

Time-Varying Effects of Housing and Stock Returns on U.S. Consumption*

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Abstract. This paper applies a time-varying parameter vector autoregressive approach to estimate the relative effects of housing and stock returns on the growth rate of US consumption over time. We use annual data from 1890 to 2012 and find that at the one- and two-year horizons and over time, generally the housing return positively affects consumption growth while the stock return negatively affects it. For the three- to six-year horizons, the two return shocks generally exert a negative, but small, effect on consumption growth. These opposite responses to changes in housing and stock returns suggest different mechanisms through which wealth affects consumption. Further, the housing return effect generally increases after 1980. The sub-period from 1980 to 2012 includes the 1997/2002 asset price boom/bust where house prices continued to rise moderately as stock prices fell. These findings suggest that the magnitude of the relative return effects differs with both time and horizons and also depends on whether prices increase or decrease.

Keywords: Asset Returns, Consumption, Time-Varying Parameter Vector Autoregressive

JEL Classification: C32, E21, G10

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1. Introduction

The housing and stock markets comprise the two major sources of US household wealth. The stock market accounts for about 25 percent of the total net worth (Poterba 2000) while housing represents approximately 40 percent of households' assets and just under 50 percent of total wealth (Iacoviello 2011). These two markets experienced big swings in the last decades culminating in the 2007 "Great Recession". Similar to the Great Depression, which began with the crash of the stock market, the recent turmoil began with the bust of the subprime mortgage market and the collapse of the housing price bubble. The concomitant decline in consumption reflects, in part, the wealth effect on household spending. The wealth effect characterises the mechanism through which asset price fluctuations may affect financial and business cycles dynamics, making it crucial for policymakers in charge of macroeconomic and financial stability.

This paper considers how the growth rate of real per capita US consumption responds dynamically to both real housing and stock returns (i.e., the logarithmic difference in real prices) and how these relationships evolved over time. Examining changes in asset return effects across time may provide further insight on the sources of different responses of consumption to wealth, which proves crucial to policy makers and macroeconomic policy. Using over 120 years of annual data that includes the Great Depression and the Great Recession, this paper implements a time-varying parameter vector autoregressive (TVP-VAR) model that captures the potential time-varying structure in the estimation of asset return effects. Figure 1 plots the growth rate of real per capita consumption in the US, showing significant volatilities during the twelve decades of the sample period and, thus, implying the possibility of distinct changes in asset return effects over time.

The life cycle and permanent income hypotheses suggest that as financial or housing

assets grow, households will more likely increase their consumption spending. Likewise, consumption will decrease as household wealth declines. Since consumption comprises such a large share of real GDP, the effects of the housing and stock markets on consumption through the wealth effect serve as a key link between the asset market and economic activity. Therefore, the dynamics of real house and stock returns and their effects on the growth rate of consumption can importantly affect policy choices as policy makers address asset market and, hence, macroeconomic instability. Conventional macroeconomic models, however, do not provide a clear answer as to whether the propensity to consume out of financial wealth exceeds or falls below that of non financial wealth.

Alternative conceptual rationales generate differences in the consumption effect of changes in the value of different wealth categories, especially housing and stock market wealth. On the one hand, some researchers argue that stock market wealth should exert a bigger effect on consumption than housing wealth. For example, noting that most homeowners live in the houses they own, Aoki *et al.* (2004) suggest that an increase in house prices raises the opportunity cost of housing services, which directly outweighs the benefits of the induced wealth. Similarly, Poterba (2000) argues that housing price fluctuations induce smaller consumption changes than stock market dynamics due to housing related transaction costs. Furthermore, Mishkin (2007) notes that older people, who hold a larger share of stock wealth, exhibit a high marginal propensity to consume out of wealth. Therefore, the effect of positive housing price shocks on aggregate consumption probably falls below the effect of positive shocks to stock prices, which, in contrast, tend to shift directly the aggregate budget constraint upwards.

On the other hand, other researchers argue that the consumption response to changes in housing wealth exceeds that generated by stock wealth. For example, the relative distributions of

housing and stock market wealth may play an important role. Mishkin (2007) suggests that unlike housing wealth, which is generally spread more evenly over the population, stock market wealth concentrates amongst wealthy households (Brady and Stimmel 2011). The resulting highly skewed distribution of stock ownership generates a smaller equity wealth effect for most households (Poterba 2000). Furthermore, during economic expansions with consumer confidence rising, Aoki *et al.* (2004) argue that homeowners probably borrow to finance consumption and housing investment, since housing represents secured collateral. For the US, Wilkerson and Williams (2011) note that the limited use of stock market wealth for consumption may reflect capital gains taxes on stocks as well as the inaccessibility, except at a cost, of a sizeable share of stock wealth held in restricted retirement or pension accounts. That is, Benjamin *et al.* (2004) note that for many households, they hold financial wealth indirectly through pensions and insurance. Moreover, tax policy favours home ownership and the concentration of wealth in homes. Thus, an increase in the housing price exerts more of an effect on aggregate consumption than stock market wealth, since housing transactions correlate with complementary consumption goods such as furniture, appliances, and so on. Conversely, besides the permanent nature of capital gains from housing wealth, Lettau and Ludvigson (2004) argue that transitory movements dominate stock market wealth changes and consumption responds much less to transitory than permanent movements in wealth. Finally, US tax laws favours holding housing debt, making housing equity more accessible than other forms of assets.

Empirically, numerous studies document significant and positive wealth effects on US consumption, with a large consensus that the housing wealth effect exceeds that coming from stock market wealth (e.g., Benjamin *et al.* 2004; Case *et al.* 2005; Carrol *et al.* 2006; Dvornak and Kohler 2007; and Kishor 2007). Sousa (2008) points out, however, that the magnitude of the

wealth effect depends not only on the wealth measures, but also on the econometric methodologies employed in the analysis. Much of the existing evidence comes from cointegration regressions, which remain questionable (e.g., Carroll *et al.* 2006). The cointegration approach implicitly presumes the existence of a stable long-run relationship between consumption, labour income, and wealth, which proves counterintuitive given the presence of structural changes in the economy. Moreover, the wealth effects from housing and stock market wealth may alter their relative positions depending on whether wealth falls or rises (Wilkerson and Williams 2011). For example, Leonard (2010) finds that the US housing wealth effect exceeds the stock market wealth effect in absolute value after 2005 than the years before, suggesting that pessimistic households during the housing bust produced a larger decrease in consumption than the induced increase during the boom years.

More importantly, wealth changes may exert a positive or negative effect on consumption depending on the relevant transmission mechanism. Ludwig and Sløk (2001) identify four and five different channels of influence for stock and housing prices, respectively.¹ First, the realised wealth effect implies that an increase in house (stock) prices exerts a direct positive effect on homeowners' (stockholders') consumption as a consequence of the realised gain. Second, the unrealised wealth effect refers to the increase in consumption spending based on the expectation that raising current the housing (stock) price will result in higher future income and wealth. Third, the liquidity constraint effect implies that increasing housing (stock) prices raise the value of collateral against which financially constraint households may borrow to increase their consumption. Fourth, the stock option value effect, specific to stock market, implies that an

¹ This discussion in Ludwig and Sløk (2001) considers the effects of changes in stock and housing prices on consumption. Our empirical analysis examines the effects of house and stock returns, or the logarithmic differences in prices, on the growth rate of per capita real consumption.

increase in stock prices leads to the increase in the value of stockholders options which may translate into higher consumption irrespective of whether the gains are realised or unrealised. This differs from the budget constraint effect applicable to the housing market. For this channel, an increase in house prices negatively affects renters' consumption as a result of tighter budget constraint due to the realised capital loss. Finally, the substitution effect associates an increase in housing prices to further saving to finance larger downpayments for potential home buyers, which, in turn, lowers consumption.

The first four channels imply that stock prices should exert positive effects on consumption. As just noted, however, the existing literature suggests that the gains from stock price increases may prove difficult to tap for consumption increases than similar increases in housing prices. For housing price changes, however, the budget constraint and substitution effects suggest a negative effect on consumption. We find, however, that over different horizons and over time, frequently the housing price positively affects consumption while the stock price negatively affects consumption. These opposite responses to changes in housing and stock prices suggest different mechanisms through which wealth affects consumption. Between 1980 and 2007, housing wealth generally exerted a growing, positive effect on consumption.

We organize the rest of the paper as follows. Section 2 presents the empirical methodology. Section 3 describes the data and discusses the estimation results. Section 4 concludes.

2. Empirical methodology

Primiceri (2005) developed the TVP-VAR model, which is now widely used in macroeconometric analysis. Its flexibility and robustness capture the time-varying properties underlying the structure of the economy. Further, Nakajima (2011) notes that the TVP-VAR

model with constant volatility probably produces biased estimates due to a potential variation of the volatility in disturbances; thus emphasizing the role of stochastic volatility. The TVP-VAR model with stochastic volatility avoids this misspecification issue by taking care of simultaneous relations among variables as well as the heteroskedasticity of the innovations. This gain in flexibility comes at the expense of a more complicated structure. Therefore, the estimation of the model requires using Markov-Chain Monte-Carlo (MCMC) methods with Bayesian inference.

The TVP-VAR model emerges from the basic VAR model defined as follows:

$$Ay_t = F_1 y_{t-1} + \dots + F_s y_{t-s} + u_t \quad t = s+1, \dots, n \quad (1)$$

where y_t denotes a $k \times 1$ vector of observed variables, and A, F_1, \dots, F_s denote $k \times k$ matrices of coefficients. The disturbances u_t is a $k \times 1$ structural shock assumed to follow a normal distribution of the form $u_t \sim N(0, \Sigma)$, where

$$\Sigma = \begin{pmatrix} \sigma_1 & 0 & \dots & 0 \\ 0 & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \dots & 0 & \sigma_k \end{pmatrix}. \quad (2)$$

To specify the simultaneous relations of the structural shock by recursive identification, A takes on a lower-triangular structure as follows:

$$A = \begin{pmatrix} 1 & 0 & \dots & 0 \\ a_{21} & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ a_{2k} & \dots & a_{k,k-1} & 1 \end{pmatrix}. \quad (3)$$

The model in Equation (1) solves for the following reduced form specification

$$y_t = B_1 y_{t-1} + \dots + B_s y_{t-s} + A^{-1} \Sigma \varepsilon_t, \quad \varepsilon_t \sim N(0, I_k) \quad (4)$$

where $B_i = A^{-1} F_i$ for $i = 1, \dots, s$. Stacking the elements in the rows of the B_i 's to form β

($k^2 \times 1$ vector), and defining $X_t = I_k \otimes (y'_{t-1}, \dots, y'_{t-s})$, where \otimes denotes the Kronecker product, we can rewrite the model as follows:

$$y_t = X_t \beta + A^{-1} \Sigma \varepsilon_t. \quad (5)$$

All parameters in Equation (5) are time-invariant. By allowing the parameters to change over time, Equation (5) further extends to the following specification:²

$$y_t = X_t \beta_t + A_t^{-1} \Sigma_t \varepsilon_t, \quad t = s+1, \dots, n, \quad (6)$$

where the coefficients β_t , and the parameters A_t and Σ_t are all time varying. To model the process for these time-varying parameters, Primiceri (2005) assumes the parameters in equation (6) follow a random walk process. Let $a_t = (a_{21}, a_{31}, a_{32}, a_{41}, \dots, a_{k,k-1})'$ denote a stacked vector of the lower-triangular elements in A_t and $h_t = (h_{1t}, \dots, h_{kt})'$ with $h_{jt} = \log \sigma_{jt}^2$ for $j = 1, \dots, k$, $t = s+1, \dots, n$. Thus,

$$\begin{aligned} \beta_{t+1} &= \beta_t + u_{\beta_t}, \\ a_{t+1} &= a_t + u_{a_t}, \\ h_{t+1} &= h_t + u_{h_t}, \end{aligned} \quad \begin{pmatrix} \varepsilon_t \\ u_{\beta_t} \\ u_{a_t} \\ u_{h_t} \end{pmatrix} \sim N \left(0, \begin{pmatrix} I & 0 & 0 & 0 \\ 0 & \Sigma_{\beta} & 0 & 0 \\ 0 & 0 & \Sigma_a & 0 \\ 0 & 0 & 0 & \Sigma_h \end{pmatrix} \right) \quad (7)$$

for $t = s+1, \dots, n$, where $\beta_{s+1} \sim N(\mu_{\beta_0}, \Sigma_{\beta_0})$, $a_{s+1} \sim N(\mu_{a_0}, \Sigma_{a_0})$ and $h_{s+1} \sim N(\mu_{h_0}, \Sigma_{h_0})$.

This methodology exploits the salient feature of the VAR model with time-varying coefficients to estimate a three variable VAR model (consumption, the housing price, and the stock market price), focusing on the dynamics of the wealth effects from both house and stock price adjustments. By allowing all parameters to vary over time, this paper examines the assumption of parameter constancy for the VAR's structural shocks based on the standard

² See Nakajima (2011) and Pimiceri (2005) for further details on the TVP-VAR methodology.

recursive identification procedure known as the Choleski decomposition. We achieve identification by imposing a lower triangular representation on the matrix A_t . The recursive ordering of the variables that proves consistent with the VAR based empirical literature on wealth effects of consumption.³ That is, consumption comes first in the ordering and it does not respond contemporaneously to housing and stock market price (wealth) shocks, while house prices react with a lag to stock market price shocks. Thus, the housing price appears second in the ordering before the stock market price.

3. Data and results

3.1. Data

To examine the time-varying structure of wealth effects, we estimate the three-variable TVP-VAR model using annual data from 1890 to 2012. The dataset comes primarily from the Online Data section of Robert Shiller's website⁴ and includes real per capita consumption, the real stock market price, and the real housing price. The data series on these variables however, only run to 2009 on Robert Shiller's website. We update the data through 2012, using the definition of the variables and sources outlined in Shiller's data files. We transform all variables in their log-differenced form to ensure stationarity, given the existence of unit root in their level forms.⁵ We

³ See Aye *et al.*, (forthcoming) for a detailed discussion in this regard.

⁴ <http://www.econ.yale.edu/~shiller/data.htm>. A referee suggested that the Shiller data may exhibit some reliability issues. As a robustness check, we also collected annual data on the Standard and Poor's 500 and Dow Jones Industrial Average indexes as well as per capita consumption data from the Federal Reserve Bank of St. Louis FRED® database from 1929 to 2012, where all data are deflated by the CPI. We redid our analysis with this shorter annual sample and report the results in the text. The findings differ between the two different stock price measures.

⁵ We use standard unit-root tests, namely, Augmented Dickey and Fuller (ADF)(1981), Phillips and Perron (PP) (1988), Dickey and Fuller with Generalised Least Squares detrending (DF-GLS), and the Ng and Perron (2001) modified version of the PP (NP-MZt) to confirm that the log-levels of the three variables under consideration are integrated of order 1, i.e., $I(1)$. Given nonstationary data, we also conducted the Johansen (1988, 1991) tests of cointegration. Both the Trace and Maximum Eigenvalue tests, however, do not reject the null of no cointegration, which, in turn, implies that our VAR in first differences does not need to account for error correction, and hence, is not misspecified. The unit-root and cointegration tests are available on request from the authors.

define the growth rates of consumption, the real housing price, and the real stock price as C , RHR , and RSR , respectively, where the growth rates of real housing and stock prices equal real housing and stock returns. For ease of comparison and interpretation, we first standardize the stock market and housing prices series using the standard deviation. We choose a lag length of two based on the Akaike information criteria applied to a stable constant parameter VAR.⁶ Since we convert the variables into their growth rates and use two lags, the effective sample of our analysis starts in 1894.

3.2. Estimation results

Table 1 reports the posterior estimates computed using MCMC algorithm based on keeping 100,000 draws after 10,000 burn-ins.⁷ Figure 2 plots the posterior draws for these chosen set of parameters (reported in Table 1) of the TVP-VAR model with stochastic volatility. We perform diagnostic tests for convergence and efficiency. The 95-percent credible intervals include the estimates of the posterior means and the convergence diagnostic (CD) statistics developed by Geweke (1992).⁸ We cannot reject the null hypothesis of convergence to the posterior

⁶ We find that all roots of the constant parameter VAR lie within the unit circle, implying stability.

⁷ The MCMC method assesses the joint posterior distributions of the parameters of interest based on certain prior probability densities that are set in advance. This paper adopts the following priors as found in Nakajima (2011): $\Sigma_\beta \sim IW(25, 0.01I)$, $(\Sigma_a)_i^{-2} \sim G(4, 0.02)$, $(\Sigma_h)_i^{-2} \sim G(4, 0.02)$, where $(\Sigma_a)_i^{-2}$ and $(\Sigma_h)_i^{-2}$ are the i^{th} diagonal of elements of Σ_a and Σ_h , respectively. IW and G denote the inverse Wishart and the Gamma distributions, respectively. We use flat priors to set initial values of time-varying parameters such that: $\mu_{\beta_0} = \mu_{a_0} = \mu_{h_0} = 0$ and $\Sigma_{\beta_0} = \Sigma_{a_0} = \Sigma_{h_0} = 10 \times I$.

⁸ Geweke (1992) suggests comparing the first n_0 draws to the last n_1 draws, dropping out the middle draws, to check for convergence in the Markov chain. We compute the CD statistics as follows: $CD = (\bar{x}_0 - \bar{x}_1) / \sqrt{\hat{\sigma}_0^2 / n_0 + \hat{\sigma}_1^2 / n_1}$, where $\bar{x}_j = (1/n_j) \sum_{i=m_j}^{m_j+n_j-1} x^{(i)}$, $x^{(i)}$ is the i^{th} draw, and $\hat{\sigma}_j^2 / n_j$ is the standard error of \bar{x}_j respectively for $j = 0, 1$. If the sequence of the MCMC sampling is stationary, it converges to a standard normal distribution. We set $m_0=1$, $n_0=10000$, $m_1=50001$, and $n_1=50000$. $\hat{\sigma}_j^2$ is computed using a Prazen window with bandwidth $(B_m) = 500$. The

distribution at the conventional level of significance. In addition, we also observe low inefficiency factors, confirming the efficiency of the MCMC algorithm in replicating the posterior draws.

3.2.1. Estimates of the stochastic volatility

Figure 1 plots the data for each time series (top graphs) and the posterior estimates of the stochastic volatility (bottom graphs). The results indicate that per capita consumption growth volatility peaks at the beginning of the sample followed by a downward trend thereafter. The volatility stabilized at a low level in the early 1970s, which includes the Great Moderation. Towards the end of the sample, the stochastic volatility of the consumption growth remains low, reflecting the Great Moderation. The real housing price exhibits relative spikes between 1891 and 1951. Shiller (2005) indicates, however, the absence of any major real estate boom before 1940 and associates the observed downward trend to World War I with the great influenza pandemic of 1918-19, the severe recession in 1920-21, and the high unemployment during the 1930s Great Depression. The volatility of the real housing return followed the volatility of consumption, falling from its peak at the beginning of the sample until it stabilized in the early 1950s. After a long period of relative stability, the real housing return experiences new increases in volatility toward the end of the sample, indicating the recent housing boom that started just prior to the financial crisis and Great Recession in the 2000s and its subsequent bust. Further, the stochastic volatility of the real stock return shows that stock market booms bear virtually no resemblance to housing market booms except in the second half of 2000s where peaks in the housing market followed peaks in the stock market with an average lag of three years. Two

inefficiency factor is defined as $1+2\sum_{s=1}^{B_M}\rho_s$, where ρ_s is the sample autocorrelation at lag s and is computed to measure how well the MCMC chain mixes.

periods of relatively high volatility in real stock returns deserve mention. The first peak which occurs during the Great Depression and the second occurs during the 2000s. These relatively high volatilities in the variables confirm the presence of structural breaks mentioned earlier, thus implying the possibility of significant changes in the wealth effects over time. This provides the rationale for using a TVP-VAR where the sources of time variation include both the coefficients and the variance of the innovations.

3.2.2. Impulse responses

To compare the evolution of the consumption effect from real housing and stock return shocks over time, we use the impulse response functions to capture the macroeconomic dynamics based on the estimated VAR model. Figure 3 displays the results of both constant VAR and TVP-VAR models. The standard VAR with time-invariant parameters shows impulse responses whose shapes associate with the average levels of the responses at all points in time over the sample period. Correspondingly, impulse responses from the TVP-VAR model show the responses for each selected horizon (i.e., 1 to 6 years ahead) at all points in time, using the estimated time-varying parameters and showing the magnitude of the responses at each step.

The dynamic responses of consumption to both real housing and stock return shocks appear positive in the first year of the constant VAR model, although the positive response to the real stock return shock does not differ significantly from zero and becomes significantly negative a year later. The positive response of consumption to the real housing return shock does prove significantly positive in year one and then falls to nearly zero in all other forecast horizons. Moreover, in terms of magnitude, the return effects generated by both asset categories seem comparable in absolute values, where we contrast the time-varying impulse responses with different magnitudes obtained from the TVP-VAR model. In general, the real housing return

effect exhibits a positive effect much more frequently than the real stock return effect, which generally exhibits a negative effect over different horizons and over time. In addition, the real housing return exerts a positive, increasing effect post-1980, while the real stock return effect remains negative, but small. The Tax Reform Act of 1986 tilted the playing field toward borrowing against home equity to finance consumption, as the interest payments on all other forms of credit no longer received a tax deduction. Even without homeowners using their equity as collateral to finance consumption, higher homeowner equity provides a reason to reduce precautionary saving and, hence, increase consumption. Prior to 1980, a positive shock to real stock returns results in a 10- to 30-percent decline in consumption at short-term horizons against a positive response to real house return shocks ranging between 5- to 15-percent. The relatively larger effect of changes in the real housing return on consumption occurs between 1980 and 2007. In absolute values, the consumption response to a one standard deviation change in the real housing return falls between 10 and 25 percent for the 1- and 2-year horizons, while the magnitude of the real stock return effect oscillates between 0 and 10 percent. This relatively lower responsiveness to changes in the real housing return before 1980 corresponds to the historical movement in US housing prices, which shows that the housing market boomed from the 1990s.

Although the 1997-2002 asset price boom/bust was driven by both stock and housing markets, the real housing return effect dominates the real stock return effect. That is, real housing returns continue to rise moderately in 2000-2001 as real stock returns fall. Consistent with Benjamin *et al.* (2004), this suggests that consumption responds more to the moderate increase in the housing price than to the substantial decrease in the stock market price. Different from past episodes, the 2007-2009 boom/bust that occurred in both markets resulted in the decline in both

prices. We also observe the resurgence of the bigger and negative effects from the real stock return changes after 2007 for the 6-year horizon, confirming that the magnitude of relative wealth effects may also depend on whether wealth rises or falls (Wilkerson and Williams 2011).

Studies on the wealth effect on consumption almost exclusively report positive wealth effects. This paper finds that the assumption of parameter constancy may importantly drive those previous findings. The negative impulse responses observed with the real stock return shock over different horizons and over time prove inconsistent with the existing literature.⁹ Accordingly, besides the negative consumption effect due to the decline in the real stock return, stakeholders draw on their wealth during stock market booms to increase their financial investment and, hence, reduce their consumption. At longer-term horizon, this negative effect dies out, possibly indicating that the positive wealth effect offsets the negative substitution effect in the long run. The plausible implication is that the ultimate purpose of financial investment is to increase future wealth and, hence, future consumption.

We also observe negative responses to the real housing return shock, starting from the third year horizon. We may also ascribe this to the budget constraint and substitution effects. As the house price increases, households who rent face higher costs and reduce their consumption and home owners who plan to buy a home may increase the down payment and future loans, resulting either in a choice of a smaller house or a lower consumption (Ludwig and Sløk 2001).

3.2.3. Robustness tests

We also consider robustness tests, given the unusual findings with respect to real stock return shocks. First, we use annual data from 1929 to 2012 on the Standard and Poor's (S&P)

⁹ Case, Shiller, and Quigley (2005) and, more recently, Zhou and Carroll (2012) do document a significant positive housing wealth effect and an insignificant negative stock wealth effect in some of their econometric specifications. We consider the robustness of our findings in the next sub-section.

500 index and per capita consumption as well as Shiller's house price index. We deflate all variables by the CPI. The S&P 500 index, per capita consumption, and the CPI come from the Federal Reserve Bank of St.; Louis FRED® database. Figure 4 presents the findings. The constant VAR model provides impulse response pictures that closely conform to the corresponding charts in Figure 3. That is, a real house return shock generates a significant positive response from real per capita consumption for several years, whereas a real stock return shock generates a significantly negative response from real per capita consumption only in year one. Our analysis in Figure 3 shows a significant positive response of real per capita consumption to a real housing return shock for only one year and a significantly negative response to a real stock return shock only in year 2.

The TVP-VAR results appear in Figure 4.B. These time-varying impulse responses show a much smoother pattern than the corresponding results in Figure 3. We do see, however, that the real stock return shock causes a negative response on real per capita consumption, whereas a real housing return shock causes a positive response. In addition, the real housing return shock causes a larger response in absolute value than the real stock return shock, although these effects become smaller as the horizon lengthens.

Second, we also collected annual Dow Jones Industrial Average (DJIA) index data from 1929 to 2012 to replace the S&P 500 index data used in our first robustness check. This data also comes from the Federal Reserve Bank of St. Louis FRED® database. Figure 5 presents the findings.

The constant VAR model provides impulse response pictures that differ dramatically from those in Figure 3 for the real stock return shock. That is, now the real stock return shock generates a significantly positive response on real per capita consumption for two years. The real

housing return shock also generates a significantly positive response for several years, as it did in Figure 4. In addition, the response to the real stock return shock exceeds that of the real housing return shock.

The TVP-VAR results appear in Figure 5.B. For years 1 and 2, both the real housing and stock return shocks exert a positive response over the entire sample period. For year 1, a general downward trend exists in the responses for the real stock return shock whereas the downward trend in the response to a real housing return shock levels out in the early 1950s and turns up in the 2000s. Nonetheless, the response to the real stock return shock still exceeds the response to the real housing return shock, although the gap narrows at the end of the sample period. For year 2, the responses to both return shocks nearly match each other in magnitude. Moreover, no discernable trend up or down exists over the sample period. In years 3 to 6, the response to real housing return shocks exceeds the response to the real stock return shocks in absolute value. The response to a real housing return shock continues to remain positive, although small, whereas the response to a real stock return shock becomes negative and even smaller.

In sum, our robustness analysis suggests that the time-series properties of the real stock return shocks differ between the DJIA and S&P 500 indexes. Using either stock index, however, still shows that the real housing return shocks exert a positive and significant response on real per capita consumption for two years.

4. Conclusion

This paper provides empirical evidence of a variation in the relative asset return effects over time. Using the S&P 500 index, the response of real per capita consumption growth to changes in the real housing return remains positive for the one- and two-year horizons. Moreover, the magnitude of the response tends to rise over the sample. The larger effect of the real housing

return on consumption occurs between 1980 and 2007. This sub-period includes the 1997/2002 asset price boom/bust where the housing price continued to rise moderately as the stock market price fell. The one- and two-year responses of real per capita consumption growth to a real stock return shock exerts a negative effect of the entire sample, although the magnitude falls to a small magnitude around 1970.

Additionally, we find that changes in the real stock return deliver a negative effect on consumption over different horizons and over time while the direction of the real housing return effect varies with both horizon and time. This evidence of a negative asset return effect provides further insight on the transmission mechanism from wealth to consumption, hence complementing the almost exclusively reported positive wealth effect in the existing literature. In addition to the ability of the TVP-VAR to track the shape and magnitude of the wealth effect over time, the long length of our dataset captures both the direct and indirect channels through which asset returns may affect consumption. Particularly, our results suggest that the negative substitution effect offsets the aggregate positive wealth effect associated to the stock market over the sample period. This outcome does not appear in the housing market where the aggregate positive wealth effect appears to outweigh the negative budget constraint and substitution effects at most points in time.

Finally, the robustness tests that we considered for a shorter annual sample period from 1929 to 2012 suggests a difference in the time-series properties of real stock return shocks generated by the DJIA and S&P 500 indexes. That is, the DJIA index return generates positive responses from real per capita consumption growth at the one- and two-year horizons and the magnitude exceeds the positive effect of the real housing return shock at the one-year horizon.

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Table 1: Posterior estimates results

Parameters	Mean	Std Dev.	95% Intervals	Geweke CD	Inefficiency
$(\Sigma_{\beta})_1$	0.239	0.059	[0.144, 0.375]	0.426	22.02
$(\Sigma_{\beta})_2$	0.165	0.041	[0.101, 0.261]	0.570	19.66
$(\Sigma_{\alpha})_1$	0.109	0.038	[0.053, 0.196]	0.569	62.50
$(\Sigma_{\alpha})_2$	0.069	0.020	[0.040, 0.120]	0.697	35.53
$(\Sigma_h)_1$	0.158	0.047	[0.088, 0.273]	0.615	41.10
$(\Sigma_h)_2$	0.418	0.134	[0.208, 0.729]	0.392	54.15

The estimates of Σ_{β} and Σ_{α} are multiplied by 100.

Figure 1: Posterior estimates for the stochastic volatility of the structural shock

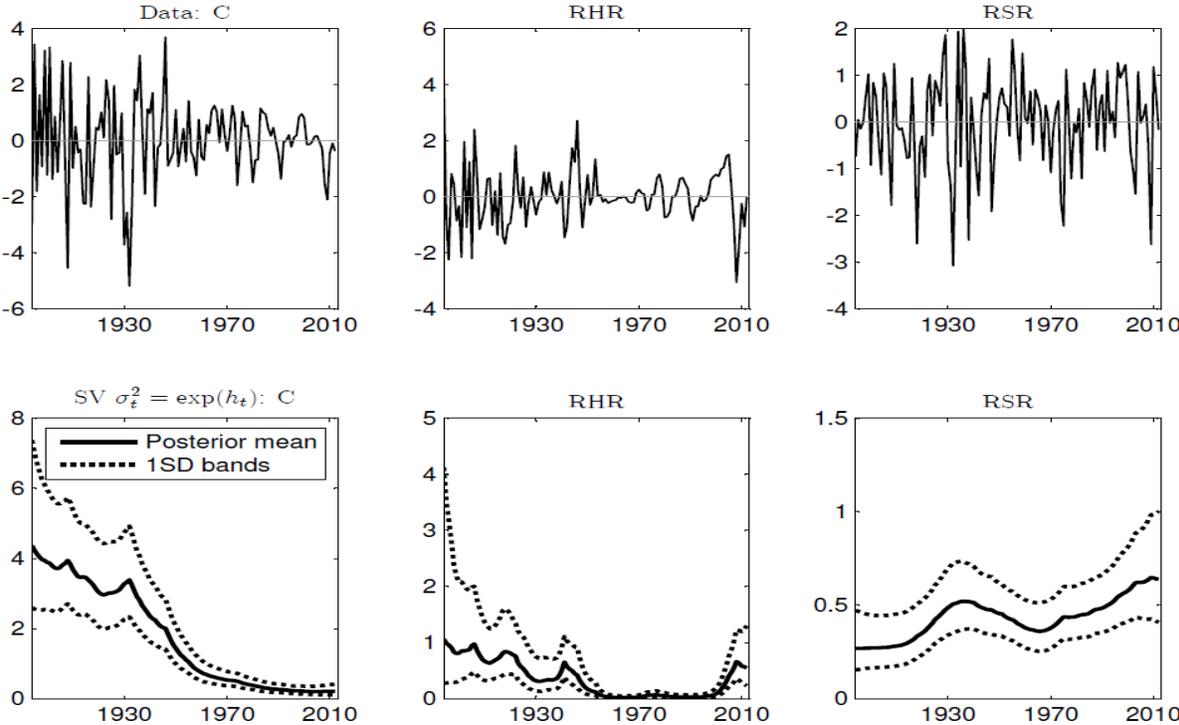
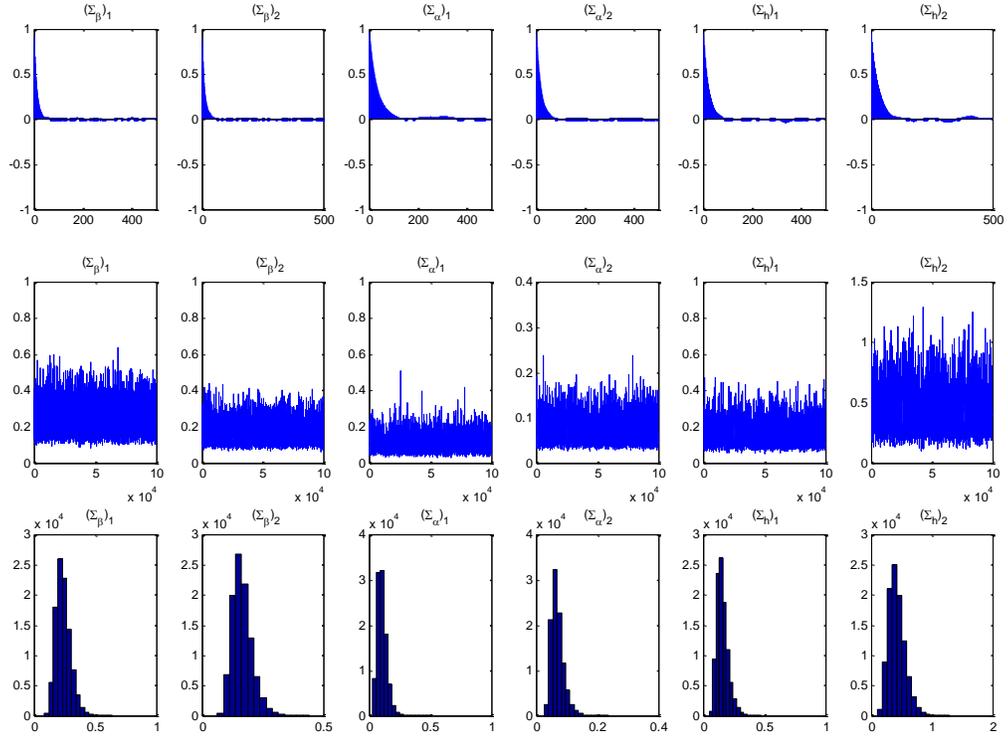


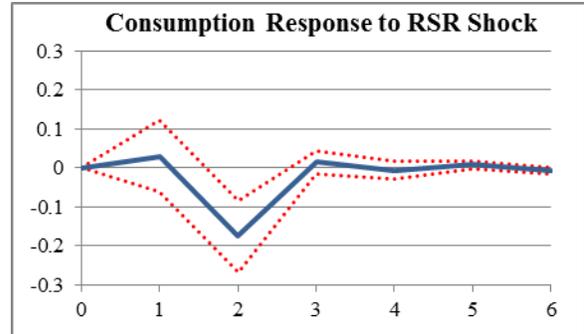
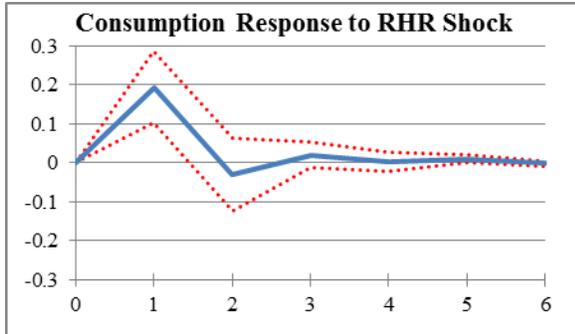
Figure 2: Estimates of the moments and posterior distributions of the model



Sample autocorrelations (Top chart), sample paths (middle chart), and posterior densities (bottom chart). The estimate of (Σ_β) and (Σ_α) are multiplied by 100.

Figure 3: Impulse responses of per capita consumption growth to shocks in real housing and stock returns

A: Constant VAR Model



B: TVP-VAR Model

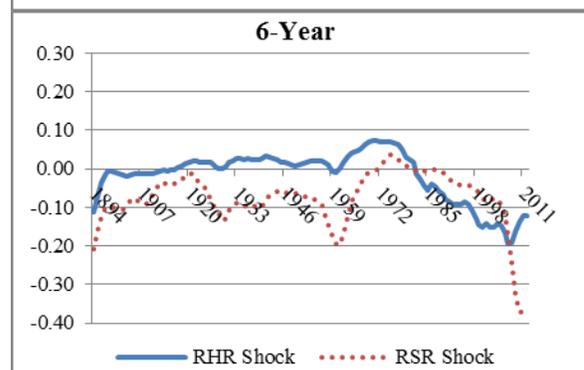
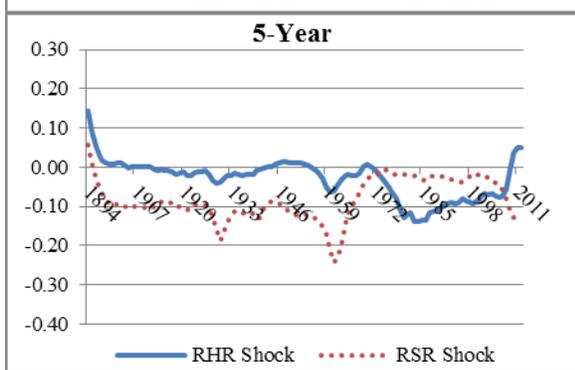
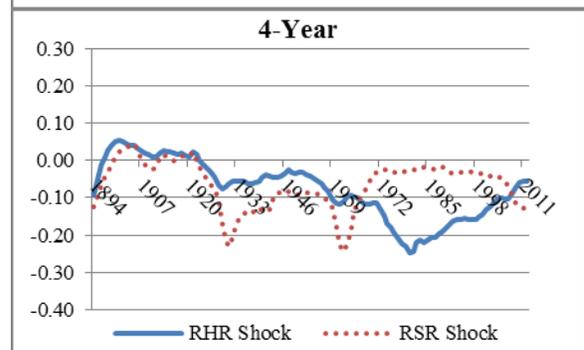
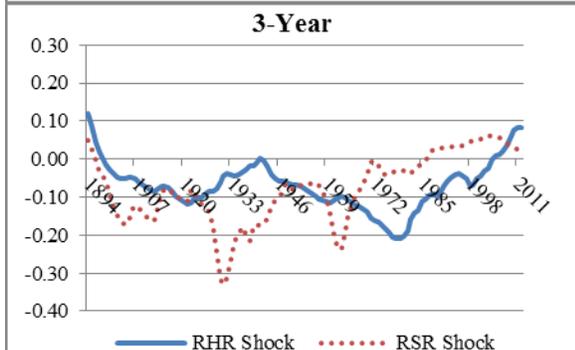
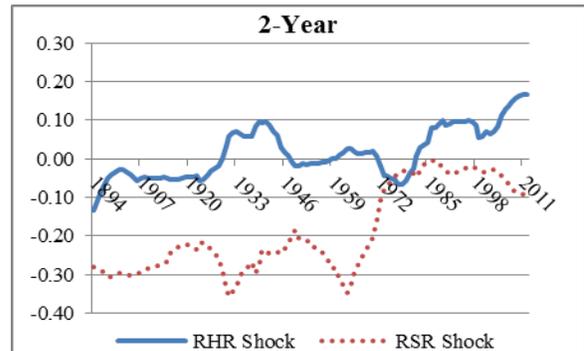
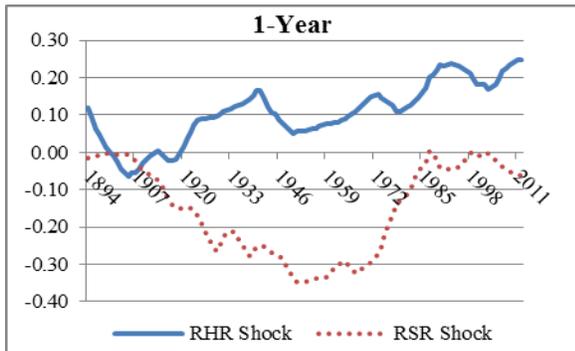
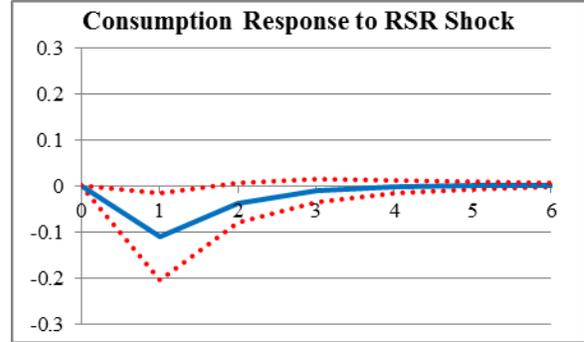
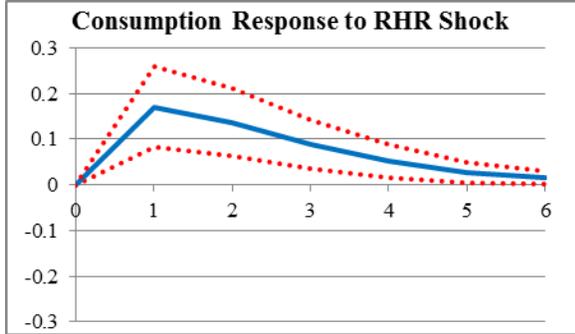


Figure 4: Impulse responses of per capita consumption growth to shocks in real housing and stock returns

A: Constant VAR Model



B: TVP-VAR Model

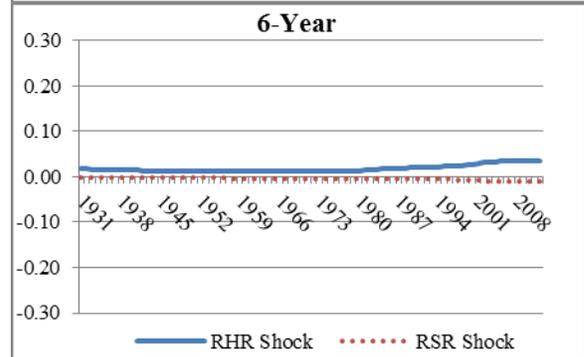
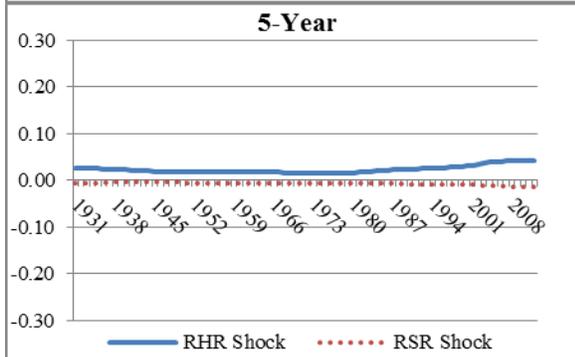
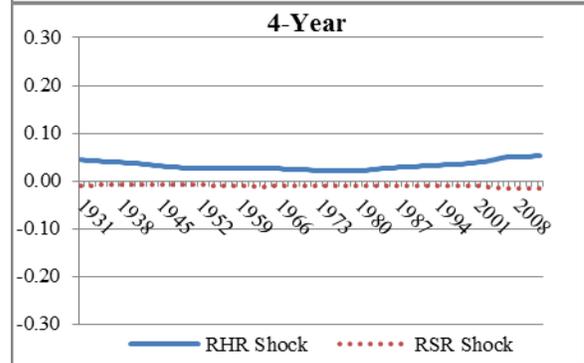
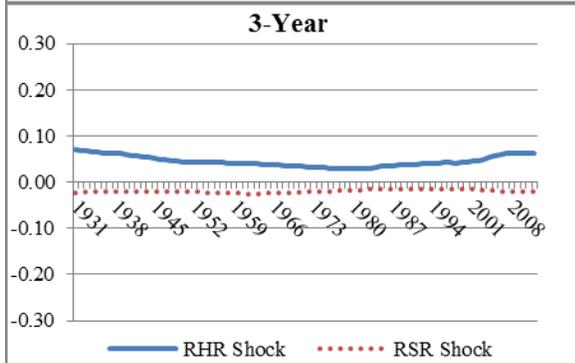
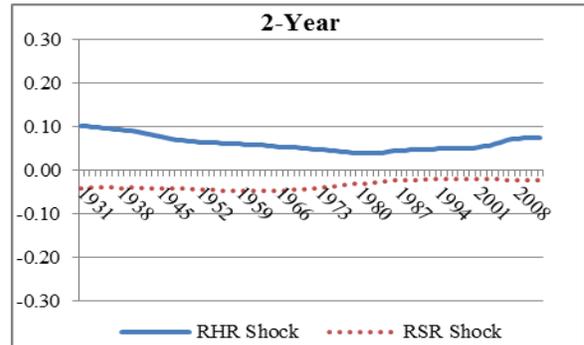
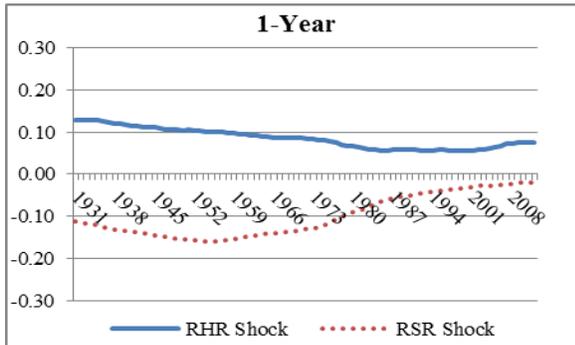
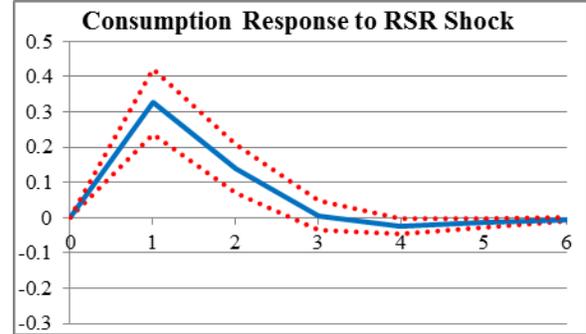
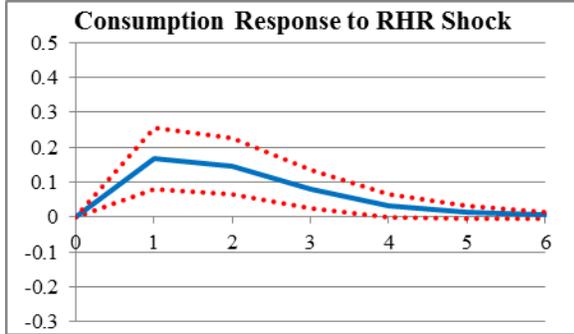


Figure 5: Impulse responses of per capita consumption growth to shocks in real housing and stock returns

A: Constant VAR Model



B: TVP-VAR Model

