051)	(0.015)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
State Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes
MPC						
Income	0.046	0.030	0.050	0.034	0.050	0.036
Home Equity	0.054	0.048	0.098	0.050	0.053	0.055
Stock	0.015	0.005	0.020	0.006	0.018	0.007
Instrumented Extracted Home Equity	0.052	0.087	0.117	0.142	0.259	0.087
No. of Obs.	9563	9486	4780	14352	1990	17142
Adjusted R2	0.3041	0.2974	0.2878	0.2987	0.2974	0.2914

*Notes: This table reports IV regression results (Wooldridge 2002) for liquidity-constrained households (in gray columns) and unconstrained households (in white columns). Liquidity-constrained households are defined as households with loan to value ratios higher than 0.4 (50th percentile), 0.6 (75th percentile) and 0.8 (90th percentile). Households below the threshold are defined as unconstrained households. Variables are as defined in Tables 3 and 4. Standard deviations are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.*

Table 9 Regression by Consumption Type for Households Segmented by LTV

	Durable Goods		Nondurable Goods and Service	
	Above ≥0.8	Below <0.8	Above ≥0.8	Below <0.8
Coef.				
Log of Income	0.165***	0.121***	0.200***	0.119***
	(0.050)	(0.013)	(0.022)	(0.006)
Log of Home Equity	-0.007	0.187***	0.035***	0.154***
	(0.029)	(0.014)	(0.013)	(0.007)
Log of Stock	0.074***	0.065***	0.007	0.018***
	(0.013)	(0.005)	(0.006)	(0.003)
	0.400***	-0.025	0.021	0.031
	(0.115)	(0.034)	(0.069)	(0.020)
Control Variables	Yes	Yes	Yes	Yes
State Dummy	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes
MPC				
Income	0.019	0.017	0.043	0.030
Home Equity	-0.006	0.028	0.062	0.041
Stock	0.020	0.005	0.004	0.003
Instrumented Extracted Home Equity	0.346	-0.041	0.035	0.093
No. of Obs.	1990	17142	1990	17142
Adjusted R2	0.1628	0.1447	0.3254	0.2624

*Notes: This table reports IV regression results (Wooldridge 2002) for durable goods, and nondurable goods and services. Households are divided into two categories: liquidity-constrained households (in gray columns) and unconstrained households (in white columns). Liquidity-constrained households are defined as households with loan to value ratios higher than 0.8 or 80% LTV (the 90^{th} percentile). Households below the threshold are defined as unconstrained households. Variables are as defined in Tables 3 and 4. Standard deviations are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.*

Table 10 Alternative Specification for Households Segmented by LTV

	First Mortgage		Income Shock		Falsification
	Above	Below	Above	Below	Test for
	≥0.8	<0.8	≥0.8	<0.8	Renters
Coef.					
Log of Income	0.207***	0.119***	0.200***	0.119***	0.175***
	(0.021)	(0.006)	(0.022)	(0.006)	(0.015)
Log of Home Equity	0.034***	0.169***	0.025*	0.167***	0.002
	(0.013)	(0.006)	(0.013)	(0.006)	(0.004)
Log of Stock	0.034***	0.042***	0.029***	0.042***	0.067***
	(0.006)	(0.002)	(0.006)	(0.002)	(0.006)
	0.154***	0.025	0.133***	0.024	-0.002
	(0.053)	(0.015)	(0.051)	(0.015)	(0.006)
	-0.005	-0.001			
	(0.007)	(0.002)			
			-0.017	0.001	
			(0.013)	(0.006)	
Control Variables	Yes	Yes	Yes	Yes	Yes
State Dummy	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes
MPC					
Income	0.053	0.036	0.051	0.036	0.053
Home Equity	0.068	0.054	0.053	0.054	0.001
Stock	0.020	0.007	0.017	0.007	0.014
Instrumented Extracted Home Equity	0.295	0.090	0.257	0.085	-0.007
No. of Obs.	1990	17142	1990	17142	2432
Adjusted R2	0.3009	0.2915	0.2977	0.2913	0.3241

*Notes: This table reports IV regression results (Wooldridge 2002) for three sets of robustness checks. In the first two sets, households are divided into two categories: liquidity-constrained households (in gray columns) and unconstrained households (in white columns). Liquidity-constrained households are defined as households with loan to value ratios higher than 0.8 or 80% LTV (90th percentile). Households below the threshold are defined as unconstrained households. Log of first mortgage is the log of first mortgage outstanding. Income shock is measured as an indicator variable with value of 1 when households experienced an unemployment spell in the past year, and zero otherwise. The remaining variables are as defined in Tables 3 and 4. The third set of tests is shown in the last column. Here, a falsification test is reported for IV regression results using renters as the sample. Additional details pertaining to this test are found in the text. Standard deviations are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.*

Appendix 1: Proof of Proposition

Proposition 1: *The elasticity of consumption to extracted home equity is larger for liquidity-constrained households than for liquidity-unconstrained households.*

Proof: As $r_{d0} > 0$, $r_s > 0$ and $\Psi > 0$, it can be shown that $\frac{\Psi[1+r_{d0}+(1+r_s)r_{d0}]}{1+\Psi(1+r_s)} > 0$. As a result, $\frac{\Psi(r_s-r_{d1})}{1+\Psi(1+R)} + \frac{\Psi[1+r_{d0}+(1+r_s)r_{d0}]}{1+\Psi(1+r_s)} > \frac{\Psi(r_s-r_{d1})}{1+\Psi(1+R)}$, which implies $\frac{\partial C_1^{constrained}}{\partial D_1} > \frac{\partial C_1^{unconstrained}}{\partial D_1}$.

Proposition 2: *The elasticity of consumption to extractable home equity is smaller for liquidity-constrained households than for liquidity-unconstrained households, given that the elasticity of consumption to extractable home equity and the elasticity of consumption to extracted home equity are both positive for liquidity-unconstrained households, which means that* $r_s > r_{d1}$, *and* $\frac{\partial C_1^{unconstrained}}{\partial(HP_0-D_0-D_1)} > 0$.

Proof: For liquidity-constrained households, as $r_s > 0$, $r_{d0} > 0$ and $\Psi > 0$, it can be shown that $\frac{\Psi[1+r_{d0}+(1+r_s)r_{d0}]}{1+\Psi(1+r_s)} > 0$. As $1 > \bar{L} > 0$, we have $\frac{\Psi(1+g_h)\lambda^H}{1+\Psi(1+r_s)} - \bar{L}\frac{\Psi[1+r_{d0}+(1+r_s)r_{d0}]}{1+\Psi(1+r_s)} < \frac{\Psi(1+g_h)\lambda^H}{1+\Psi(1+r_s)}$. As a result $\frac{\partial C_1^{constrained}}{\partial(1-\bar{L})HP_1} = (1-\bar{L})\left[\frac{\Psi(1+g_h)\lambda^H}{1+\Psi(1+r_s)} - \bar{L}\frac{\Psi[1+r_{d0}+(1+r_s)r_{d0}]}{1+\Psi(1+r_s)}\right] < (1-\bar{L})\frac{\Psi(1+g_h)\lambda^H}{1+\Psi(1+r_s)} < \frac{\Psi(1+g_h)\lambda^H}{1+\Psi(1+r_s)}$.

For liquidity-constrained households, as $1 > r_s > 0$ and $1 > r_{d0} > 0$, it can be shown that $1 + r_{d0} + (1+r_s)r_{d0} > 1$. As $r_s - r_{d1} < 1$, we have $1 + r_{d0} + (1+r_s)r_{d0} > r_s - r_{d1}$. As long as

$r_s - r_{d1} > 0$, which means that the return on investment is larger than the debt interest rate, it can be shown that $\frac{1+\Psi(1+r_s)}{\Psi[1+r_{d0}+(1+r_s)r_{d0}]} < \frac{1+\Psi(1+r_s)}{\Psi[r_s-r_{d1}]}$, which implies that $\frac{1+\Psi(1+r_s)}{\Psi[1+r_{d0}+(1+r_s)r_{d0}]} - \frac{1+\Psi(1+r_s)}{\Psi[r_s-r_{d1}]} < 0$. So $\frac{1+\Psi(1+r_s)}{\Psi(1+g_h)\lambda^H} + \frac{1+\Psi(1+r_s)}{\Psi[1+r_{d0}+(1+r_s)r_{d0}]} - \frac{1+\Psi(1+r_s)}{\Psi[r_s-r_{d1}]} < \frac{1+\Psi(1+r_s)}{\Psi(1+g_h)\lambda^H}$. As long as housing equity has a positive impact on consumption for liquidity-unconstrained households, which means that $\frac{1+\Psi(1+r_s)}{\Psi(1+g_h)\lambda^H} + \frac{1+\Psi(1+r_s)}{\Psi[1+r_{d0}+(1+r_s)r_{d0}]} - \frac{1+\Psi(1+r_s)}{\Psi[r_s-r_{d1}]} > 0$, we have $\frac{\partial C_1^{unconstrained}}{\partial(HP_1-D_0-D_1)} = \frac{1}{\frac{1+\Psi(1+r_s)}{\Psi(1+g_h)\lambda^H}+\frac{1+\Psi(1+r_s)}{\Psi[1+r_{d0}+(1+r_s)r_{d0}]}-\frac{1+\Psi(1+r_s)}{\Psi[r_s-r_{d1}]}} > \frac{1}{\frac{1+\Psi(1+r_s)}{\Psi(1+g_h)\lambda^H}} = \frac{\Psi(1+g_h)\lambda^H}{1+\Psi(1+r_s)}$. Hence, we can see that $\frac{\partial C_1^{unconstrained}}{\partial(HP_1-D_0-D_1)} > \frac{\Psi(1+g_h)\lambda^H}{1+\Psi(1+r_s)} > \frac{\partial C_1^{constrained}}{\partial(1-\bar{L})HP_1}$.

Appendix 2: Related Micro-level Studies[17]

Study	Theoretical framework	Measure of housing wealth / home-equity extraction	Measure of consumption	Data sample	Empirical methodology	Conclusions
Campbell and Cocco (2003)	Life-cycle theory	Predictable change in home value and unpredictable change in home value	Nondurable consumption	UK household-level data from the UK Family Expenditure Survey (FES) over the period 1988–2000	Unbalanced panel regression	On average, housing MPC is 7.7 cents. Largest house price elasticity of consumption for older homeowners, and the smallest elasticity, insignificantly different from zero, for younger renters.
Bostic, Gabriel and Painter (2005)	—	Household net home value	Total consumption, durable consumption, and nondurable consumption	U.S. household-level data from the Survey of Consumer Finance and the Consumer Expenditure Survey over the period 1989–2005	Unbalanced panel regression	Housing wealth has an MPC of 6 cents, while financial wealth has an MPC of 2 cents. MPCs also diverge sharply across credit-constrained and non-credit-constrained households.
Browning et al. (2013)	—	Expected house price change and unexpected house price change	Total consumption	Danish households data from 1987 to 1996	Panel regression	No significant “pure” housing wealth effect, as household expenses are not significantly affected by unexpected house price change. Home value affects consumption by the collateral effect, as consumption by young house owners reacts to house price changes after 1992 credit reform.
Leth-Petersen (2010)	—	Property value	Total consumption	Danish households data from 1987 to 1996	Difference in difference method	After the 1992 credit reform, which enabled Danish households to use housing as collateral, consumption increases 1-4%.
Cooper (2010)	—	Home-equity extraction is defined as the decrease in	Non-housing consumption,	U.S. household-level data from PSID	Linear regression	One dollar of equity extracted leads to no more than a 20-cent increase

[17] For space consideration, this table focuses on empirical studies using household-level data.

		home equity for movers and increase in mortgage balance for non-movers.	home improvement, and investment.	database from 1999 to 2009.		in household expenditures. The amount of equity extracted that goes toward saving or home improvement investment is nearly double that of consumption.
Hurst and Stafford (2014)	Permanent income theory	Home-equity extraction is defined as the decrease in home equity due to refinancing.	Total wealth	U.S. household-level data from PSID database from 1989 to 1996. Households are restricted to homeowners with mortgages and non-movers.	Median regression, Heckman two-stage regression.	For every $1 of equity removed by the liquidity-constrained household, wealth declines by two-thirds of a dollar. For liquidity non-constrained households, no significant impact is found.
Guo and Hardin (2014)	Life-cycle/ Permanent income model	Households' net home value	Nondurable consumption	U.S. household-level data from PSID database from 1994 to 2007	Median regression	1% increase in home equity is associated with a 0.02% increase in consumption. Wealth and its composition affects MPC. Households with higher net wealth have a higher housing wealth effect.
Fan and Yavas (2017)	—	Household mortgage payment	Total consumption	Chinese household-level data from Urban Household Survey (UHS) database from 2002 to 2009	Heckman two-stage regression.	Households with a mortgage consume a higher portion of their income than households without a mortgage.