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# Housing Wealth, Consumption Channels and Mortgage Liberalization

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This paper investigates two types of housing wealth effects: conventional housing wealth and collateral. We incorporate home equity extraction (HEE) and the influence of mortgage liberalization into the model in Campbell and Mankiw (1989). Based on U.S. data during the 1977Q1–2019Q4, our empirical results suggest that consumption is remarkably influenced by the use of HEE, rather than home equity. Furthermore, the rapid expansion of mortgage securitization significantly amplifies the collateral effect. Conditional on the use of HEE and the share of non-bank mortgage holdings, housing wealth has an average marginal propensity to consume (MPC) of 0.84 cents and a maximum MPC of 6.06 cents. In 2007, when market-based mortgage pools and issuers of asset-backed securities held more than 60% of home mortgages, the HEE shock explained for over 50% of the forecasting variance of consumption growth. The results provide evidence that with a focus on collateral value, lenders allow more equity withdrawal, which leads to higher consumption.

**Keywords**

Consumption, Housing Wealth, Home Equity Extraction, Market-Based Mortgage Holdings, Time-Varying Cointegration.

# 1. Introduction

Studying how housing wealth impacts consumption has garnered widespread attention recently in the macroeconomic literature. There has been a great deal of concern that the fluctuations in the stock and housing markets – particularly in house values – will yield significant impacts on consumer spending. According to the previous literature, consumption in the mid-1990s and mid-2000s became more sensitive to housing wealth changes (Carroll et al., 2011, Case et al., 2008, Iacoviello and Neri, 2010).

However, disagreements over the causes of the increase remain. Browning et al. (2013) summarize three alternative explanations. First, some in the literature posit that changes in housing wealth affect household consumption, i.e., the conventional wealth effect (Campbell and Cocco, 2007, Carroll et al., 2011), which suggests that households may consume more when their home values appreciate. As emphasized by Guo and Hardin (2017), more equity could benefit households in the long term as it provides fixed housing costs at a below-market rate, which serves as a hedge against the increase in the market rate of housing costs. This so-called housing dividend delivers a non-trivial effect on household non-housing consumption. Second, another strand of the literature focuses on the role that housing capital can play in loan collateral – i.e., the "collateral effect" (Iacoviello, 2004, Aoki et al., 2004, Buiter, 2008, Leth-Petersen, 2010, Browning et al., 2013). That is, rising home values can impact the spending of households by allowing them to borrow against their home value via home equity credit or cash-out refinancing. Third, the recent literature also argues that the growth of housing wealth and consumption can be driven by certain common factors, such as expectations about productivity growth (Aron et al., 2012) and financial liberalization (Attanasio and Weber, 1994, Aron et al., 2012, Duca et al., 2012). Thus, the influence of housing wealth on consumption may be overestimated if these common factors are ignored. Recent evidence shows that increasing housing wealth has economically significant effects on consumption for the period leading up to the 2007 financial crisis (Aladangady, 2017, Kaplan et al., 2020, Guren and McQuade, 2020, Farrell et al., 2020).

This paper aims to empirically investigate the conventional housing wealth effect and the collateral effect, as well as the influence of mortgage liberalization on the two types of wealth effects. We extend the aggregate consumption–wealth ratio model (Campbell and Mankiw, 1989, Lettau and Ludvigson, 2001; 2004), and incorporate home equity extractions (HEEs) and non-prime mortgage supply into the long- and short-run relationships between consumption and housing wealth. We show that lenders focus on collateral value and lend more out through HEEs when house price appreciates. The credit expansion provides liquidity to households and significantly improves their consumption.

Our study contributes to the existing literature in the following aspects. First, there is a lack of understanding between cash and equity in the literature. In this paper, we separate housing wealth into an equity part and a collateral part. The empirical results provide evidence that the collateral effect is positive and significant, but no noticeable long-term conventional wealth effect from a change in home equity. Conditional on the use of HEE, one dollar of extra increase in housing wealth is associated with an average of 0.84 cents increase in consumption from 1977 to 2019 and a maximum increase of 6.06 cents. The time-varying marginal propensity to consume (MPC) estimates in this study are consistent with the literature estimates with the use of both macro-level and micro-level data. Unlike the previous literature, our study shows that the MPC is mainly driven by the use of HEEs, rather than the changes in home equity value.

Second, we estimate the impact of mortgage market liberalization on the two types of housing wealth effects. We use the share of non-bank mortgage holdings to proxy mortgage market liberalization. With the advent of financial liberalization, market-based financial intermediaries (such as issuers of asset-backed securities (ABSs)) held more than 60% of the total home mortgages in the 2000s. This market shift increased the competition of banks and government sponsored enterprises (GSEs) and led to a decrease in incentives to maintain high lending standards (Hellmann et al., 2000, Loutskina and Strahan, 2011, Demyanyk and Loutskina, 2016, Nadauld and Sherlund, 2013). As a result, the supply of risky mortgages can increase. Previous studies in the literature have shown that financial liberalization affected housing market performance (Milcheva, 2013), subprime lending activities (Mian and Sufi, 2011), risky mortgage originations (Demyanyk and Loutskina, 2016), and market risk sharing and transfer (Acharya et al., 2013). In this paper, we provide evidence of its impact on the housing wealth effect. We find that credit liberalization affects the housing wealth effect mainly by amplifying the collateral impact. Over the long-term, the increase in the collateral impact is remarkable. With the increase in the non-bank mortgage supply, by 2007, the HEE shock explained for the most significant proportion of the forecast error variance of consumption growth, which amounted to 50%. This suggests that market-based lenders focused on collateral value and allowed more equity withdrawals, which consequently led to higher consumption.

The remainder of this paper is organized as follows. Section 2 provides a literature review, and Section 3 is an introduction of our theoretical framework. Section 4 presents the econometric setting and data. Our empirical results are in Section 5, and Section 6 concludes the paper.

## 2. Literature Review

The impact of fluctuations in household housing wealth on consumption has received widespread attention (e.g., see Abdallah and Lastrapes, 2013, Belsky and Prakken, 2004, Kishor, 2007, Bostic et al., 2009, Case et al., 2008, Guo and Hardin, 2014, Tsai et al., 2012, Zhu et al., 2019, among many others). There has been ample evidence that shows the economically significant impact of increasing housing wealth on consumption for the period leading up to the 2007 financial crisis. Mian et al. (2013) and Aladangady (2017) show that the MPCs of housing wealth range from approximately 4 to 9 cents between the late 1990s and through the financial crisis,[1] while Kaplan et al. (2020) suggest that the MPC may have been as high as 11 cents during the crisis period. Pistaferri (2016) documents a decline in the MPC from approximately 4 cents for the period of 1998 to 2009 to 0 cents from 2010 to 2015. Guren and McQuade (2020) estimate the housing wealth effect from the 1980s to mid-2010s and find lower MPCs in certain years than other studies. However, their estimated average MPC for the entire period is in line with that of other studies. Farrell et al. (2020) show that the MPC of housing wealth between 2012 and 2019 is near zero, using individual account-level mortgage, deposit account, and credit card data for 1.7 million bank customers based on an ordinary least squares (OLS) regression.

There is evidently no consensus among researchers on whether housing wealth affects consumption spending through the conventional housing wealth effect or via the collateral effect. Some in the literature posit that there is no significant collateral effect because the major impact of extracted home equity is to allow households to diversify their wealth holdings, rather than to drive consumption (Greenspan and Kennedy, 2008). Using U.S. panel data from 1984 through to 1996, Hurst and Stafford (2004) find that liquidity-constrained households convert two-thirds of every $1 removed in refinancing to consumption; non-liquidity-constrained households do not use any of those funds for consumption. Using Danish household data from 1987–1996 and the difference-in-difference method, Leth-Petersen (2010) finds a statistically significant but economically moderate impact of the 1992 credit reform that enabled Danish households to use housing as collateral. Guo and Hardin (2017) emphasize the impact of home equity. They define housing dividend as the difference between the market rent and the actual house ownership costs. In addition to price appreciation, house dividend provides a hedge against long term increases in market housing cost and delivers a non-trivial effect on household non-housing expenditures, after controlling for housing value, housing equity, financial assets and income.

In contrast, others in the literature argue that the collateral effect plays a critical role in explaining the housing wealth effect. Buiter (2008) argues that changes

[1] The marginal propensity to consume is the proportion of an increase in income or wealth that a consumer chooses to spend on goods and services rather than save.

in housing prices affect consumption only through two channels: 1) redistribution effects, if the MPC differs between those who are long and short housing, and 2) collateral effects. Therefore, a significant conventional housing wealth effect should not exist. Using the Danish household data, Browning et al. (2013) find that total household expenditures are not correlated with unexpected innovations to house prices, thus indicating that there is no significant conventional housing wealth effect. Case et al. (2008) observe consumption in ten developed countries. They find that when the HEE is added to the long-run relationship, the coefficient of housing wealth on consumption becomes insignificant in the U.S. market. Based on a dynamic stochastic general equilibrium (DSGE) model, Iacoviello and Neri (2010) find that the collateral effect increases a reduced-form elasticity of consumption to housing wealth from about 0.11 to 0.135. Before the 1980s, the housing collateral effect contributed to approximately 6% of the variance in consumption growth. After the 1980s, this rose to 12%. Using U.S. household data, Guo and Hardin (2014) document that the mortgage balance has a larger impact on consumption than net home equity. Wealthier households—those with a potentially greater percentage of net worth in financial assets—are less likely to finance consumption through loans with the use of housing as collateral.

Another strand of the literature links the increase in the housing wealth effect to financial liberalization. Financial liberalization can affect consumption by changing the proportion of liquidity constrained and unconstrained households (Campbell and Mankiw, 1989, Aron and Muellbauer, 2013) and increase the marginal availability of funds for credit-constrained agents (Iacoviello and Neri, 2010). For example, Duca et al. (2012) estimate the change in the U.S. housing wealth effect from 1965 to 2010 conditional on the liquidity of housing wealth. They measure the liquidity of housing wealth as an unobserved component that is related to refinancing activities. Financial liberalization is measured by the willingness of banks to grant unsecured loans. Their empirical work shows that, due to the increased liquidity, housing wealth has been responsible for an increasingly larger proportion of consumption since 1970. Our paper differs from Duca et al. (2012) in two ways. First, we explicitly investigate the impact of HEE on the housing wealth effect. Second, we use an alternative way to measure financial liberalization. Instead of the unsecured loan supply provided by banks, we focus on the loan supply provided by mortgage pools and private asset bank securities (ABS) issuers – a credit mix variable. A mix variable of the credit supply by banks and non-banks has been introduced in Kashyap et al. (1993) to identify the loan supply shock (Demyanyk and Loutskina, 2016, Nadauld and Sherlund, 2013). The advantage of using a mix variable is that it does not change following a credit demand shock, as both market-based and bank credit are expected to increase concurrently. A shock in a mix variable should be associated with changes in credit supply and not credit demand, as "a general change in the demand for credit, all else equal is assumed to change the demand for credit from the deposit-financed commercial/savings banks and the bond-financed mortgage banks in equal proportions and thereby not alter the credit mix" (Abildgren, 2012).

# 3. Theoretical Framework

In the theoretical framework, we divide households into three categories: unconstrained, liquidity-constrained, and credit-constrained households. *Unconstrained households* face no restrictions on their borrowing; they have access to all kinds of credit. They are patient consumers and make their consumption decision based on existing and expected wealth. *Liquidity-constrained households* are not cut off from all borrowing possibilities; they can borrow when an increase in the value of their home gives them access to additional funding opportunities. They have access to secured loans such as home equity loans, but not to non-secured loans. They are rule-of-thumb consumers and would spend all they hold, including income and extracted home equity (Aoki et al., 2004, Hurst & Stafford, 2004). *Credit-constrained households* have no access to any form of credit, so their consumption simply comes from their income. The three following sections calculate the consumption of these three groups of households.

## 3.1 Unconstrained Households

Unconstrained households have access to all forms of credit, and adjust their consumption based on existing and expected wealth. Given a representative agent economy, where $W_t$ is the total wealth at time $t$, their budget constraint is:

$$W_{t+1} = (1+R_{w,t+1})(W_t - C_t^u) \qquad (1)$$

where $R_{w,t}$ denotes the rate of return on aggregate wealth and $C_t^u$ is the consumption of an unconstrained household.

Assuming $r \equiv \log(1+R)$, we take a first-order Taylor approximation of Equation (1) and solve the resulting differential equation for log wealth. Imposing a transversality condition and assuming expectations, the consumption wealth ratio (Campbell and Mankiw,1989) is derived as follows:

$$c_t^u - w_t = E\sum_{i=1}^{\infty} \rho_w^i (r_{w,t+1} - \Delta c_{t+i}^u) \qquad (2)$$

where $\rho_w^j$ represents the steady-state value of the ratio of investment to consumption, and $\Delta c_{t+i}^u$ is the consumption growth rate between time $t$ and $t+i$. Equation (2) implies that, given any deviation from the long-run ratio of consumption and wealth, wealth or consumption would be adjusted accordingly to correct the disequilibrium.

Lettau and Ludvigson (2001) decompose wealth $W$ into three parts: financial wealth ($F_t$), human wealth ($L_t$), and housing wealth ($H_t^{Total}$):

$$W_t = F_t + L_t + H_t^{Total} \tag{3}$$

In line with Aron et al. (2012) and Duca et al. (2012), where financial wealth is divided into liquid and illiquid parts, we separate housing wealth into home equity and extracted home equity. Home equity is illiquid. However, via cash-out refinancing or home equity credit, households can extract equity from their illiquid home wealth. So, the HEE represents the increase in the net worth of households relative to their debt. Hence, we substitute total housing wealth ($H_t^{Total}$) in Equation (3) with two terms: the home equity ($H_t^{Equity}$), and the HEE ($H_t^{HEE}$):

$$W_t = F_t + L_t + H_t^{Equity} + H_t^{HEE} \tag{4}$$

Equation (4) can, therefore, be log-linearized as:

$$w_t \approx \omega f_t + \theta l_t + (1-\omega-\theta)(1-\gamma)h_t^{Equity} + (1-\omega-\theta)\gamma h_t^{HEE} \tag{5}$$

where the lower-case letters represent the logarithms of the corresponding variables. $\omega$ is the steady-state share of financial wealth, $\theta$ is the steady-state share of labor income, and $\gamma$ is the steady-state ratio of extracted home equity to total housing wealth. The sensitivity of consumption to the extracted home equity determines the level of collateral effect of housing wealth on consumption. Keeping other things constant, the elasticity of consumption to home equity reflects the conventional wealth effect.

Given $W_t = F_t + L_t + H_t^{Total}$, the aggregate gross wealth return can then be decomposed as:

$$(1+R_{W,t}) = \omega_t(1+R_{F,t}) + \theta_t(1+R_{L,t}) + (1-\omega_t-\theta_t)(1+R_{H,t}) \tag{6}$$

where $\omega_t$ represents the ratio of financial wealth to total wealth in period *t*, and $\theta_t$ is the ratio of human wealth to total wealth. We can log-transform Equation (6) as follows:

$$r_{W,t} \approx \omega r_{F,t} + \theta r_{L,t} + \left(1-\omega-\theta\right) r_{H,t} \tag{7}$$

If we substitute for $w_t$ and $r_{W,t}$ using the relationship in Equations (5) and (7), we can obtain

$$\begin{aligned} & c_t^u - \omega f_t - \theta y_t^u - (1-\omega-\theta)(1-\gamma)h_t^{Equity} - (1-\omega-\theta)\gamma h_t^{HEE} \\ & = E_t \sum_{i=1}^{\infty} \rho_w^i (\omega r_{F,t+i} + \theta r_{L,t+i} + (1-\omega-\theta) r_{H,t+i} - \Delta c_{t+i}^u) + z_t \end{aligned} \tag{8}$$

where $y_t^u$ is the observed income of unconstrained households, which is a proportion of the unobserved human wealth: $l_t = y_t^u + z_t + \tau$. Lettau and Ludvigson (2001, 2004) suggest using $y_t^u$ to proxy $l_t$. $\rho_w^i$ represents the steady-state value of the ratio of investment to consumption, and $\Delta c_{t+i}^u$ is the consumption growth rate between time *t* and *t+i*. Equation (8) implies that, given any deviation from the long-run ratio of consumption and wealth, wealth or consumption would be adjusted accordingly to correct the disequilibrium. Since the right side of Equation (8) is stationary, it can be written as:

$$c_t^u = \omega f_t + \theta y_t^u + (1-\omega-\theta)(1-\gamma)h_t^{Equity} + (1-\omega-\theta)\gamma h_t^{HEE} + \eta_t \qquad (9)$$

## 3.2 Liquidity-Constrained Household

Equation (9) denotes the behavior of forward-looking households who do not face current credit constraints. Alternative households have constraints on their borrowing. According to Aoki et al. (2004) and Hurst and Stafford (2004), they are impatient households. Their consumption equals their current labor income, plus the extracted home equity:

$$C_t^{c1} = Y_t^{c1} + H_t^{HEE} \qquad (10)$$

where $C_t^{c1}$ stands for the consumption of liquidity-constrained households. After log-transformation and linear approximation, we obtain:

$$c_t^{c1} \approx (1-\delta)y_t^{c1} + \delta h_t^{HEE} \qquad (11)$$

where $\delta$ is the steady-state ratio of extracted home equity to consumption.

## 3.3 Credit-Constrained Household

The third group of households, credit-constrained households, has no borrowing possibilities. Therefore, their consumption equals their income: $c_t^{c2} = y_t^{c2}$, , where $c_t^{c2}$ denotes the log-transformed consumption of credit-constrained households.

## 3.4 Total Consumption

We can represent total consumption as:

$$C = C_t^u + C_t^{c1} + C_t^{c2}$$

After log-linearization, we have:

$$c \approx \pi_1 c_t^{c1} + \pi_2 c_t^{c2} + (1-\pi_1-\pi_2)c_t^u \qquad (12)$$

Using $\pi_1$ to denote the steady-state ratio of unconstrained households to total households, and $\pi_2$ to denote the share of liquidity-constrained households, $1-\pi_1-\pi_2$ is the proportion of credit-constrained households. We assume $y_t^u \approx \alpha_1 y_t$, $y_t^{c1} \approx \alpha_2 y_t$, and $y_t^{c2} \approx \alpha_3 y_t$, where $a_1$, $a_2$, and $a_3$ are the ratio of the income of unconstrained households, liquidity-constrained households, and credit-constrained households to aggregate income, respectively. The total consumption of the three groups of households is:

$$
\begin{aligned}
& c_t = \beta_y y_t + \beta_f f_t + \beta_h h_t^{Equity} + \beta_{hee} h_t^{HEE} + u_t \\
& \text{with} \quad \beta_y = \pi_1 \theta a_1 + \pi_2 (1-\delta) a_2 + (1-\pi_1-\pi_2) a_3 \\
& \qquad\quad \beta_f = \pi_1 \omega \\
& \qquad\quad \beta_h = (1-\omega-\theta)(1-\gamma)\pi_1 \\
& \qquad\quad \beta_{hee} = (1-\omega-\theta)\gamma\pi_1 + \delta\pi_2
\end{aligned}
\tag{13}
$$

Campbell and Mankiw (1989) suggest that credit liberalization, particularly a larger credit supply to non-prime borrowers, affects consumption by changing the proportion of credit-constrained households. With improved access to credit, more households, primarily low-income households, can possess housing assets. Therefore, the aggregate portion of housing wealth $(1 - \omega - \theta)$ can increase, which in turn increases both the conventional and the collateral effect. Additionally, credit liberalization, such as the advent of cash-out refinancing, also allows households to extract more from their housing wealth. When the HEE ratio $\gamma$ increases, the elasticity of consumption with respect to HEE could also increase. The following presents our proposition.

Proposition: *with financial liberalization, the elasticity of consumption with respect to HEE increases.*

# 4. Econometric Setting and Data

## 4.1 Econometric Model

### 4.1.1 Constant Wealth Effect

Note that the right side of Equation (12) is stationary, which indicates that total consumption, income, financial wealth, conventional housing wealth, and the HEE ratio should exhibit cointegration relationships. Therefore, we use a vector error correction model (VECM) to investigate the long- and short-term wealth effects.

$$
\Delta x_t = \upsilon + \alpha\beta' x_{t-1} + \sum_{k=1}^{p-1} \Gamma_k \Delta x_{t-p} + \sum_{k=1}^{p-1} \Phi_k D_{t-p} + \varepsilon_t \tag{14}
$$

where $x$ is a vector of consumption ($c$), unsecured bank loan supply measured by unsecured consumer credit conditions index ($CCI$), income ($y$), home equity ($h^{pure}$), financial wealth ($f$), and the HEE ratio ($HEE$), so that $x = [c \quad y \quad CCI \quad f \quad h^{pure} \quad HEE]$. Aron et al. (2012) suggest that the influence from the consumer credit supply should not be ignored, because that can lead to overestimating the wealth effect. Therefore, we include CCI in the long-run relationship. $\alpha$ are vectors of the adjustment coefficients, and $\beta$ denotes a matrix of long-run elasticity.

*D* denotes other stationary control variables. We control for the change in the unemployment rate (d_ump), that is, the income growth expectation ($E_t \Delta y^m_{t+1}$). Since the influence of interest rate is insignificant in the long-term relationship, we include the interest rate only in the short-term dynamics. As the shock that affects income growth expectations may correlate with the shock of consumption growth, we use a one-period lag of income growth expectation as the instrument variable. We try up to four-period lags of income growth expectation as instrument variables. The results are robust.

$\Gamma_k$ and $\Phi_k$ are the infinite order distributed lag operators. Based on the Bayesian information criterion (BIC), the information criteria indicate one lag of autoregressive terms (*p*=1). $\varepsilon_t$ is the error term.

### 4.1.2 Time-Varying Wealth Effect

To estimate the change in the wealth effect, we allow the long- and short-term coefficients to vary over time, as follows:

$$\Delta x_t = \upsilon + \alpha \beta_t' x_{t-1} + \Gamma'_t \Delta x_{t-1} + \Phi_1 D_{t-1} + \varepsilon_t \tag{15}$$

The estimation of Equation (15) follows the time-varying cointegration technique in Bierens and Martins (2010), in which the time-varying coefficients are calculated based on the Chebyshev time polynomial. Our time-varying long-run coefficients are conditional on the indicator of credit supply.

Let $\beta_t' x_{t-1} = \xi' x^{min}_{t-1}$ and $\Gamma_t' x_{t-1} = \Psi' \Delta x^{min}_{t-1}$, and we obtain

$$\Delta x_t = \upsilon + \alpha \xi' x^{mix}_{t-1} + \Psi' \Delta x^{mix}_{t-1} + \Phi_1 D_{t-1} + \varepsilon_t \tag{16}$$

with $x^{mix}_{t-1} = [c_{t-1} \quad y_{t-1} \quad CCI_{t-1} \quad f_{t-1} \quad h_{t-1} \quad HEE_{t-1} \quad mix^f_{t-1} y_{t-1} \quad mix^f_{t-1} CCI_{t-1} \quad mix^f_{t-1} f_{t-1} \quad mix^m_{t-1} h_{t-1} \quad mix^m_{t-1} HEE_{t-1}]$
$\xi' = [\beta_r' \quad \beta_r^{mix\prime}]$, and $\Psi' = [\Gamma_r' \quad \Gamma_r^{mix}]$ where $mix^f_t$ denotes the variable to measure the credit supply in consumer credit lending, and $mix^m_t$ is for mortgage lending. The two mix variables are standardized between 0 and 1 to account for the mortgage market development in period *t* relative to all of the other periods.

## 4.2 Data

### 4.2.1 Consumption and Wealth Data

Consumption includes seasonally adjusted durable goods, non-durable goods, and service expenditures, but excludes food and energy expenses and housing services. As a robustness check, we also differentiate between durable and non-durable consumption, which have different characteristics as documented in previous studies in the literature.

We calculate labor income as wages/salaries + transfer payments + other labor income - personal contributions for social insurance - taxes. Financial wealth is defined as the difference between financial assets and liabilities. Total housing wealth is calculated as household real estate assets, excluding home mortgages. Home equity is calculated as total housing wealth, subtracted by net HEEs. We use quarterly U.S. data from 1977Q1 to 2019Q4, obtained from the Bureau of Economic Analysis, Flow of Funds, and Federal Home Finance Agency.

All data are based on current prices. The consumer price index is used to deflate these series (with 1983 as the base period). The series are then converted to per capita series. Financial and housing wealth, and income are also seasonally adjusted. The population data are from U.S. labor statistics, and the consumer price index is from the Bureau of Economic Analysis.

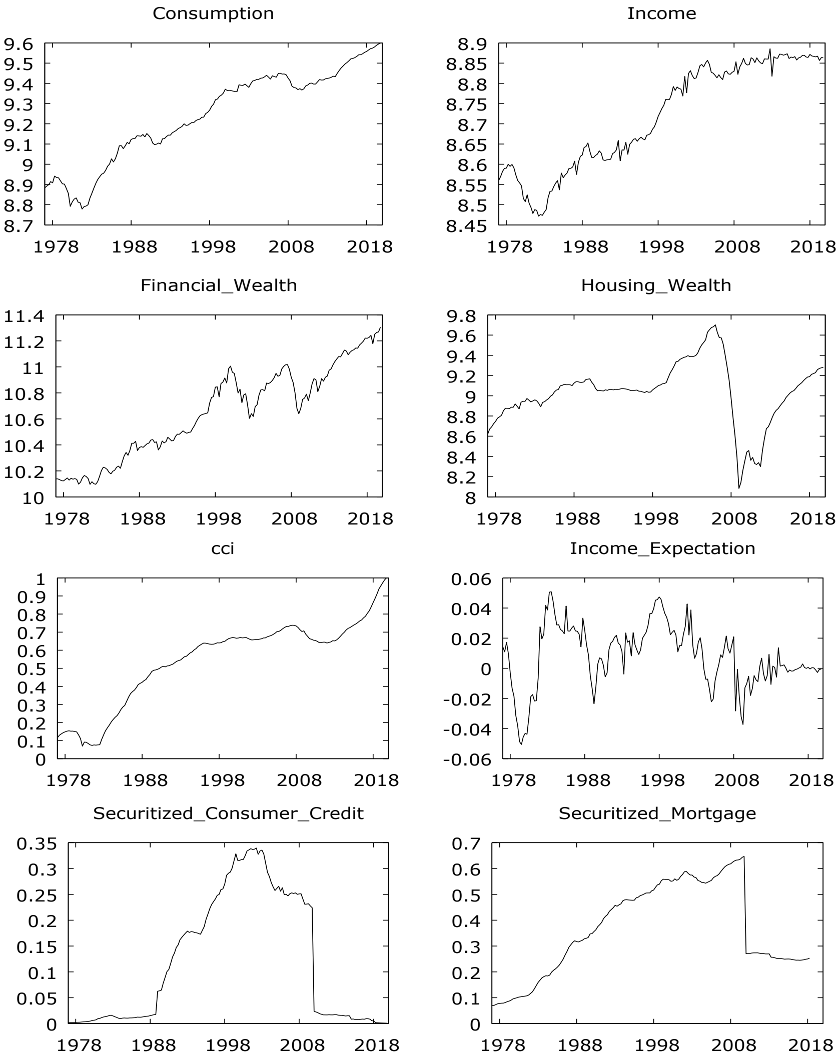
### 4.2.2 Credit Liberalization Variables

With regulatory changes and market liberalization, the U.S. mortgage market has undergone a gradual structural shift. Instead of depository institutions, mortgage companies became the primary holders of home mortgages in the 2000s. This shift has had a profound impact on the U.S. mortgage market by increasing the mortgage supply, especially lending to non-prime borrowers (Nadauld and Sherlund, 2013, Demyanyk and Loutskina, 2016).

The mortgage mix variable is defined as the ratio of home mortgage holdings by market-based financial intermediaries to outstanding total mortgages of households, including agency-backed mortgage pools, and issuers of asset-backed securities (Adrian and Shin, 2008). As Figure 1 shows, the banks and deposit institutions were the dominant holders of home mortgages until the early 1980s. Since the 1990s, GSEs and agency-backed mortgage pools and issuers of ABSs have become the primary holders. During the crisis, the share dropped to less than 25% (see Figure 1). The data come from the Flow of Funds and Securities Industry and Financial Markets Association (SIFMA) Statistics Database.

The growing importance of market-based financial intermediaries extends to other forms of lending, such as consumer loans for credit card and automobile purchases. And, similar to the mortgage mix variable, the consumer credit mix variable is defined as the ratio of consumer credit loans held by private issuers of ABSs to total consumer credit loans (Adrian and Shin, 2008). Before 1980, consumer loans were granted only by banks. However, in 2003, the share of non-bank consumer credit holdings reached a record high of 30% (see Figure 1). After that, it gradually fell to 20% in 2007. During the crisis, loan supplies by market-based financial intermediaries stopped. The data are from the Flow of Funds.

**Figure 1 Overview of Variables**



### 4.2.3 Equity Extraction from Home

We use the HEE ratio to measure the intensity of HEEs, which is calculated as the ratio of net extracted home equity to total housing wealth. Greenspan and Kennedy (2008) define gross equity extraction as the discretionary initiatives of homeowners to convert equity in their homes into cash by borrowing in the residential mortgage market. We base our HEE data from 1977Q1 to 2019Q4 by using the method proposed by Bill McBride (a retired technology executive in the USA), which is a simplified version of the calculations in Greenspan and Kennedy (2008).[2] Figure 2 shows the estimated ratio. The ratio series exhibit a noticeable seasonal effect. We smooth the ratio by using a four-quarter moving average. The HEE ratio has increased since the 1990s, and peaked in 2004.

Note that the HEE can be affected by housing price changes and the mortgage credit supply. For example, Mian and Sufi (2011) and Disney and Gathergood (2011) show that homeowners in high house price appreciation areas tend to borrow heavily against their home equity. A rise in housing prices provides households with a positive gain, theoretically motivating households to extract even more equity. HEE may thus actually track the evolution of housing wealth development.

Using a Granger causality test, we find that the growth in the equity extraction ratio is significantly predicted by housing price growth (Table 1). We subtract the influence of housing price growth from HEE increases. We then transform the adjusted growth rate of HEEs to the level rate. From Figure 2, we observe that the adjusted extraction ratio is lower than the original, especially during the 2000s.

### 4.2.4 Other Variables

Consumption can be affected by unsecured consumer credit supply. Duca et al. (2012) construct an unsecured consumer credit conditions index to proxy for the willingness of banks to lend to consumers. This index is based on the findings of the Senior Loan Officer Opinion Survey on Bank Lending Practices conduced by the Federal Reserve. Duca et al. (2012) modify the index to remove the influence of the interest rate and the macroeconomic outlook and leave only regulatory influences such as credit controls, Regulation Q, and the London Inter-bank Offered Rate (LIBOR) spread with the federal funds rate.

Second, based on the permanent income theory, consumption can also be affected by income growth expectations. We follow Aron et al. (2012) and measure the difference between permanent income and labor income by using $E_t \Delta y_t^m$, where $\Delta y_t^m$ is defined as a weighted moving average of forward-

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[2] Detailed information is at: http://www.calculatedriskblog.com/2013/06/q1-2013-mortgage-equity-withdrawal.html.

looking income growth rates. $\Delta y_t^m$ is then regressed on a constant, the unemployment rate, year-over-year T-bill yield, and University of Michigan index of consumer expectations of future economic conditions. We use the fitted value of income growth rate to proxy for the income growth expectation $E_t \Delta y_t^m$, (see Figure 1).

**Table 1 Home Equity Extraction**

Notes: The estimate is based on a vector autoregressive (VAR) model using the data from 1977Q1 to 2019Q4. It includes four variables: housing price (hp), real interest rate (ir), mortgage mix variable (mix), and home equity extraction ratio (HEE):

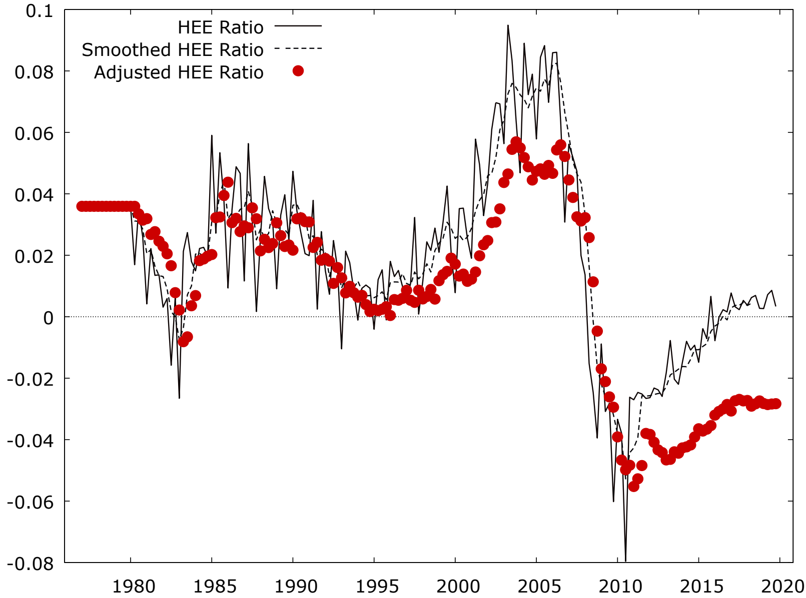
$$\Delta x_t = \nu + \sum_{k=1}^{4} \Gamma_k \Delta x_{t-k} + \varepsilon_t$$

The Granger causality test is based on an F restriction test. Each equation is in one row. Only significant coefficients in the equation for the HEE ratio are reported (the full set of results is available from the authors upon request). Standard deviations are in parentheses. ***, **, and * denote significance at the1%, 5%, and 10% levels, respectively.

| Granger causality test | d_hp | d_ir | d_mix | d_HEE |
|---|---|---|---|---|
| Eq1: d_*hp* | 578.21*** | 2.857** | 7.002*** | 2.293* |
| Eq2: d_*ir* | 7.451*** | 3.174** | 1.429 | 1.088 |
| Eq3: d_*mix* | 8.258*** | 2.529** | 1.0488 | 0.571 |
| Eq4: d_*HEE* | 6.971*** | 1.5706 | 16.548*** | 10.287*** |

| HEE Equation | | Coefficient |
|---|---|---|
| d_hp_2 | | 0.4762** |
| | | (0.1456) |
| d_hp_3 | | -0.4488* |
| | | (0.2285) |
| d_mix_2 | | 0.0280*** |
| | | (0.0111) |
| d_mix_4 | | -0.0448*** |
| | | (0.0109) |
| d_ir_1 | | -0.0008** |
| | | (0.0004) |
| d_HEE_1 | | 0.2252*** |
| | | (0.0765) |
| d_HEE_2 | | 0.1591** |
| | | (0.0739) |
| d_HEE_3 | | 0.1769** |
| | | (0.0718) |
| d_HEE_4 | | -0.3623*** |
| | | (0.0734) |
| Adjusted R2 | 0.4035 | |

**Figure 2 Ratio of Home Equity Extraction to Total Home Equity**




# 5. Empirical Results

## 5.1 Estimation Results

Table 2 shows the results for the model with the constant wealth effect (Model 1) and the time-varying wealth effect (Model 2). The latter is conditional on the two mix variables. Compared to Model 1, Model 2 fits the consumption data better with a higher adjusted R2. The likelihood ratio statistic (Bierens and Martins, 2010) also confirms that including mix variables for a time-varying cointegration relationship can significantly improve the goodness of fit of the overall model.[3]

Based on Model 2, mortgage liberalization amplifies the collateral effect, which is captured by the significantly positive coefficient for the interaction variable (HEE_MIX) between the share of HEEs and the standardized mortgage market development indicator (MIX). As mentioned in the previous section, the mortgage market development indicator is measured by the market-based securitization share of mortgages. In 2007, when the percentage of mortgage pools and private ABS mortgage holdings rose to its highest level – 60% of the total home mortgage, a 1% increase in HEE was associated with a 1.53% increase in consumption, which is statistically significant and economically

[3] The cointegration model estimates the long term static results, which do not capture the dynamic inter-temporal consumption path.

remarkable. However, in 1977, when banks were the dominant lenders in the mortgage market, the elasticity of consumption spending with respect to HEE was insignificant. The increased share of non-banks mortgage supply is primarily associated with securitization activities and the increasingly predominant role of market-based financial intermediaries in the mortgage market. Securitization activities allow mortgage originators to avoid holding mortgages on their balance sheets. Therefore, they can reduce the cost of lending and/or discourage lenders to screen borrowers carefully (Nadauld and Sherlund, 2013). Additionally, market-based financial intermediaries only face a weak form of safety and soundness regulations. Thus, they tend to originate riskier mortgages (Demyanyk and Loutskina, 2016). As a result, this structural shift is strongly related to the relaxed credit-constrained and riskier mortgage supply, which can increase housing wealth ownership and the use of HEE. Consequently, the elasticity of consumption spending with respect to HEE increases.

**Table 2 Estimated Results**

Notes: Estimation for the period 1977Q1to 2019Q4. Model 1 estimates constant wealth effects. Model 2 estimates time-varying wealth effects conditionally on credit mix variables. Income growth expectation uses a one-period lag of expected income growth as the instrument. In the interaction term, CCI and mix variable are standardized variables. We only report the equation with the variable of consumption growth as the dependent variable. The full results are available from the authors upon request. We use the likelihood ratio (L.R.) test to determine whether time-varying cointegration can substantially improve the fit of the models, compared with constant cointegration. the L.B. test is the Ljung-Box test for autocorrelation, with a null hypothesis of no one- to four-order autocorrelation. ARCH test has the null hypothesis of no one- to four-order ARCH effect. Standard deviations are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. # indicates that the results are for the equation with the variable of consumption growth as the dependent variable.

| | Model 1: VECM Model | Model 2: TV-VECM Model |
|---|---|---|
| Long-run relationship | | |
| *C* | 1.000 | 1.000 |
| *y* | 1.2151*** | 0.9629*** |
| | (0.1227) | (0.1271) |
| *y_mix* | | -0.0265 |
| | | (0.1240) |
| *CCI* | 0.3659*** | 0.3981*** |
| | (0.0367) | (0.0593) |
| *CCI_mix* | | 0.3530 |
| | | (0.2451) |
| *f* | 0.0583 | 0.1025 |
| | (0.0390) | (0.0866) |

**(*Continued…*)**

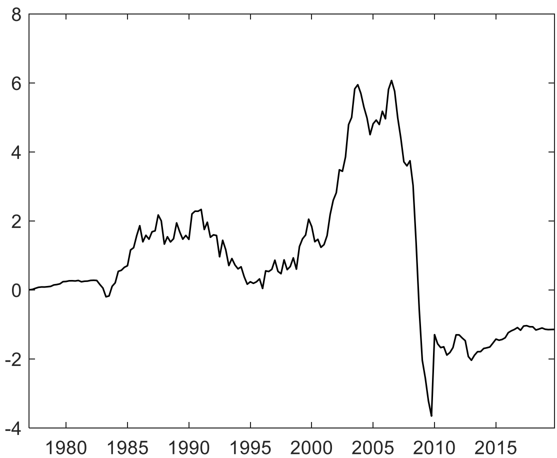
**(Table 2 Continued)**

| | Model 1: VECM Model | Model 2: TV-VECM Model |
|---|---|---|
| *f_mix* | | -0.0027 |
| | | (0.1100) |
| *h* | -0.0292 | -0.0360 |
| | (0.0236) | (0.0240) |
| *h_mix* | | 0.0026 |
| | | (0.0037) |
| *HEE* | 0.3050 | -0.4804 |
| | (0.3012) | (0.4572) |
| *HEE_mix* | | 1.5290** |
| | | (0.6839) |
| Short-run dynamics# | | |
| $\alpha_1$ | -0.1154*** | -0.1301*** |
| | (0.0392) | (0.0479) |
| *d_c_1* | −0.1377 | -0.1209 |
| | (0.0876) | (0.0861) |
| *d_y_1* | 0.14887 | 0.4632** |
| | (0.1629) | (0.2296) |
| *d_y_mix_1* | | -0.6079 |
| | | (0.4141) |
| *d_CCI_1* | 0.6027*** | 0.5047*** |
| | (0.1279) | (0.1448) |
| *d_CCI_mix_1* | | -0.0590 |
| | | (0.3997) |
| *d_f_1* | 0.0475 | 0.1724* |
| | (0.0502) | (0.1011) |
| *d_f_mix_1* | | -0.2074 |
| | | (0.1336) |
| *d_h_1* | 0.0406 | 0.0052 |
| | (0.0176) | (0.0448) |
| *d_h_mix_1* | | 0.0695 |
| | | (0.0585) |
| *d_HEE_1* | -0.1720 | -0.3431 |
| | (0.2034) | (0.4505) |
| *d_HEE_mix_1* | | -0.1301*** |
| | | (0.0479) |
| $E_t \Delta y_{t+1}^m$ | 0.3227*** | 0.2745*** |
| | (0.0536) | (0.0504) |
| d_Ump | 0.0032 | 0.0060 |
| | (00036) | (0.0037) |
| Diagnostics | | |
| Adjusted R2# | 0.3117 | 0.3141 |
| LB test# | 4.82 | 3.13 |
| ARCH test# | 2.64 | 2.06 |
| L.R. (35) | | 83.0*** |

Interestingly, the illiquid part of housing wealth does not show a significant relationship with consumption. This indicates that house price influences the consumption mainly because HEE provides a cheap way for households to "liquidate" their home. With the increased collateral value and liberalized mortgage market, lenders allow more equity withdrawals, which stimulates consumption.

We convert the estimated long-run elasticity to the MPC by multiplying it with the average consumption wealth ratio. Figure 3 illustrates the housing MPC, conditional on the HEE ratio. The insignificant long-term coefficient of consumption with respect to home equity implies a zero MPC by home equity. Conditional on the use of HEE, housing wealth has an average MPC of 0.84 cents. At the beginning of the 1990s, the HEE ratio decreased probably due to the increased capital ratio requirement, and consequently, housing wealth dropped. Since 2000, the housing MPC shows the most severe increase and soared to 6.06 cents in 2007 because of the increased use of cash-out refinancing and intensified mortgage securitization. This finding is consistent with the result with the use of household survey data from 1989 to 2001 in Bostic et al. (2009).

**Figure 3 Marginal Propensity to Consume of House Wealth**




Regarding the other control variables, our results show that in the long run, a 1% rise in the labor income increases consumption by 0.93%. A 1% increase in the unsecured loan supply index increases consumption by 0.40%. In the short term, consumption growth is positively affected by the change in consumer credit loan supply and financial wealth. Besides, consumption growth is negatively influenced by the previous change in extracted home equity and the impact is amplified by the mortgage market liberalization. The negative coefficient reflects a mean-reversion process. Moreover, consumption is significantly and positively influenced by income growth expectations, which is in line with the permanent income theory. The interaction of income growth expectation and unsecured loan supply is significantly negative, which confirms the buffer-stock theory (Carroll, 1997); that is, an increased credit supply reduces the impact of income expectations on consumption growth. Consequently, consumers, especially buffer-stock savers, would be less affected by their income uncertainty and future expectations.

## 5.2 Responses to Housing and HEE Shocks

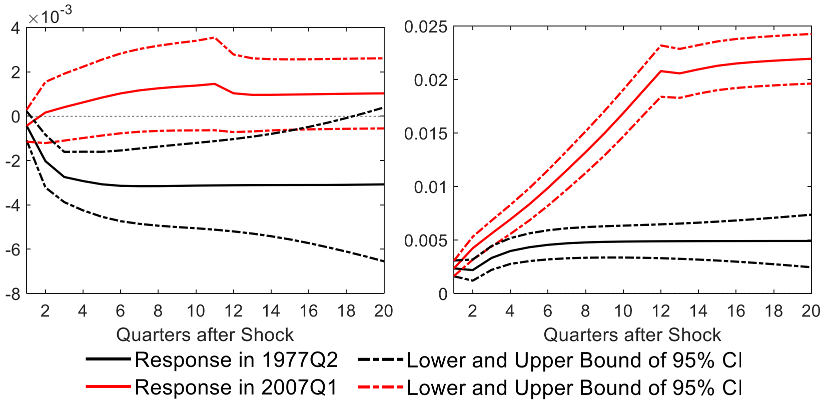
We further show the response of consumption growth to a one standard deviation exogenous positive shock in home equity and HEE to provide further evidence of the impact of the two kinds of housing wealth effects on consumption in the short term. The HEE shock is a one-time increase in the HEE ratio, calculated as one standard deviation of the error terms in the HEE equation of the equation system (Equation 16). Home equity shock is defined as a one-time increase in the home equity, amounting to one standard deviation of the error term in the home equity equation. Figure 4 shows the response of consumption to these two one-time shocks. For comparison, we show the responses when the shock is in 1977Q2 (with black lines), and 2007Q1 (with red lines). The solid line shows the expected responses, and the dotted line illustrates the upper and lower 95% confidence intervals. The Cholesky decomposition order is CCI – Income – HEE –Housing wealth – Financial wealth – Consumption. This decomposition helps to solve the identification problem in the simultaneous correlations between shocks.

In 1977, consumption responded negatively to the home equity shock, and in 2007, the response became insignificant. Compared to the response to HEE shock, the response to home equity shock is marginal. In 1997, the response to the HEE shock was low, amounting to 0.5% twenty quarters after the shock. With the liberalized credit supply, the influence of the HEE shock increased noticeably. In 2007Q1, the response to the HEE shock grew to 2.3% in the twelfth quarter after the shock. It was over five times that in 1977. The change in the composition of the lenders provides households with greater access to HEE, which leads to a higher impact of HEE shock on consumption.

Figure 5 shows the responses at T=20, when the shock arrives from 1977 to 2019. The solid line shows the responses to the HEE shock, and the dotted line shows the responses to the home equity shock. The response to the HEE shock is significantly stronger than that of the housing shock from 1990 to 2007. The response to the home equity shock was insignificant in most periods. The impact of the HEE shock grew remarkably in the 1990s. With the advent of cash-out refinancing and rapid growth of non-bank mortgage holdings, the influence of the HEE shocks soared. The maximum response appeared in 2007, which amounted to a 2.7% increase in consumption growth in the twentieth quarter after the shock. In 2010, with the bust of subprime mortgage and tightened credit standards, the credit supply by market-based financial intermediaries decreased remarkably. Consequently, the influence of the HEE shock dropped to that of the 1977 level. The results in Figures 3 and 5 show a near-zero impact of housing wealth on consumption after 2010, which is consistent with the findings in Farrell et al. (2020), which uses the account data of 1.4 million bank customers. Unlike their study, we also document that HEE has a much stronger impact than home equity and the impact varies with credit supply.

**Figure 4 Impulse Response of Consumption to Housing and HEE Shocks**

(a) Response to home equity shock (b) Response to HEE shock




***Note***: Solid lines show the response of consumption growth to one standard deviation housing and HEE shocks that happened in 1977Q2 (Figure 4(a)) and 2007Q1 (Figure 4(b)) based on time-varying VECM model (Model 2). Dotted lines show the upper and lower 95% confidence interval of responses to the corresponding shocks.

Figure 6 decomposes the forecast error variance of consumption growth in 1977 and 2007. In 1977Q2, we note that the consumer credit supply shock had the most significant impact on consumption growth, and explained for nearly 40% of the forecasting variance, in the twentieth quarter after the shock. The financial and income shocks explained for around 15% of the consumption variations, respectively. In 2007, the HEE shock became the most crucial factor and contributed to over 50% of the forecast error variance of consumption growth, when the mortgage pools and issuers of asset-backed securities held nearly 60% of the home mortgages.

**Figure 5 Responses of Consumption to Home Equity and HEE Shocks at T=20**

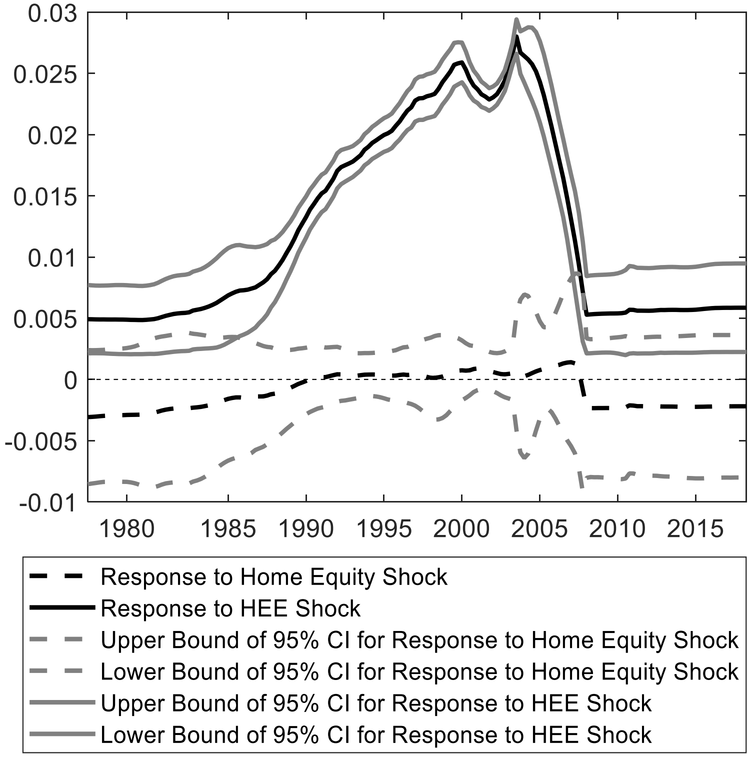
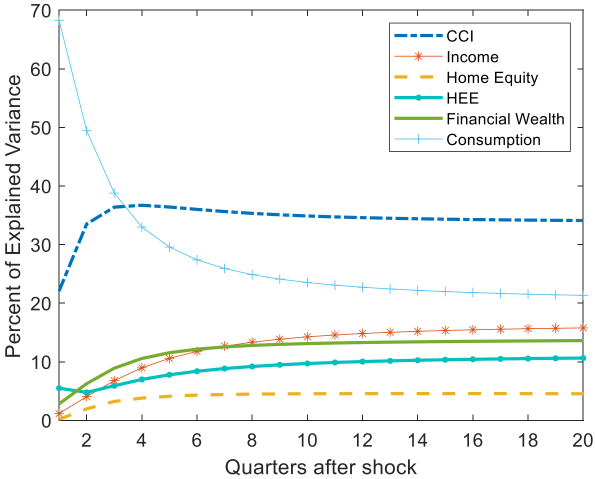


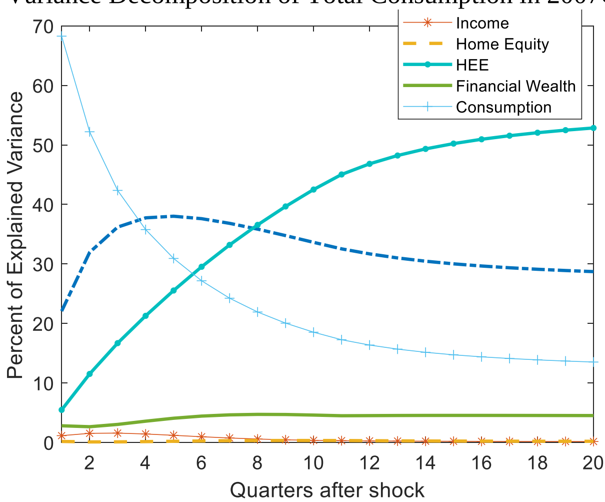

Figure 7 illustrates the percentage of explained forecast variance by the home equity and HEE shocks from 1977 to 2019 at T=20 when the shocks arrive. From 1977 to 2019, the HEE shock can explain an average of 30% of the variance of errors in forecasting consumption growth, while the home equity shock can predict only 1%. Since 1990, the importance of the HEE shock in forecasting the variance of consumption growth has shown remarkable growth and contributed to more than 50% of the forecasting variance in the 2000s. During the crisis, the impact of HEE fell with the decline of the non-prime mortgage supply, and the composition of the consumption variance was similar to that in 1977. Similarly, as is the case with the findings by impulse response, we can see that the HEE shock can explain for a larger proportion of consumption change than home equity shock, and mortgage market liberalization increases the collateral effect.

**Figure 6 Decomposition of Forecast Error Variance for Total Consumption Growth**

(a) Variance Decomposition of Total Consumption in 1977Q2

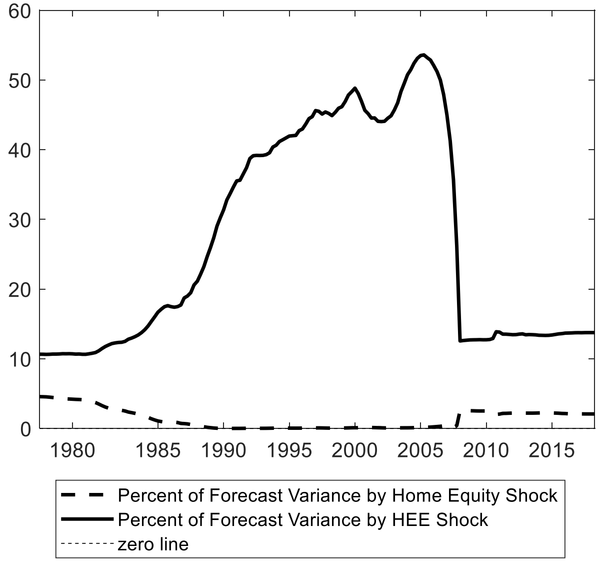



(b) Variance Decomposition of Total Consumption in 2007Q1




***Notes***: Figure 6(a) shows the percentage of explained variance of consumption growth by one standard deviation CCI, income, home equity, HEE, financial and consumption shocks based on time-varying VECM (Model 2). Figures 6(a) and 6(b) show the percentage of explained variance by the six exogenous shocks in 1977Q2 and 2007Q1, respectively.

**Figure 7 Percent of Forecast Variance of Consumption by Home Equity and HEE Shocks at T=20**




## 5.3 Robustness Checks

We further investigate whether the wealth effect differs between durable and non-durable consumption as a robustness check. Table 3 reports the results for non-durable goods and service (Model 3) and durable goods (Model 4). The conventional housing wealth effect plays a significant role in stimulating non-durable goods and service, and the sensitivity slightly increases with mortgage market liberalization. If we convert the elasticity to MPC, every $1 increase in home equity resulted in an average of 23.43 cent increase in the consumption of non-durable goods and service. The maximum MPC was 24.09 cents in 2007.

Regarding durable goods, the change in home equity does not yield a significant impact on durable consumption. By contrast, HEE plays the dominant role in stimulating durable goods consumption and the impact increases with mortgage liberalization. In 2007, a 1% extra increase in the use of HEE was related to a 2.30% increase in durable consumption, which implies that holding home equity constant, every $1 increase in HEE would stimulate a maximum of 43.89 cent increase in durable consumption spending in 2007. As expected, mortgage liberalization relaxed household credit constraints and therefore allowed them to purchase more durable goods, such as expensive cars and entertainment equipment.

**Table 3 Robustness Checks**

This table reports the estimation for the period of 1977Q1 to 2019Q4. Model 3 estimates the time-varying wealth effects on non-durable consumption and Model 4 estimates the time-varying wealth effects on durable consumption. Income growth expectation uses a one-period lag of expected income growth as the instrument. In the interaction term, CCI and mix variables are standardized variables. Only the equation with the variable of consumption growth as the dependent variable is reported. The full results are available from the authors upon request. We use the L.R. test to determine whether time-varying cointegration can substantially improve the fit of the models, compared with the constant cointegration. L.B. test is the Ljung-Box test for autocorrelation, with the null hypothesis of no one- to four-order autocorrelation. ARCH test has the null hypothesis of no one- to four-order ARCH effect. Standard deviations are in parentheses. ***, **, and * denote significance at the1%, 5%, and 10% levels, respectively.

| | Model 3: Non-durable goods and service | Model 4: Durable goods |
|---|---|---|
| Long-run relationship | | |
| *c* | 1.000 | 1.000 |
| *y* | 1.1340*** | 1.4614*** |
| | (0.1976) | (0.2443) |
| *y_mix* | -0.2913 | 0.1090 |
| | (0.1924) | (0.2388) |
| *CCI* | 0.1562* | 0.5716*** |
| | (0.0920) | (0.1141) |
| *CCI_mix* | -1.0220*** | 2.0164*** |
| | (0.3802) | (0.4724) |
| *f* | -0.1066 | 0.2009 |
| | (0.1342) | (0.1667) |
| *f_mix* | 0.2853* | -0.2133 |
| | (0.1706) | (0.2118) |
| *h* | 0.2185*** | -0.0187 |
| | (0.0372) | (0.0462) |
| *h_mix* | 0.0132** | -0.0041 |
| | (0.0058) | (0.0072) |
| *HEE* | 0.1414 | -1.3570 |
| | (0.7089) | (0.8813) |
| *HEE_mix* | -1.4556 | 2.2962* |
| | (1.0606) | (1.3165) |
| Short-run dynamics# | | |
| *a*1 | -0.0187 | -0.2043*** |
| | (0.0251) | (0.0496) |
| *d_c_*1 | -0.0110 | -0.2640*** |
| | (0.0937) | (0.0777) |
| *d_y_*1 | 0.4090** | 0.7054 |
| | (0.1927) | (0.4928) |

**(*Continued…*)**

**(Table 3 Continued)**

| | Model 3: Non-durable goods and service | Model 4: Durable goods |
|---|---|---|
| *d_y_1_mix* | -0.5539 | -0.3393 |
| | (0.3416) | (0.8872) |
| *d_CCI_*1 | 0.1883 | 1.2185*** |
| | (0.1211) | (0.3059) |
| *d_CCI_mix_*1 | -0.0240 | 0.2858 |
| | (0.3254) | (0.8575) |
| *d_f_*1 | 0.1287 | 0.4577** |
| | (0.0825) | (0.2165) |
| *d_f_mix_*1 | -0.1243 | -0.6439** |
| | (0.1092) | (0.2864) |
| *d_h_*1 | 0.0132 | -0.0092 |
| | (0.0366) | (0.0960) |
| *d_h_mix_*1 | 0.0188 | 0.2224* |
| | (0.0478) | (0.1249) |
| *d_HEE_*1 | -0.2477 | -0.5182 |
| | (0.3688) | (0.9669) |
| *d_HEE_mix_*1 | -0.0187 | -0.2043*** |
| | (0.0251) | (0.0496) |
| $E_t \Delta y_{t+1}^m$ | 0.2116*** | 0.4690*** |
| | (0.0419) | (0.1059) |
| *d_*ump | 0.0066 | 0.0070 |
| | (0.0060) | (0.0079) |
| | | |
| Diagnostics | | |
| Adjusted R2# | 0.313 | 0.296 |
| LB test# | 4.00 | 1.60 |
| ARCH test# | 3.65 | 6.14 |
| LR(35) | $85^{***}$ | $92^{***}$ |

## 6. Conclusion

The recent consumption boom and bust have given rise to many questions on the relationship between housing wealth and consumption. Many studies find that consumption has become more sensitive to housing wealth since the mid-1990s, while disagreements about the causes of such a relation persist.

This paper extends the aggregate consumption–wealth ratio model (Lettau and Ludvigson, 2001, 2004) by incorporating home equity withdrawals and mortgage liberalization into the long- and short-run relationships between consumption and wealth. Based on net mortgage withdrawals from 1977Q1 to 2019Q4, our empirical results suggest that the collateral effect contributes to housing MPC, not to net home equity. Mortgage supplies by mortgage companies significantly increase the long-term elasticity of HEE on consumption. Housing MPC had a dramatic increase during the 1995–2007 period, going from 0.1 cents to 6.06 cents for total consumption. This structural shift also intensified the response of consumption growth to the HEE shock. In 2007, the HEE shock explained for over 50% of consumption variations. The findings of this study suggest that liberalization in mortgage lending allows for more cash extraction of home equity, thus collateral value is a major factor that affects aggregate consumption and not housing equity *per se*.

The results of this study have important implications. After the financial crisis, tightened lending standards have limited the credit supply to more credit-constrained mortgage holders. These borrowers also have a higher demand for equity extraction. Our results suggest that HEE has a positive impact on consumption. However, with reduced HEEs after the crisis, the total effect on consumption from HEEs is smaller. Consistent with previous studies in the literature, we also find the MPC of the conventional housing wealth effect is near zero after the crisis. This means that households do not increase their spending as their home value increases, which builds up the equity amount. This increase in illiquid savings provide homeowners with a financial cushion and improve their ability to deal with financial distress. This is very important during an economic downturn, such as during the current COVID-19 pandemic. With the rise in unemployment, the financial cushion and forbearance policies help families to smooth consumption and stay current with their mortgage.

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# Appendices

## Appendix 1 Data Sources and Definitions

| Variable | Source | Description | Notation |
|---|---|---|---|
| Total consumption (*c*) | Bureau of Economic Analysis | Durable goods, non-durable goods, and service expenditures, but excludes food and energy expenses and housing services. | Deflated, seasonally adjusted |
| Labor income (*y*) | Bureau of Economic Analysis | Wages and salaries + transfer payments + other labor income – personal contributions for social insurance – taxes. | Deflated, seasonally adjusted |
| Financial wealth (*f*) | Flow of Funds | The difference between financial assets and liabilities. | Deflated, seasonally adjusted |
| Total housing wealth (*h*) | Flow of Funds | Household real estate assets, excluding home mortgages. | Deflated, seasonally adjusted |
| Home equation extraction (*HEE*) | Greenspan and Kennedy (2008) | The ratio of extracted home equity to total housing wealth. | Data from Greenspan and Kennedy (2008) are only from 1990Q1 to 2008Q4. Data are extended to the period of 1977Q1 to 2012Q3 by using the simplified method by CalculateRisk. |
| | Flow of Funds. Webpage: CalculateRisk. | Extracted home equity: the cash converted from home equity by borrowing in the residential mortgage market. | Seasonally adjusted. The impact of housing price is removed. |
| Housing wealth | | Total housing wealth – extracted home equity. | |
| Mortgage mixed variable (*Mix_mort*) | Flow of Funds, SIFMA statistics database. | The ratio of home mortgage holdings by non-GSE agency-backed mortgage pools and issuers of ABS to outstanding total mortgages of households. | |

(***Continued…***)

**(Appendix 1 Continued)**

| Variable | Source | Description | Notation |
|---|---|---|---|
| Consumer credit mixed variable (*Mix_credit*) | Flow of Funds | The ratio of consumer credit loans held by private issuers of ABS to total consumer credit loans. | |
| Unsecured consumer credit conditions index (*CCI*) | Duca et al. (2012) | The willingness of banks to lend to consumers. | The influence of the interest rate and the macroeconomic outlook are removed. Only regulatory influences are left. See Duca et al. (2012). |
| Income growth expectations ($E_t \Delta y_{t+1}^m$) | Duca et al. (2012) | Weighted moving average of forward looking income growth rates. | The fitted value of income growth rates based on the unemployment rate, T-bill yield, and sentiment index. See Duca et al. (2012). |

## Appendix 2 Summary Statistics

Consumption, Durable Goods, Non-durable Goods and Service, Labor Income, Housing Wealth, and Financial Wealth are in USD per capita.

| | Mean | Std | Max | Min |
|---|---|---|---|---|
| Consumption | 10551 | 2269 | 14735 | 6429 |
| Durable goods | 1640 | 232 | 1991 | 1094 |
| Non-durable goods and service | 8911 | 2064 | 12757 | 5398 |
| Labor income | 6159 | 787 | 7226 | 4778 |
| CCI | 0.5419 | 0.2337 | 1 | 0.007 |
| Financial wealth | 44650 | 15319 | 17141 | 3187 |
| Housing wealth | 8868 | 2733 | 17141 | 3187 |
| Home equity extraction ratio | 0.019 | 0.0300 | 0.095 | -0.080 |
| Securitized mortgage | 0.3636 | 0.1752 | 0.6470 | 0.0691 |
| Securitized consumer credit | 0.1199 | 0.1237 | 0.3396 | 0.000 |

## Appendix 3 Unit Root Test

The augmented Dickey-Fuller-generalized least squares (ADF-GLS) test has the null hypothesis of one-unit root. L stands for level. d stands for the first differenced series. The test specification includes trend, and maximum of four period lags. $^{***}$, $^{**}$, and $^{*}$ denote significance at the1%, 5%, and 10% levels, respectively.

| | ADF-GLS | |
|---|---|---|
| | L | d |
| Consumption | 1.1202 | -3.7685*** |
| Labor income | 0.5431 | -2.9192*** |
| CCI | 0.5776 | -2.0935** |
| Financial wealth | 1.0969 | -6.2241*** |
| Housing wealth | -1.4707 | -3.4000*** |
| Home equity extraction ratio | -0.7236 | -4.1397*** |