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Wealth Shocks and Risk Aversion

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Abstract

Modern literature departs from time-separable constant relative risk aversion preferences to explain asset pricing facts. This deviation typically implies that wealth shocks generate transitory variations in agents' relative risk aversion and, possibly, portfolio re-allocations over time.

I empirically analyze this relationship using U.S. macroeconomic data and find evidence for time-variation in portfolio shares that is consistent with counter-cyclical risk aversion. These results suggest, therefore, that wealth-dependent, habit-formation or loss and disappointment aversion utility functions are a good description of preferences.

Controlling for observed *versus* expected asset returns, I also show that: (*i*) wealth effects are significant (although temporary) and there is no evidence of inertia contrary to Brunnermeier and Nagel (2006); and (*ii*) the consumption-wealth ratio (Lettau and Ludvigson, 2001), the labor income risk (Julliard, 2004) and the labor income-consumption ratio (Santos and Veronesi, 2006) partially explain changes in the risky asset share.

Keywords: wealth, risk aversion.

JEL classification: E21, G11, E44.

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1 Introduction

Time-separable utility functions with constant relative risk aversion (CRRA) are commonly used in macroeconomics and asset pricing. An important implication of this kind of preferences is that shocks to an agent's wealth leave his relative risk aversion (RRA) unchanged. A growing number of studies have recently explored alternative preferences that allow wealth shocks to generate transitory effects on relative risk aversion. The ways by which these effects take place include: (*i*) habit-formation preferences;[1] (*ii*) agents may care about relative social status or have direct preferences over wealth;[2] and (*iii*) agents may have loss or disappointment aversion preferences.[3]

These modifications are appealing because they help explain the counter-cyclicality of risk premia in asset markets and they seem plausible from a psychological perspective. However, whilst researchers have typically focused on time-variation in risk premium, the models also imply time-variation on portfolio shares, an implication that has not yet been put into a rigorous empirical test.[4]

Moreover and despite the apparent agreement regarding the counter-cyclical pattern of risk aversion (Cochrane, 1997; Guvenen, 2004), the empirical evidence on the relationship between wealth shocks and relative risk aversion is not consensual and the analysis has mostly been centered on the unconditional equity premium (instead of time-variation in risk aversion) using household level data.[5] Brunnermeier and Nagel (2006) provide the first test to the assumption of constant relative risk aversion, but conclude that wealth shocks do not prompt households to change the allocation of their financial wealth between risky and riskless assets.

Whilst representing an important result, the estimates of wealth effects on asset allocation based on household level data are likely to be under-estimated due to the poor coverage at the top-level of wealth

[1] Consumers may look at changes in wealth as isolated shocks with persistent effects (Campbell, 1998). Campbell and Cochrane (1999) suggest that agents are more risk averse during troughs and that a positive wealth shock leads to a transitory decrease in relative risk aversion. These effects largely depend on how quickly habit adjusts (Dunn and Singleton, 1986; Abel, 1990; Boldrin et al., 1995; Heaton, 1995).

[2] In this case, wealth has consumption characteristics due to, for example, the social status that it provides and directly affects portfolio decisions (Robson, 1992; Bakshi and Chen, 1996; St-Amour, 2005). Carroll (1997) emphasizes the accumulation of wealth as an end by itself. Cole et al. (1992, 1995) and Corneo and Jeanne (1999) focus instead on the role of wealth as determining status, a ranking mechanism that determines the allocation of non-marketed goods.

[3] See, for example, Kahneman and Tversky (1979), Gul (1991), Tversky and Kahneman (1991), Barberis et al. (2001), Fielding and Stracca, (2003), and Routledge and Zin (2003).

[4] Cox et al. (1985) and Lo and Wang (2001) suggest that portfolios that contain dynamic hedging strategies against unfavorable shifts in the state variable are qualitatively similar to those obtained under time-varying investment sets, and result in time-varying portfolio shares.

[5] See, for example, Friend and Blume (1975), Cohn et al (1975), Blake (1996), Morin and Fernandez Suarez (1983) and Guiso and Paiella (2001).

distribution where the exposure to risky assets is largest. On the other hand, the majority of works on portfolio composition share a common weakness: as they rely on cross sectional data, the effects of time-variation of asset prices, expected returns and volatility are not taken into account.[6]

In this paper, I test the assumption of constant relative risk aversion using U.S. quarterly data for the period 1953:4 - 2004:4. I use macroeconomic data to look at the relationship between unexpected wealth variation and changes of the risky asset allocation in aggregate portfolios. The results show that the risky asset share exhibits a cyclical behavior and it is significantly (and positively) affected by wealth shocks. There is, therefore, evidence suggesting that risk aversion is counter-cylical and supporting the existence of preferences that depart from the assumption of constant relative risk aversion.[7] This in accordance with cross-sectional evidence on portfolios which show that: stockholders are (*i*) wealthier (Poterba, 2000; Ait-Sahalia et al., 2004; Reynard, 2004); (*ii*) have a larger elasticity of inter-temporal substitution (Vissing-Jorgensen, 2002; Guvenen, 2006); and (*iii*) have a lower degree of risk aversion.(Mankiw and Zeldes, 1991; Attanasio et al., 2002; Brav et al., 2002). By its turn, a fall of the share of housing wealth tends to be associated with positive unexpected wealth variation, which highlights the possibility of the use of housing assets as an hedge against unfavorable states.[8]

I then show that the relationship that one observes between wealth shocks and changes in the portfolio composition does not reflect possible price effects, that is, changes in the price of financial assets, housing assets or the relative price of assets are not responsible for the time-variation of the risky asset share. Additionally, there is some weak evidence suggesting that housing returns or holding gains on housing assets (but not financial returns or holding gains in corporate equities) play a role in wealth allocation. This asymmetric behavior may be related with agents looking at changes in financial returns as transitory and perceiving changes in housing returns as persistent. Despite this, the empirical findings are still robust to asset return effects and confirm that wealth shocks are important determinants of agents' risk aversion.

One potential drawback of the previous results is that time varying portfolio shares may be simply reflecting time-variation in the expectations about future returns and/or in the volatility of returns.

[6] Heaton and Lucas (2000) and Guiso et al. (2003) show that, conditional on stock market participation, the cross-sectional relationship between the risky asset share and the level of wealth is essentially flat. Vissing-Jorgensen (2002) and Paiella (2005) emphasize the importance of participation costs as determining risky asset allocation.

[7] Cochrane (1997) and Guvenen (2004) also suggest that risk aversion is counter-cyclical, based on the counter-cyclicality of excess returns. Melino and Yian (2003) and Gordon and St-Amour (2000, 2004) emphasize the role of direct preferences over wealth to achieve the same conclusion.

[8] Cocco (2000) analyzes the benefits of housing as a hedge against income shocks. Englund et al. (2002) and Iacoviello and Ortalo-Magné (2003) show the importance of housing as a hedge against the risk of financial portfolios. Sinai and Souleles (2005) point out its benefits as a hedge against rent risk.

In fact, at the time of wealth shocks, future returns on assets can only be predicted and the mapping of risk aversion into risky asset shares is only valid when those effects are taken into account and correctly identified. Therefore, I control for changes in expected asset returns and in the volatility of asset returns. The empirical findings suggest that some empirical proxies developed by the literature on asset pricing to capture time-variation in expected returns, such as the consumption-wealth ratio (Lettau and Ludvigson, 2001), the labor income risk (Julliard, 2004) and the labor income-consumption ratio (Santos and Veronesi, 2006), partially explain the changes observed in risky asset allocation. However, the estimations show that wealth shocks remain significant and are responsible for the bulk of the variation, consistent with preferences that deviate from the assumption of constant relative risk aversion.

Considering a variety of wealth definitions, it is shown that, although significant, wealth effects on asset allocation are mainly temporary: the explanatory power of wealth shocks quickly falls over horizons of three quarters, therefore, providing evidence against the existence of long-run effects on asset composition. Additionally and contrary to the findings of Brunnermeier and Nagel (2006), there is weak evidence of inertia or slow adjustment in asset allocation, as agents quickly rebalance the composition of their portfolios following to wealth shocks.

Finally, as a robustness check of the previous results, I analyze the importance of wealth effects on asset allocation in a Bayesian framework. I estimate a reduced-form Vector Autoregressive Model (VAR) and show that: (*i*) lagged changes in wealth do not explain the changes in the risky asset share, suggesting that wealth effects on asset allocation are transitory and there is no inertia on asset allocation; (*ii*) lagged returns do not forecast future returns, but *cay* contains important predictive power, consistent with the findings of Lettau and Ludvigson (2001). Using a Markov Chain Monte Carlo algorithm to compute the error bands of the impulse-response functions to an aggregate wealth shock, I show that unexpected wealth variation has a positive (although temporary) effect on the risky asset share and that agents quickly rebalance their portfolios and the effect erodes over the next four quarters.

The paper is organized as follows. Section 2 presents the theoretical and econometric approach. Section 3 describes the data, estimates the wealth effects on portfolio allocation and checks the robustness of the results. In Section 4, I control for the effects of expected returns on asset allocation. In Section 5, I address the issues of long-run wealth effects and inertia. In Section 6, I present a reduced form Vector Autoregressive Model (VAR) and analyze the importance of wealth effects on asset allocation in a more structural framework. Finally, in Section 7, I conclude and discuss the implications of the findings.

2 Theory and Econometric Approach

2.1 Wealth Effects on Asset Allocation

Consider the optimal portfolio choice of an investor with habit-formation preferences and continuous time.[9] Assume, as in Campbell and Cochrane (1999), that agents have power utility with additive habit, that is,

$$U(C) = E\int_0^\infty e^{-\delta t}\frac{(C_t - X_t)^{1-\gamma}}{1-\gamma}dt, \tag{1}$$

which converges to a log-utility function for $\gamma = 1$.[10] Following Sundaresan (1989), Constantinides (1990) and Ingersoll (1992), X_t, the habit level, is internal, and depends on past consumption according to the following law

$$X_t = b\int_0^t e^{-a(t-s)}C_s ds + e^{-at}X_0, \tag{2}$$

with $b > 0$. Current consumption at the habit level increases X_t at a rate of b, while the impact of past consumption depreciates at a rate of a.

The investor chooses consumption, C_t, and the share of wealth invested in risky assets, α_t, to maximize expected utility, subject to

$$dW_t = (\mu_{p,t}W_t - C_t)dt + \sigma_{p,t}W_t dZ_t, \tag{3}$$

where $\mu_{p,t} := r_t + \alpha_t(\mu_t - r_t)$ is the expected instantaneous return on wealth, $\sigma_{p,t}$ is the instantaneous volatility of the return on wealth, r_t is the instantaneous return on the risk-free asset, and μ_t is the drift of the risky asset return process. The wealth process is driven by a deterministic component $(\mu_{p,t}W_t - C_t)dt$ and a stochastic component that contains a one-dimensional Brownian motion Z_t, and $\mu_{p,t}$ and $\sigma_{p,t}$ depend on the agent's portfolio choice, i.e. α_t, and, possibly, Z_t (time-varying investment opportunities).

Following Schroder and Skiadas (2002), it is possible to derive an isomorphism between optimal portfolio selection of an agent with habit formation preferences ($b > 0$) and an agent without habit formation ($X_0 = 0$ and $b = 0$). In the case of constant risk-free rate, the habit-utility agent's investment in the risky asset, α_t, is[11]

$$\alpha_t = (1 - \frac{X_t}{W_t}\frac{1}{r + (a-b)})\hat{\alpha}_t, \tag{4}$$

[9] In this Subsection, I follow Brunnermeier and Nagel (2006).

[10] An utility function with multiplicative habit of the form $U(C) = E\int_0^\infty e^{-\delta t}\frac{(C_t/X_t)^{1-\gamma}}{1-\gamma}dt$ does not exhibit time-varying risk aversion.

[11] Shore and White (2003) derive a tractable relationship in an external habit setting.

where $\hat{\alpha}_t$ is the corresponding risky asset share for an agent without habit. With constant investment opportunities, i.e. constant expected risky asset return and volatility, $\hat{\alpha}_t$ would be constant. In contrast, an agent with habit preferences invests the first $\frac{X_t}{r+(a-b)}$ dollars in the risk-free asset in order to secure a minimum consumption equal to future expected habit. Only then, a constant fraction of the surplus wealth will be invested in the risky asset.

In Appendix B, it is shown that the log risky asset share, i.e. $\rho_t := log(\alpha_t)$, follows the process

$$d\rho_t = (\frac{\hat{\alpha}_t}{\alpha_t} - 1)\left\{\left[\mu_{w,t} - \mu_{x,t} - \frac{\hat{\alpha}_t}{2\alpha_t}\sigma^2_{p,t}\right]dt + \sigma_{p,t}dZ_t\right\}, \tag{5}$$

where $w_t := \log(W_t)$, $x_t := \log(X_t)$, and $\mu_{x,t}$ and $\mu_{w,t}$ are the instantaneous drifts of the w_t and x_t processes. Since surplus wealth rises when the agent receives a positive wealth shock, one could intuitively infer that this leads to an increase in the optimal portfolio share of the risky asset. That is, everything else equal, an unexpected wealth shock of 1 percent increases the fraction invested in the risky asset, ρ_t, by $(\frac{\hat{\alpha}_t}{\alpha_t} - 1)$ percent. However, this shift in asset allocation is not permanent: over time, as the habit catches up with the new wealth level (i.e. $\mu_{x,t} > \mu_{w,t}$), the risky asset share mean-reverts, and the initial impact of the unexpected wealth shock erodes. Consequently, one can not say *a priori* what is the direction of the effects of unexpected wealth variation on the share of risky assets, and this work aims at providing more light about it.

2.2 Econometric Specification

I use the approximate discrete-time counterpart to Equation (5) to estimate the impact of wealth shocks on portfolio composition. Wealth shocks are computed in two ways. First, I use the standard set of Box-Jenkins selection procedures to determine the best fitting for wealth growth and then use the residuals, ε_t, as a proxy for unexpected wealth variation. In this case, among the models considered, the Akaike information, the Schwarz and the Hanan-Quinn criteria suggest that the data-generating process that fits better wealth growth is the ARMA(2,3) model. I hence restrict the attention to the ARIMA(2,1,3) specification for wealth. Appendix C describes in detail the computation of the wealth shock, ε_t.[12] Second, I estimate a reduced form cointegrated vector auto-regressive model (VAR) for consumption growth, Δc_t, wealth growth, Δw_t, and labor income growth, Δy_t and then use the residuals of the equation for wealth growth, ξ^w_t, as a proxy for wealth shocks.[13]

[12] I also use a Kalman filter to extract the innovation component of the wealth growth process and use it as a proxy for unexpected wealth variation. The results, however, do not change significantly.

[13] I also estimate the VAR without imposing cointegration, but the results do not change significantly.

The starting point for the econometric specification is, therefore,

$$\Delta\rho_t = \delta_0 + \delta_1\varepsilon_t + u_t, \tag{6}$$

where $\Delta\rho_t := \rho_t - \rho_{t-1}$ denotes the first-difference in the log portfolio share of risky assets, ε_t is an unexpected wealth shock at time t, and u_t is a random disturbance uncorrelated with ε_t.

In the second case, I specify the following cointegrated vector auto-regressive model (VAR) for consumption growth, Δc_t, wealth growth, Δw_t, and labor income growth, Δy_t:

$$\Delta\mathbf{X}_t = \theta + \gamma_t\beta_t'\mathbf{X}_{t-1} + \Gamma(L)\Delta\mathbf{X}_{t-1} + \xi_t, \tag{7}$$

where $\mathbf{X}_t = (c_t, w_t, y_t)$ is the vector of consumption, aggregate wealth, and labor income, $\gamma_t = (\gamma_c, \gamma_w, \gamma_y)'$ is a (4×1) vector, $\beta_t = (1, -\beta_w, -\beta_y)'$ is the vector of estimated cointegration coefficients, $\Gamma(L)$ is a finite-order distributed lag operator, $\xi_t = (\xi_t^c, \xi_t^w, \xi_t^y)$ is a vector of disturbance terms and θ is a vector of constants. Thus, γ_t is the short-run adjustment vector telling us how the variables react to the last period's cointegrating error while returning to long-term equilibrium after a deviation; β_t measures the long-run elasticities of one variable respective to another; and the term $\beta_t'\mathbf{X}_{t-1}$ measures the cointegrating residual. Following Campbell and Shiller (1988), for small perturbations around the steady state, the variables included in the VAR should capture most of the relevant information for wealth changes. Therefore, the residuals of the equation for wealth growth, ξ_t^w, shall be a good proxy for wealth shocks and I regress:

$$\Delta\rho_t = \delta_0 + \delta_1\xi_t^w + u_t. \tag{8}$$

Equations (6) and (8) shall provide a robust test to the assumption of constant relative risk aversion: if wealth shocks are important determinants of transitory risk aversion, the coefficient will be significant and this will a piece of evidence supporting preferences that depart from that assumption.[14]

3 Wealth Effects and Asset Allocation

3.1 Data

The main data sources are the Flow of Funds Accounts provided by Federal Reserve System and BEA of U.S. Department of Commerce. In Appendix A, I present a detailed discussion of data.

[14] To address the measurement error problem and the potential correlation between the wealth shock proxy and the disturbance term, I estimate a two-stage least-squares regression using instrumental variables. Whilst some precision is lost with the use of this estimation, the results are still robust and point in the direction of the significant wealth effects on asset alllocation.

In the estimations, I use quarterly, seasonally adjusted data for U.S., variables are measured at 2000 prices and expressed in the logarithmic form of per capita terms, and the sample period is 1953:4 - 2004:4.

The definition of consumption includes nondurable consumption goods and services. Data on income includes only after-tax labor income. Aggregate wealth corresponds to net worth of households and nonprofit organizations, that is, the sum of housing wealth and financial wealth.

Housing wealth (or home equity) is defined as the value of real estate held by households minus home mortgages. Financial wealth is defined as the sum of financial assets (deposits, credit market instruments, corporate equities, mutual fund shares, security credit, life insurance reserves, pension fund reserves, equity in noncorporate business, and miscellaneous assets) minus financial liabilities (credit market instruments excluding home mortgages, security credit, trade payables, and deferred and unpaid life insurance premiums). Original data on wealth correspond to the end-period values. Therefore, I lag once the data, so that the observation of wealth in t corresponds to the value at the beginning of the period $t+1$.

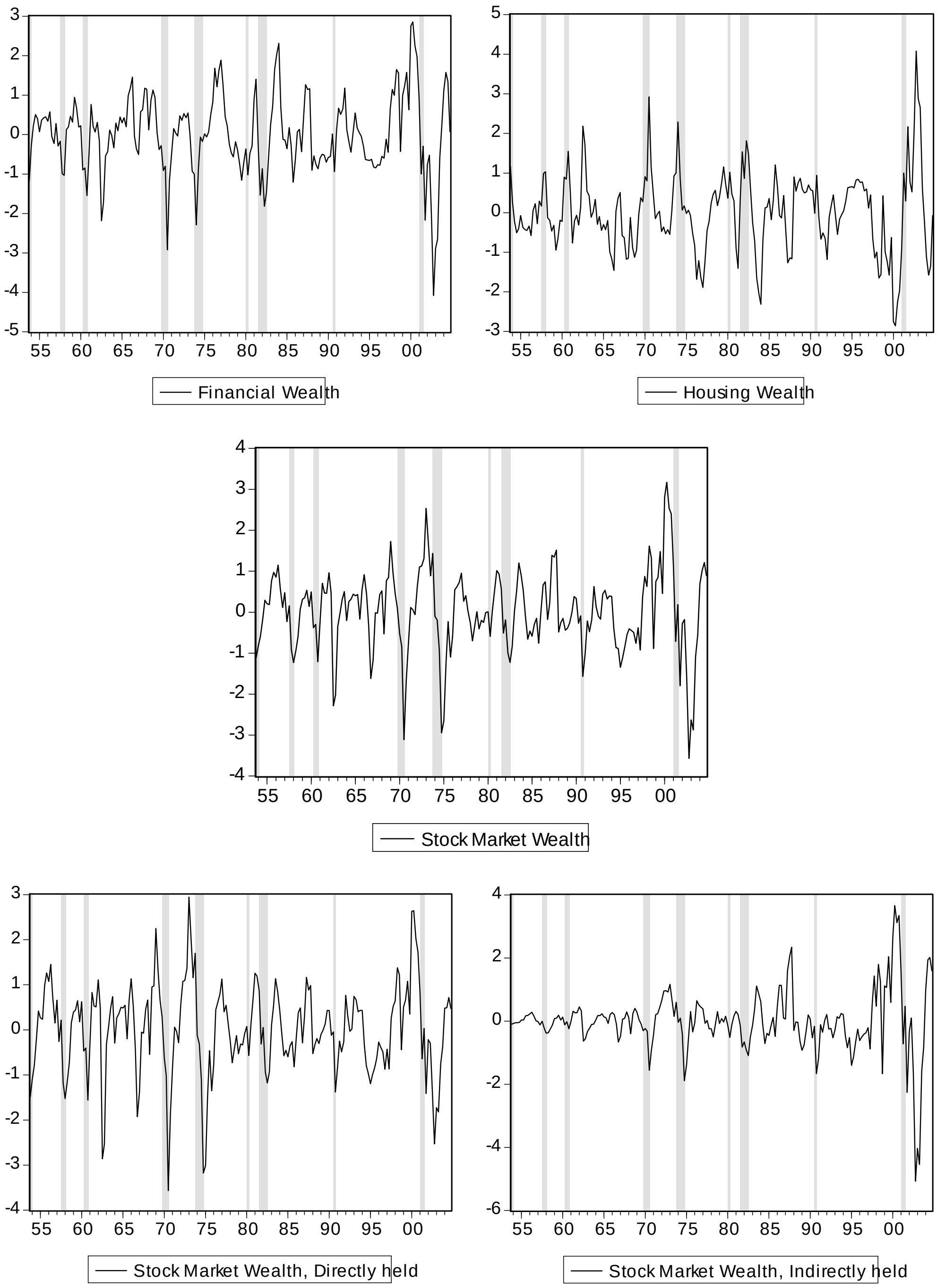
I start by defining ρ_t^1 as the log share of financial wealth in total wealth and ρ_t^2 as the log of the share of housing wealth in total wealth. Then, I consider risky asset holdings as the stock market wealth - that is, the sum of the value of corporate equities, directly and indirectly held - and denote by ρ_t^3 the log share of risky assets in financial wealth. This is the preferred proxy for agent's risk aversion. In addition, I consider two measures of risky asset holdings: (i) one that includes only risky asset direct holdings, ρ_t^4; and (ii) another that includes only indirect holdings, ρ_t^5. In both cases, the risky asset share is computed as ratios of financial wealth. [15]

Figure 1 shows the evolution of the composition of wealth: while the share of housing wealth exhibits a counter-cyclical pattern, the other portfolio shares fall during recessions and increase in expansions. This evidence suggests that housing is an hedge against unfavorable wealth shifts and that risk aversion is counter-cyclical.

[15] The estimation results do not change significantly when different measures of consumption (including durable goods) are used or when the risky asset share is measured as a ratio of total wealth.

Figure 1: Evolution of the composition of wealth.

The picture depicts the evolution of the shares of financial and housing wealth in total wealth and the shares of stock market wealth and its components in financial wealth. All series are detrended using the Hodrick-Prescott (1997) filter and normalized to standard deviations. The sample period is 1953:4 to 2004:4. Shaded areas denote NBER recessions.



3.2 Empirical Evidence

The starting points for the estimation of wealth effects on portfolio composition are equation (6) - where wealth shocks are computed using the residuals of the estimated data-generating process for wealth growth - and equation (8) - where they are computed as the residuals of the wealth growth equation in a reduced vector auto-regression model (VAR).

Tables 1 and 2 show a summary of the results. The estimated coefficient on the wealth shock (respectively, ε_t and ξ_t^w) is positive and significant and is very similar in both specifications. When the dependent variable is the change in the ratio of stock market wealth to financial wealth, i.e. the favourite definition of risky asset share, $\Delta\rho_t^3$, the coefficient associated with the wealth shock is large and positive (respectively, 2.682 and 2.210 in Tables 1 and 2): an unexpected shock of 1% in aggregate wealth leads to an increase of the share of risky assets by, respectively, 2.682% and 2.210%. The $\bar{R}^2$ are also large (respectively, 0.69 and 0.54), showing that wealth shocks are important determinants of risk aversion. When the definition of risky asset share is split into directly versus indirectly held risky risky assets, $\Delta\rho_t^4$ and $\Delta\rho_t^5$, it can be seen that wealth effects are stronger in the first case: both the coefficient on wealth shocks and the $\bar{R}^2$ are larger in magnitude. This is consistent with agents that do not trade some categories of assets (such as mutual or pension funds). The only exception to the positive effect of wealth shocks is the share of housing wealth, given that the coefficient is negative. This empirical finding is important and suggests that housing is an hedge against unexpected wealth variation: in face of a positive wealth shock, the relative risk aversion falls and the agent reduces the share of housing assets.

Table 1: Wealth effects in asset allocation - wealth shocks from single equation.

	Financial Wealth $\Delta\rho_t^1$	Housing Wealth $\Delta\rho_t^2$	Stock Market Wealth $\Delta\rho_t^3$	Stock Market Wealth, Directly. held $\Delta\rho_t^4$	Stock Market Wealth, Indirectly held $\Delta\rho_t^5$
Constant	-0.000	0.000	0.004	0.000	0.013*
	(-0.238)	(0.219)	(1.563)	(0.128)	(4.645)
ε_t	0.16*	-0.770*	2.682*	2.810*	2.292*
	(7.278)	(-7.412)	(21.291)	(11.910)	(10.264)
$\bar{R}^2$	[0.41]	[0.45]	[0.69]	[0.68]	[0.57]

Symbols *, **, *** represent, respectively, significance level of 1%, 5% and 10%.

Newey and West (1987) corrected t-statistics appear in parenthesis.

The sample period is 1953:4 to 2004:4.

Table 2: Wealth effects in asset allocation: wealth shocks from VAR system.

	Financial Wealth $\Delta\rho_t^1$	Housing Wealth $\Delta\rho_t^2$	Stock Market Wealth $\Delta\rho_t^3$	Stock Market Wealth Directly held $\Delta\rho_t^4$	Stock Market Wealth Indirectly held $\Delta\rho_t^5$
Constant	-0.000	0.000	0.004	0.000	0.013*
	(-0.210)	(0.190)	(1.045)	(0.117)	(3.908)
ξ_t^w	0.143*	-0.690*	2.210*	2.301*	1.979*
	(8.516)	(-8.454)	(11.632)	(12.066)	(10.115)
$\bar{R}^2$	[0.38]	[0.41]	[0.54]	[0.53]	[0.49]

Symbols *, **, *** represent, respectively, significance level of 1%, 5% and 10%.

Newey and West (1987) corrected t-statistics appear in parenthesis.

The sample period is 1953:4 to 2004:4.

3.3 Robustness Analysis

3.3.1 Price Effects

While the previous regressions suggest that wealth shocks affect portfolio composition, one could argue that this is just reflecting possible changes in the price of corporate equities, or housing prices or both. Therefore, I control for possible price effects and consider the log change of price of financial assets, Δp_t^f, and the log change of relative price of financial to housing assets, $\Delta\left(\frac{p_t^f}{p_t^u}\right)$ as possible explanatory variables.

Financial prices are measured using the Standard & Poor's (S&P 500) Composite Index. Housing prices are measured using two sources: (a) the Price Index of New One-Family Houses sold including the Value of Lot provided by the U.S. Census since 1963:1; and (b) the House Price Index computed by the Office of Federal Housing Enterprise Oversight (OFHEO) since 1975:1.

The results are summarized in Tables 3 and 4. For simplicity, only the results that use the Census Housing Price Index are reported, although the regressions with the OFHEO Housing Price Index corroborate the major findings. The evidence of price effects is very weak: only a few coefficients are statistically significant and their inclusion does not significantly change the R^2 statistic. Nevertheless, the signs are consistent with an increase in risky asset share, i.e. an increase in the price of financial assets or in the relative price of financial to housing assets is associated with an increase in the share of risky assets and a decrease in the share of housing assets.

Table 3: Asset allocation and financial price effects.

	Financial Wealth $\Delta\rho_t^1$	Housing Wealth $\Delta\rho_t^2$	Stock Market Wealth $\Delta\rho_t^3$	Stock Market Wealth Directly held $\Delta\rho_t^4$	Stock Market Wealth Indirectly held $\Delta\rho_t^5$
Constant	-0.000	0.000	0.003	-0.001	0.013*
	(-0.301)	(0.272)	(1.156)	(-0.248)	(4.638)
ε_t	0.159*	-0.769*	2.671*	2.795*	2.285*
	(7.357)	-7.489)	(11.522)	(12.019)	(10.243)
Δp_t^f	0.002	-0.006	0.045	0.057**	0.025
	(0.339)	(-0.296)	(1.596)	(2.024)	(0.718)
$\bar{R}^2$	[0.40]	[0.44]	[0.69]	0.68	[0.57]

Symbols *, **, *** represent, respectively, significance level of 1%, 5% and 10%.

Newey and West (1987) corrected t-statistics appear in parenthesis.

The sample period is 1953:4 to 2004:4.

Table 4: Asset allocation and relative price of assets (Census).

	Financial Wealth $\Delta\rho_t^1$	Housing Wealth $\Delta\rho_t^2$	Stock Market Wealth $\Delta\rho_t^3$	Stock Market Wealth Directly held $\Delta\rho_t^4$	Stock Market Wealth Indirectly held $\Delta\rho_t^5$
Constant	-0.000	0.001	0.001	-0.003	0.010*
	(-0.651)	(0.636)	(0.373)	(-0.911)	(3.382)
ε_t	0.155*	-0.750*	2.567*	2.693*	2.262*
	(6.268)	(-6.394)	(10.418)	(10.928)	(9.217)
$\Delta \frac{p_t^f}{p_t^u}$	0.001	-0.006	0.039	0.048***	0.033
	(0.251)	(-0.224)	(12.54)	(1.634)	(0.776)
$\bar{R}^2$	[0.38]	[0.43]	[0.67]	[0.66]	[0.57]

Symbols *, **, *** represent, respectively, significance level of 1%, 5% and 10%.

Newey and West (1987) corrected t-statistics appear in parenthesis.

The sample period is 1963:2 to 2004:4.

3.3.2 Asset Return Effects

Another channel that may affect portfolio composition is through asset returns. The previous findings may be capturing changes in asset returns instead of the effects of wealth shocks *per se*. I, therefore, add returns on financial assets, r_t, and returns on housing assets, r_t^u, as explanatory variables. The results are summarized in Tables 5 and 6 and Appendix A presents the computation of returns. Whilst financial returns do not play any role in wealth allocation, there is weak evidence suggesting that housing returns are important. This asymmetric behavior may be related with agents looking at changes in financial returns as transitory and perceiving changes in housing returns as persistent.

Table 5: Asset Allocation and returns on financial assets.

	Financial Wealth $\Delta\rho_t^1$	Housing Wealth $\Delta\rho_t^2$	Stock Market Wealth $\Delta\rho_t^3$	Stock Market Wealth Directly held $\Delta\rho_t^4$	Stock Market Wealth Indirectly held $\Delta\rho_t^5$
Constant	-0.000	0.000	0.003	-0.000	0.013
	(-0.295)	(0.263)	(1.263)	(-0.134)	(4.724)
ε_t	0.160*	-0.770*	2.680*	2.806*	2.291*
	(7.252)	(-7.386)	(11.569)	(12.096)	(10.234)
r_t	0.001	-0.005	0.030	0.042	0.005
	(0.337)	(-0.277)	(1.220)	(1.617)	(0.199)
$\bar{R}^2$	[0.41]	[0.44]	[0.69]	[0.68]	[0.57]

Symbols *, **, *** represent, respectively, significance level of 1%, 5% and 10%.

Newey and West (1987) corrected t-statistics appear in parenthesis.

The sample period is 1953:4 to 2004:4.

Table 6: Asset allocation and housing returns.

	Financial Wealth $\Delta\rho_t^1$	Housing Wealth $\Delta\rho_t^2$	Stock Market Wealth $\Delta\rho_t^3$	Stock Market Wealth Directly held $\Delta\rho_t^4$	Stock Market Wealth Indirectly held $\Delta\rho_t^5$
Constant	0.001**	-0.006**	0.005	0.002	0.017*
	(2.158)	(-2.008)	(1.058)	(0.301)	(3.693)
ε_t	0.168*	-0.807*	2.689*	2.817*	2.316*
	(8.347)	(-8.492)	(11.218)	(11.651)	(10.106)
r_t^u	-0.073*	0.318**	-0.056	-0.060	-0.211
	(-2.616)	(2.403)	(-0.287)	(-0.278)	(-1.114)
$\bar{R}^2$	[0.44]	[0.47]	[0.69]	[0.68]	[0.57]

Symbols *, **, *** represent, respectively, significance level of 1%, 5% and 10%.

Newey and West (1987) corrected t-statistics appear in parenthesis.

The sample period is 1953:4 to 2004:4.

3.3.3 Holding Gains and Net Acquisitions of Assets

In this Subsection, I test for other potential sources of variation in portfolio composition. In particular, I control for the effects of holding gains and net acquisition of assets which may be driving the changes in the risky asset allocation.

Holding gains are calculated as the change in amount outstanding less net purchases during the period and the effects of holding gains in corporate equities, $\Delta(\textit{stock gains})_t$, and holding gains in real estate, $\Delta(\textit{housing gains})_t$ are shown in Tables 7 and 8. Consistent with the previous findings, the results suggest that stock gains have no effect on portfolio allocation, but housing gains are important. This duality may be associated with the beliefs that stock gains are transitory and housing gains are persistent. Despite this, the coefficient associated with wealth shocks, ε_t, and the R^2 statistic do not change significantly, further reinforcing that these are important determinants of asset allocation.

As a final robustness check, I test the impact of the net acquisition of corporate equities, $\Delta(\textit{stock purchases})_t$, and the net acquisition of mortgages, $\Delta(\textit{mortgages})_t$, and include them as explanatory variables in different specifications. The results are summarized in Tables 9 and 10: whilst there is evidence suggesting that net acquisition of corporate equities prompt agents to increase the proportion of wealth invested in risky assets, net acquisition of mortgages has no effect on asset allocation.

Table 7: Asset allocation and holding gains in corporate equities.

	Financial Wealth $\Delta\rho_t^1$	Housing Wealth $\Delta\rho_t^2$	Stock Market Wealth $\Delta\rho_t^3$	Stock Market Wealth Directly held $\Delta\rho_t^4$	Stock Market Wealth Indirectly held $\Delta\rho_t^5$
Constant	-0.000	0.000	0.004	-0.000	0.013*
	(-0.330)	(0.310)	(1.225)	(-0.103)	(4.669)
ε_t	0.160*	-0.771*	2.685*	2.810*	2.292*
	(7.187)	(-7.314)	(11.588)	(12.162)	(10.230)
$\Delta(stock\ gains)_t$	0.000	-0.001	0.002	0.003	-0.000
	(0.663)	(-0.594)	(0.966)	(1.550)	(-0.087)
$\bar{R}^2$	[0.41]	[0.44]	[0.69]	[0.68]	[0.57]

Symbols *, **, *** represent, respectively, significance level of 1%, 5% and 10%.

Newey and West (1987) corrected t-statistics appear in parenthesis.

The sample period is 1953:4 to 2004:4.

Table 8: Asset allocation and holding gains in real estate.

	Financial Wealth $\Delta\rho_t^1$	Housing Wealth $\Delta\rho_t^2$	Stock Market Wealth $\Delta\rho_t^3$	Stock Market Wealth Directly held $\Delta\rho_t^4$	Stock Market Wealth Indirectly held $\Delta\rho_t^5$
Constant	0.000*	-0.005*	0.009*	-0.011*	0.021*
	(2.882)	(-2.724)	(2.603)	(-3.007)	(5.884)
ε_t	0.164*	-0.787*	2.698*	2.831*	2.315*
	(7.902)	(-7.985)	(11.218)	(12.082)	(10.097)
$\Delta(housing\ gains)_t$	-0.003*	0.014*	-0.013**	-0.017*	-0.020*
	(-4.192)	(4.048)	(-2.059)	(-2.526)	(-2.746)
$\bar{R}^2$	[0.46]	[0.49]	[0.69]	[0.72]	[0.58]

Symbols *, **, *** represent, respectively, significance level of 1%, 5% and 10%.

Newey and West (1987) corrected t-statistics appear in parenthesis.

The sample period is 1953:4 to 2004:4.

Table 9: Asset allocation and net acquisition of corporate equities.

	Financial Wealth $\Delta\rho_t^1$	Housing Wealth $\Delta\rho_t^2$	Stock Market Wealth $\Delta\rho_t^3$	Stock Market Wealth Directly held $\Delta\rho_t^4$	Stock Market Wealth Indirectly held $\Delta\rho_t^5$
Constant	0.000	-0.000	0.006**	0.002	0.015*
	(0.278)	(-0.243)	(-1.913)	(0.617)	(5.579)
ε_t	0.161*	-0.777*	2.697*	2.824*	2.311*
	(7.461)	(-7.507)	(11.454)	(11.901)	(10.325)
$\Delta(stock\ purchases)_t$	0.002*	-0.009**	0.021**	0.021**	0.026*
	(2.585)	(-2.433)	(2.118)	(1.956)	(2.670)
$\bar{R}^2$	[0.42]	[0.46]	[0.70]	[0.69]	[0.59]

Symbols *, **, *** represent, respectively, significance level of 1%, 5% and 10%.

Newey and West (1987) corrected t-statistics appear in parenthesis.

The sample period is 1953:4 to 2004:4.

Table 10: Asset allocation and net acquisition of mortgages.

	Financial Wealth $\Delta\rho_t^1$	Housing Wealth $\Delta\rho_t^2$	Stock Market Wealth $\Delta\rho_t^3$	Stock Market Wealth Directly held $\Delta\rho_t^4$	Stock Market Wealth Indirectly held $\Delta\rho_t^5$
Constant	-0.000	0.001	0.004	-0.000	0.013*
	(-0.506)	(0.491)	(1.223)	(-0.038)	(4.504)
ε_t	0.161*	-0.773*	2.684*	2.813*	2.292*
	(7.346)	(-7.475)	(11.474)	(11.911)	(10.309)
$\Delta mortgage_t$	0.004	-0.017	0.011	-0.018	0.001
	(1.434)	(-1.475)	(0.371)	(-0.644)	(-0.023)
$\bar{R}^2$	[0.41]	[0.45]	[0.69]	[0.68]	[0.57]

Symbols *, **, *** represent, respectively, significance level of 1%, 5% and 10%.

Newey and West (1987) corrected t-statistics appear in parenthesis.

The sample period is 1953:4 to 2004:4.

4 Expected Returns and Asset Allocation

One potential drawback of the previous analysis is that it neglects the possibility of time-variation in the expectations about future returns and in the volatility of returns. Moreover, at the time of wealth shocks, future returns on assets are not observable and, therefore, can only be predicted. Following Friend and Blume (1975), the optimal investment in risky assets can be approximated by the following formula:

$$\rho_t = \log \frac{E(r_t - r^f)}{\sigma_t^2} - \log \gamma, \tag{9}$$

where ρ_t is the log share of wealth invested in risky assets, γ is Pratt's measure of relative risk aversion,[16] r_t and σ_t^2 denote, respectively, the return and the variance of the return on the portfolio of risky assets, and r^f is the risk-free interest rate. Given estimates of ρ_t and the market price for risk, $\frac{E(r_t - r^f)}{\sigma_t^2}$, this equation can be used to estimate the coefficient of relative risk aversion. It, therefore, shows that time-varying expected returns or volatility of returns may generate transitory variation in portfolio composition.

I address the issue of time-variation in expected returns using numerous empirical proxies developed in the literature, namely: the consumption-wealth ratio (Lettau and Ludvigson, 2001), the labor income-consumption ratio (Santos and Veronesi, 2006), the labor income risk (Julliard, 2004), the composition risk (Piazzesi et al., 2007), and the housing collateral ratio (Lustig and Van Nieuwerburgh, 2005). The results show that the ARCH or GARCH specifications do not fit well the wealth growth process, so it does not capture the time-variation in the volatility of returns. Consequently, the analysis will be focusing on the effects of time-varying expected returns.

4.1 Consumption-Wealth Ratio

Lettau and Ludvigson (2001) show that fluctuations in the consumption-wealth ratio, *cay*, summarize changes in expected returns and can be used for predicting stock returns. Investors want to maintain a flat consumption path over time and will attempt to "smooth out" transitory movements in their asset wealth arising from time-variation in asset returns.

In order to capture the effect of changes in expected returns, I include *cay* as an explanatory variable for risky asset allocation. I estimate *cay* as: $cay_t := c_t - 0.42w_t - 0.65y_t$. Table 11 presents a summary of the results. It can be seen that the coefficient associated to *cay* is always significant: an increase of 1% in *cay* generates an increase of 0.349% in the share of stock market wealth. This is consistent with the idea

[16] It can be interpreted as the wealth elasticity of the marginal utility of wealth, i.e. $\gamma := -W_t \frac{U''(W_t)}{U'(W_t)}$.

that investors increase their exposition to risk when they expect higher returns. Note, however, that the coefficients associated to wealth shocks, as well as the $\bar{R}^2$, are not significantly different from those obtained in previous regressions. The results suggest, therefore, that changes in risky asset allocation are only partially explained by changes in expected returns.

Table 11: Asset allocation and consumption-wealth ratio.

	Financial Wealth $\Delta\rho_t^1$	Housing Wealth $\Delta\rho_t^2$	Stock Market Wealth $\Delta\rho_t^3$	Stock Market Wealth Directly held $\Delta\rho_t^4$	Stock Market Wealth Indirectly held $\Delta\rho_t^5$
Constant	0.000	-0.002	0.008**	0.004	0.0168*
	(1.107)	(-1.275)	(2.336)	(1.077)	(5.095)
ε_t	0.166*	-0.800*	2.735*	2.858*	2.336*
	(7.367)	(-7.442)	(11.864)	(12.260)	(10.678)
cay_t	0.035*	-0.167*	0.294*	0.270**	0.245**
	(3.280)	(-3.492)	(2.737)	(2.351)	(2.180)
$\bar{R}^2$	[0.43]	[0.47]	[0.70]	[0.69]	[0.58]

Symbols *, **, *** represent, respectively, significance level of 1%, 5% and 10%.

Newey and West (1987) corrected t-statistics appear in parenthesis.

The sample period is 1953:4 to 2004:4.

4.2 Labor Income-Consumption Ratio

Santos and Veronesi (2006) propose a model in which investors' income has two sources, wages and dividends, growing stochastically over time. As the fraction of consumption funded by the endowment flow of labor income - i.e. labor income-consumption ratio, lc - fluctuates, the relationship between stock returns and consumption growth varies, thereby generating changes in the risk premia that investors require to hold stocks.

In Table 12, I include lc as an explanatory variable of risky asset allocation. The coefficient associated to lc is small in magnitude and is not significant in most of the regressions, although the sign is consistent with the predictions of the theory: an increase of 1% in lc - or a fall in the fraction of consumption funded by dividends - leads to a decrease of the risky asset share of 0.103%. Moreover, as the coefficients associated to wealth shocks, as well as the $\bar{R}^2$, do not change significantly relative to the previous regressions, the results show that wealth shocks are responsible for most of the variation in portfolio composition.

Table 12: Asset allocation and labor income-consumption ratio.

	Financial Wealth $\Delta\rho_t^1$	Housing Wealth $\Delta\rho_t^2$	Stock Market Wealth $\Delta\rho_t^3$	Stock Market Wealth Directly held $\Delta\rho_t^4$	Stock Market Wealth Indirectly held $\Delta\rho_t^5$
Constant	0.000	-0.001	0.008**	0.004	0.015*
	(0.311)	(-0.276)	(2.371)	(1.026)	(4.584)
ε_t	0.160*	-0.769*	2.678*	2.807*	2.290*
	(7.031)	(-7.202)	(11.563)	(11.989)	(10.253)
lc_t	-0.006	0.024	-0.103**	-0.086***	-0.046
	(-0.800)	(0.699)	(-2.164)	(-1.664)	(-0.942)
$\bar{R}^2$	[0.41]	[0.45]	[0.69]	[0.68]	[0.57]

Symbols *, **, *** represent, respectively, significance level of 1%, 5% and 10%.

Newey and West (1987) corrected t-statistics appear in parenthesis.

The sample period is 1953:4 to 2004:4.

4.3 Labor Income Risk

Julliard (2004) uses the representative consumer's budget constraint to derive an equilibrium relation between future labor income growth rates, lr, and expected future asset returns. The author shows that expectations of high (low) future labor income growth are associated with lower (higher) stock market excess returns.

In order to capture the effect of labor income risk, lr is added as an explanatory variable of portfolio composition. The results, summarized in Table 13, show that labor income risk is a source of variation of risk aversion: the coefficient associated to lr is significant in the regressions with the share of stock market wealth, $\Delta\rho_t^4$, and the share of directly held risky assets, $\Delta\rho_t^4$, as the dependent variables. The coefficients are negative (respectively, -0.704 and -0.806), consistent with a high lr representing a state of the world in which returns on asset wealth are low, because agents expect to have abundance of resources in the future to finance consumption. As before, the coefficients associated to wealth shocks and the $\bar{R}^2$ statistics remain basically unchanged, therefore, suggesting that wealth shocks are important determinants of changes in aggregate portfolio shares.

Table 13: Asset allocation and labor income risk.

	Financial Wealth $\Delta\rho_t^1$	Housing Wealth $\Delta\rho_t^2$	Stock Market Wealth $\Delta\rho_t^3$	Stock Market Wealth Directly held $\Delta\rho_t^4$	Stock Market Wealth Indirectly held $\Delta\rho_t^5$
Constant	0.000	-0.001	0.004	0.001	0.014*
	(0.516)	(-0.551)	(1.506)	(0.418)	(4.609)
ε_t	0.139*	-0.685*	2.872*	3.020*	2.371*
	(6.286)	(-6.150)	(10.224)	(10.635)	(8.592)
lr_t	-0.014	0.058	-0.663**	-0.765**	-0.331
	(-0.459)	(0.411)	(-1.981)	(-2.223)	(-0.879)
$\bar{R}^2$	[0.32]	[0.36]	[0.68]	[0.68]	[0.54]

Symbols *, **, *** represent, respectively, significance level of 1%, 5% and 10%.

Newey and West (1987) corrected t-statistics appear in parenthesis.

The sample period is 1953:4 to 2000:4.

4.4 Non-Separability of Preferences

Yogo (2006) shows that when utility is nonseparable in nondurable and durable consumption and the elasticity of substitution between the two consumption goods is sufficiently high, marginal utility rises when durable consumption falls.[17] Stock returns are unexpectedly low at business cycle troughs, when durable consumption falls sharply, helping to explain the countercyclical variation in the equity premium. Piazzesi et al. (2007) explicitly model housing both as an asset and a consumption good. Nonseparable preferences describe households' concern with composition risk, that is, fluctuations of the relative share of non-housing in their consumption basket, φ, the housing share can be used to forecast returns on stocks.

The importance of nundurability of preferences in generating transitory risk aversion is tested in Table 14. It suggests that composition risk does not play a role in asset allocation: the coefficient associated to φ is not significant and is small in magnitude in most of the regressions and the $\bar{R}^2$ statistics remain unchanged.

[17] Pakos (2003) argues that the falling price of durables raised real income and increased the consumption of durables, i.e. preferences are non-homothetic. On the other hand, Dunn and Singleton (1986) and Eichenbaum and Hansen (1990) report evidence against separabilility of preferences, but conclude that introducing durables does not help in reducing the pricing errors for stocks.

Table 14: Asset allocation and composition risk.

	Financial Wealth $\Delta\rho_t^1$	Housing Wealth $\Delta\rho_t^2$	Stock Market Wealth $\Delta\rho_t^3$	Stock Market Wealth Directly held $\Delta\rho_t^4$	Stock Market Wealth Indirectly held $\Delta\rho_t^5$
Constant	-0.019***	0.084**	0.030	-0.001	0.097
	(-1.913)	(1.980)	(0.318)	(-0.008)	(0.969)
ε_t	0.159*	-0.767*	2.683*	2.810*	2.295*
	(7.234)	(-7.381)	(11.423)	(11.874)	(10.221)
φ_t	-0.091***	0.412**	0.131	-0.006	0.411
	(-1.912)	(1.979)	(0.278)	(-0.012)	(0.837)
$\bar{R}^2$	[0.42]	[0.46]	[0.69]	[0.68]	[0.57]

Symbols *, **, *** represent, respectively, significance level of 1%, 5% and 10%.

Newey and West (1987) corrected t-statistics appear in parenthesis.

The sample period is 1953:4 to 2004:4.

4.5 Housing Collateral Ratio

Lustig and Van Nieuwerburgh (2005) show that the ratio of housing wealth to human wealth shifts the conditional distribution of asset prices and consumption growth and helps predicting stock returns. There are two main channels that transmit shocks originated in the housing market to the risk premia in asset markets: (i) when housing prices fall, collateral is destroyed and households are more exposed to idiosyncratic income risk; (ii) households want to hedge against rental price shocks or composition shocks when the utility function is nonseparable in nondurable consumption and housing services. Housing provides, therefore, utility and collateral services.

The aggregate stock of housing collateral is measured using the value of residential fixed assets (structures), $hvfa$. The housing collateral ratio, $myfa$, is then computed as the deviation from the cointegration relationship between the value of the aggregate housing stock and the aggregate labor income (both when the coefficient associated with income, ϖ, is restricted to be equal to -1 and is freely estimated) and added as an explanatory variable. Appendix A provides a detailed description.

Tables 15 and 16 present a summary of the results and show that $myfa$ is not an important determinant of risk aversion, as the estimated coefficients are not significant. In addition, the coefficients associated to wealth shocks remain significant and the $\bar{R}^2$ are similar to those previously found.

Table 15: Asset allocation and housing collateral ratio (ϖ=−1).

	Financial Wealth $\Delta\rho_t^1$	Housing Wealth $\Delta\rho_t^2$	Stock Market Wealth $\Delta\rho_t^3$	Stock Market Wealth Directly held $\Delta\rho_t^4$	Stock Market Wealth Indirectly held $\Delta\rho_t^5$
Constant	-0.000	0.000	0.004	0.000	0.013*
	(-0.253)	(0.232)	(1.412)	(0.130)	(4.713)
ε_t	0.159*	-0.765*	2.677*	2.804*	2.287*
	(7.132)	(-7.278)	(11.422)	(11.868)	(10.220)
$myfa_t$	-0.003*	0.012*	-0.012	-0.015	-0.013
	(-2.791)	(2.848)	(-1.112)	(-1.189)	(-1.386)
$\bar{R}^2$	[0.43]	[0.47]	[0.69]	[0.68]	[0.57]

Symbols *, **, *** represent, respectively, significance level of 1%, 5% and 10%.

Newey and West (1987) corrected t-statistics in parenthesis. The sample period is 1954:1 to 2004:4.

Table 16: Asset allocation and housing collateral ratio (ϖ is freely estimated).

	Financial Wealth $\Delta\rho_t^1$	Housing Wealth $\Delta\rho_t^2$	Stock Market Wealth $\Delta\rho_t^3$	Stock Market Wealth Directly held $\Delta\rho_t^4$	Stock Market Wealth Indirectly held $\Delta\rho_t^5$
Constant	-0.000	0.000	0.004	0.000	0.013*
	(-0.253)	(0.232)	(1.412)	(0.130)	(4.713)
ε_t	0.159*	-0.765*	2.677*	2.804*	2.287*
	(7.132)	(-7.278)	(11.421)	(11.868)	(10.220)
$myfa_t$	-0.013*	0.055*	-0.053	-0.066	-0.057
	(-2.791)	(2.848)	(-1.112)	(-1.189)	(-1.386)
$\bar{R}^2$	[0.43]	[0.47]	[0.69]	[0.68]	[0.57]

Symbols *, **, *** represent, respectively, significance level of 1%, 5% and 10%.

Newey and West (1987) corrected t-statistics in parenthesis. The sample period is 1954:1 to 2004:4.

5 Long-Run Effects and Inertia in Asset Allocation

In this Section, I look at the long-run effects of wealth shocks and explore the issue of inertia in asset allocation. The previous regressions suggest that there are important wealth effects on asset allocation, but they do not allow us to distinguish between short-run and long-run effects. This distinction is important because we may want to know whether unexpected wealth variation is better characterized as producing transitory effects on portfolio composition or as generating persistent effects on asset allocation.

To assess the long-run effects of wealth shocks, I regress the following specification:

$$\sum_{h=0}^{H} \Delta\rho_{t+h} = \beta_0 + \beta_1 \varepsilon_t + u_t, \tag{10}$$

where H represents the number of quarters and the results.

On the other hand, inertia may also play some role on asset allocation. Changes in wealth may accrue first in the form of riskless, liquid assets such as checking accounts. Additionally, adjustment costs (transaction costs or cognitive costs), limited attention or a belief that changes are transitory may be important. Finally, capital gains and losses on risky assets may have a direct impact on utility (as in loss aversion preferences or narrow framing of risks) or on beliefs about future returns (trend-chasing). In these circumstances, agents will gradually adjust their portfolio composition, implying that the previous regressions using contemporaneous wealth shocks and risky asset holdings are downward biased.

To address the issue of inertia in asset allocation, I include the lag of the change in the portfolio share, $\Delta\rho_{t-1}$, as an explanatory variable and regress the following specification:

$$\sum_{h=0}^{H} \Delta\rho_{t+h} = \beta_0 + \beta_1 \varepsilon_t + \beta_2 \Delta\rho_{t-1} + u_t, \tag{11}$$

where T represents the number of quarters. If inertia results from adjustment costs that are traded off against the benefits of rebalancing, then there could be inertia in the short run, but the share of stock holdings should revert to its optimal level in the long run. On the other hand, if investors chase returns, i.e. increase their exposure to risky assets following a positive wealth shock, then long-run effects would exceed short-run effects.

Table 17 shows that the effects of wealth shocks on the allocation between financial and housing assets are mainly transitory: in the case of the share of financial wealth, $\Delta\rho_t^1$, the $\bar{R}^2$ falls from 0.41 to 0.15 after 2 quarters and wealth shocks explain only 6% of the changes in portfolio composition over the next 3 quarters. Moreover, in the face of a positive wealth shock, agents reduce the share of housing assets, that is, housing is an important hedge against unexpected wealth variation. Table 18 confirms these findings: the effects of wealth shocks are transitory and in the case of the preferred definition of risky asset holdings, $\Delta\rho_t^3$, the $\bar{R}^2$ falls from 0.69 to 0.18 over the next 3 quarters.

By its turn, Tables 19 and 20 suggest that there is very weak evidence of inertia in asset allocation, as agents strongly rebalance their portfolios following a wealth shock: the coefficient associated to the lag of the portfolio share, $\Delta\rho_{t-1}$, is not statistically significant and its magnitude is very close to zero in most of the regressions. This goes against the findings of Brunnermeier and Nagel (2006) who argue that there are important inertia effects at the microeconomic level due to the failure of households to rebalance following capital gains and losses.

These results, therefore, show that the estimates of the wealth effects on asset allocation based on household level data are likely to be under-estimated: due to the poor coverage at the top-level of wealth distribution, where the exposure to risky assets is largest, a large component of the variation of wealth is not captured at the microeconomic level and, as a consequence, the estimates tend to be biased towards rejecting the existence of wealth effects. The use of macroeconomic data avoids this problem and the empirical findings clearly indicate that the risky asset share exhibits a cyclical behavior, whilst housing is an hedge against unexpected wealth variation.

Table 17: Long-run effects of wealth shocks on asset allocation - financial and housing wealth.

	Horizon H			
Regressor	0	1	2	3
	Panel A: Financial Wealth, $\sum_{h=0}^{H}\Delta\rho_{t+h}^1$			
ε_t	0.160*	0.141*	0.145*	0.139*
	(7.278)	(4.742)	(3.776)	(3.135)
$\bar{R}^2$	[0.41]	[0.15]	[0.09]	[0.06]
	Panel B: Housing Wealth, $\sum_{h=0}^{H}\Delta\rho_{t+h}^2$			
ε_t	-0.770*	-0.686*	-0.686*	-0.673*
	(-7.412)	(-4.923)	(-3.791)	(-3.133)
$\bar{R}^2$	[0.45]	[0.16]	[0.10]	[0.07]

Symbols *, ** and *** represent significance at a 1%, 5% and 10% level, respectively.

Newey and West (1987) corrected t-statistics appear in parenthesis.

The sample period is 1953:4 to 2004:4.

Table 18: Long-run effects of wealth shocks on asset allocation - stock market wealth.

Regressor	Horizon H 0	1	2	3
Panel A: Stock Market Wealth, $\sum_{h=0}^{H} \Delta\rho^3_{t+h}$				
ε_t	2.682*	2.693*	2.724*	2.780*
	(21.291)	(7.052)	(6.014)	(5.495)
$\bar{R}^2$	[0.69]	[0.33]	[0.22]	[0.18]
Panel B: Stock Market Wealth, directly held, $\sum_{h=0}^{H} \Delta\rho^4_{t+h}$				
ε_t	2.810*	2.770*	2.815*	2.906*
	(11.910)	(6.964)	(5.907)	(5.310)
$\bar{R}^2$	[0.68]	[0.31]	[0.21]	[0.17]
Panel C: Stock Market Wealth, indirectly held, $\sum_{h=0}^{H} \Delta\rho^5_{t+h}$				
ε_t	2.292*	2.369*	2.413*	2.380*
	(10.264)	(7.073)	(6.096)	(5.746)
$\bar{R}^2$	[0.57]	[0.29]	[0.21]	[0.16]

Symbols *, ** and *** represent significance at a 1%, 5% and 10% level, respectively.

Newey and West (1987) corrected t-statistics appear in parenthesis.

The sample period is 1953:4 to 2004:4.

Table 19: Inertia in asset allocation: financial and housing wealth.

Regressor	Horizon H 0	1	2	3
Panel A: Financial Wealth, $\sum_{h=0}^{H} \Delta\rho^1_{t+h}$				
Constant	-0.000	-0.000	-0.000	-0.000
	(-0.280)	(-0.210)	(-0.305)	(-0.438)
ε_t	0.1604*	0.142*	0.146*	0.140*
	(11.983)	(6.064)	(4.722)	(3.748)
$\Delta\rho^1_{t-1}$	0.098***	0.168***	0.195	0.243
	(1.817)	(1.766)	(1.559)	(1.607)
$\bar{R}^2$	[0.41]	[0.16]	[0.10]	[0.7]
Panel B: Housing Wealth, $\sum_{h=0}^{H} \Delta\rho^2_{t+h}$				
Constant	0.000	0.000	0.001	0.001
	(0.222)	(0.139)	(0.171)	(0.221)
ε_t	-0.772*	-0.689*	-0.690*	-0.678*
	(-7.430)	(-5.074)	(-3.902)	(-3.247)
$\Delta\rho^2_{t-1}$	0.080	0.163	0.202	0.270
	(1.584)	(1.453)	(1.229)	(1.400)
$\bar{R}^2$	[0.45]	[0.17]	[0.11]	[0.08]

Symbols *, ** and *** represent significance at a 1%, 5% and 10% level, respectively.

Newey and West (1987) corrected t-statistics appear in parenthesis. The sample period is 1953:4 to 2004:4.

Table 20: Inertia in asset allocation: stock market wealth.

Regressor	Horizon H 0	1	2	3
	Panel A: Stock Market Wealth, $\sum_{h=0}^{H}\Delta\rho^3_{t+h}$			
Constant	0.004	0.008	0.012	0.016
	(1.358)	(1.274)	(1.191)	(1.169)
ε_t	2.681*	2.693*	2.725*	2.781*
	(11.681)	(7.032)	(5.982)	(5.455)
$\Delta\rho^3_{t-1}$	0.054***	0.000	-0.023	-0.043
	(1.598)	(0.005)	(-0.172)	(-0.318)
$\bar{R}^2$	[0.69]	[0.32]	[0.22]	[0.17]
	Panel B: Stock Market Wealth, Directly held, $\sum_{h=0}^{H}\Delta\rho^4_{t+h}$			
Constant	0.000	0.001	0.002	0.001
	(0.140)	(0.208)	(0.198)	(0.150)
ε_t	2.806*	2.769*	2.816*	2.907*
	(20.849)	(9.587)	(7.433)	(6.488)
$\Delta\rho^4_{t-1}$	0.040	0.009	-0.007	-0.006
	(1.000)	(0.105)	(-0.065)	(-0.047)
$\bar{R}^2$	[0.68]	[0.31]	[0.21]	[0.16]
	Panel C: Stock Market Wealth, Indirectly held, $\sum_{h=0}^{H}\Delta\rho^5_{t+h}$			
Constant	0.012*	0.027*	0.041*	0.054*
	(4.365)	(4.324)	(4.138)	(4.182)
ε_t	2.300*	2.367*	2.405	2.370*
	(10.526)	(7.058)	(5.985)	(5.607)
$\Delta\rho^5_{t-1}$	0.068***	-0.017	-0.064	-0.082
	(1.817)	(-0.184)	(-0.462)	(-0.667)
$\bar{R}^2$	[0.58]	[0.29]	[0.21]	[0.16]

Symbols *, ** and *** represent significance at a 1%, 5% and 10% level, respectively.

Newey and West (1987) corrected t-statistics appear in parenthesis. The sample period is 1953:4 to 2004:4.

6 Asset Allocation in a VAR Framework: a Skeptical Look

As a robustness check of the previous results, I analyze the importance of wealth effects on asset allocation in a more structural framework. I estimate the following Vector Autoregressive Model (VAR)

$$\mathbf{X}_t = \theta + B(L)\mathbf{X}_{t-1} + \mathbf{\Psi}\mathbf{Z}_{t-1} + \Upsilon_t, \tag{12}$$

where $X_t = (\Delta\rho_t, \Delta w_t, \Delta c_t, \Delta y_t, r_t)$ is the vector of the change of share of risky assets in financial wealth, wealth growth, consumption growth, income growth, and real returns on financial assets, $B(L)$ is a finite-order distributed lag operator, $Z_{t-1} = (cay_{t-1}, d_{t-1} - p_{t-1}, RREL_{t-1}, DEF1_{t-1}, DEF2_{t-1}, TRM_{t-1})$ is a vector of exogenous variables including the consumption-wealth ratio, the dividend yield, the relative bill rate, the default rates (the Moody's BAA corporate bond rate minus the AAA corporate bond rate and the Moody's BAA corporate bond yield minus the 10-year Treasury bond yield) and the term spread (the 10-year Treasury bond yield minus the 3-month Treasury bond yield), $\mathbf{\Psi}$ is a matrix of coefficients associated with Z_{t-1}, Υ_t is a vector of error terms, and θ is a vector of constants.[18]

Using the VAR in specification (12), I assess the effect of a wealth shock.[19] Under a diffuse prior, the posterior distribution of the estimated VAR can be factorized as the product of an inverse Wishart and, conditional on the covariance matrix, a multivariate normal distribution

$$\beta|_{\Sigma} \sim N(\hat{\beta}, \Sigma \otimes (X'X)^{-1})$$

$$\Sigma^{-1} \sim Wishart((n\hat{\Sigma})^{-1}, n - m)$$

where β is the vector of VAR coefficients, Σ is the covariance matrix of the residuals, the variables with a hat denote the corresponding estimates, X is the matrix of regressors, n is the sample size and m is the number of estimated parameters (Zellner, 1971; Schervish, 1995; Bauwens et al., 1999).[20] I compute 50,000 draws from the posterior distribution of the VAR coefficients and report 95 percent confidence intervals from the Monte Carlo iterations. The procedure is described in Appendix E.

Table 21 summarizes the results and shows that: (*i*) lagged changes in wealth do not explain the changes in the risky asset share, suggesting that wealth effects on asset allocation are transitory and there is no inertia on asset allocation; and (*ii*) lagged returns do not forecast future returns, but *cay* contains important predictive power, consistent with the findings of Lettau and Ludvigson (2001). Figure 2 shows the impulse-response functions to a wealth shock. Consistently, wealth shocks have a

[18] The selected optimal lag length is 1, in accordance with findings from Akaike and Schwarz tests.

[19] The Granger Causality tests with 4 lags clearly indicate that causality runs one-way from wealth shocks to asset allocation.

[20] This result is exact under normality and the Jeffrey's prior $f(\beta, \Sigma) \propto |\Sigma|^{-(p+1)/2}$ (where p is the number of left hand side variables), but can also be obtained as an asymptotic approximation around the posterior MLE.

positive (although temporary) effect on the risky asset share. Following a shock, agents rebalance their portfolios, wealth mean-reverts and the effect erodes over the next four quarters.

Table 21: Stock market wealth: estimates from vector-autoregressions (VAR).

	Equation				
Dependent variable	$\Delta\rho_t$	Δw_t	Δc_t	Δy_t	r_t
$\Delta\rho_{t-1}$	0.047	-0.013	0.006	0.018	-0.372**
	(1.240)	(-0.623)	(0.716)	(0.967)	(-2.060)
Δw_{t-1}	-0.180	0.022	-0.031	-0.090	1.227**
	(-1.434)	(0.325)	(-1.096)	(-1.457)	(2.071)
Δc_{t-1}	-0.137	0.165	0.179*	0.464*	0.451
	(-0.425)	(0.962)	(2.478)	(2.935)	(0.296)
Δy_{t-1}	-0.070	0.134	0.077**	-0.120	-0.244
	(-0.443)	(1.589)	(2.177)	(-1.548)	(-0.326)
r_{t-1}	0.721*	0.221*	0.015*	0.020**	-0.065
	(42.451)	(24.471)	(3.923)	(2.372)	(-0.808)
Constant	-0.067**	0.003	0.015**	-0.013	0.137
	(-2.110)	(0.202)	(2.118)	(-0.839)	(0.905)
cay_{t-1}	0.018	-0.043	-0.076*	-0.037	1.260*
	(0.205)	(-0.930)	(-3.868)	(-0.866)	(3.047)
$d_{t-1} - p_{t-1}$	-1.262***	0.124	0.251***	-0.362	-1.823
	(-1.908)	(0.353)	(1.693)	(-1.114)	(0.582)
$RREL_{t-1}$	-0.075	0.249*	-0.019	-0.049	-1.514**
	(-0.493)	(3.072)	(-0.562)	(-0.650)	(-2.104)
$DEF1_{t-1}$	0.477	-0.315	-0.170	-0.311	-0.099
	(0.582)	(-0.720)	(-0.924)	(-0.773)	(0.025)
$DEF2_{t-1}$	-0.173	0.193	0.021	0.076	-0.688
	(-0.422)	(0.880)	(0.230)	(0.379)	(-0.353)
TRM_{t-1}	0.017	0.126***	0.099*	0.069	-0.556
	(0.132)	(1.851)	(3.432)	(1.092)	(-0.916)
$\bar{R}^2$	[0.93]	[0.80]	[0.25]	[0.11]	[0.09]

This table reports the estimated coefficients from vector-autoregressions (VAR).

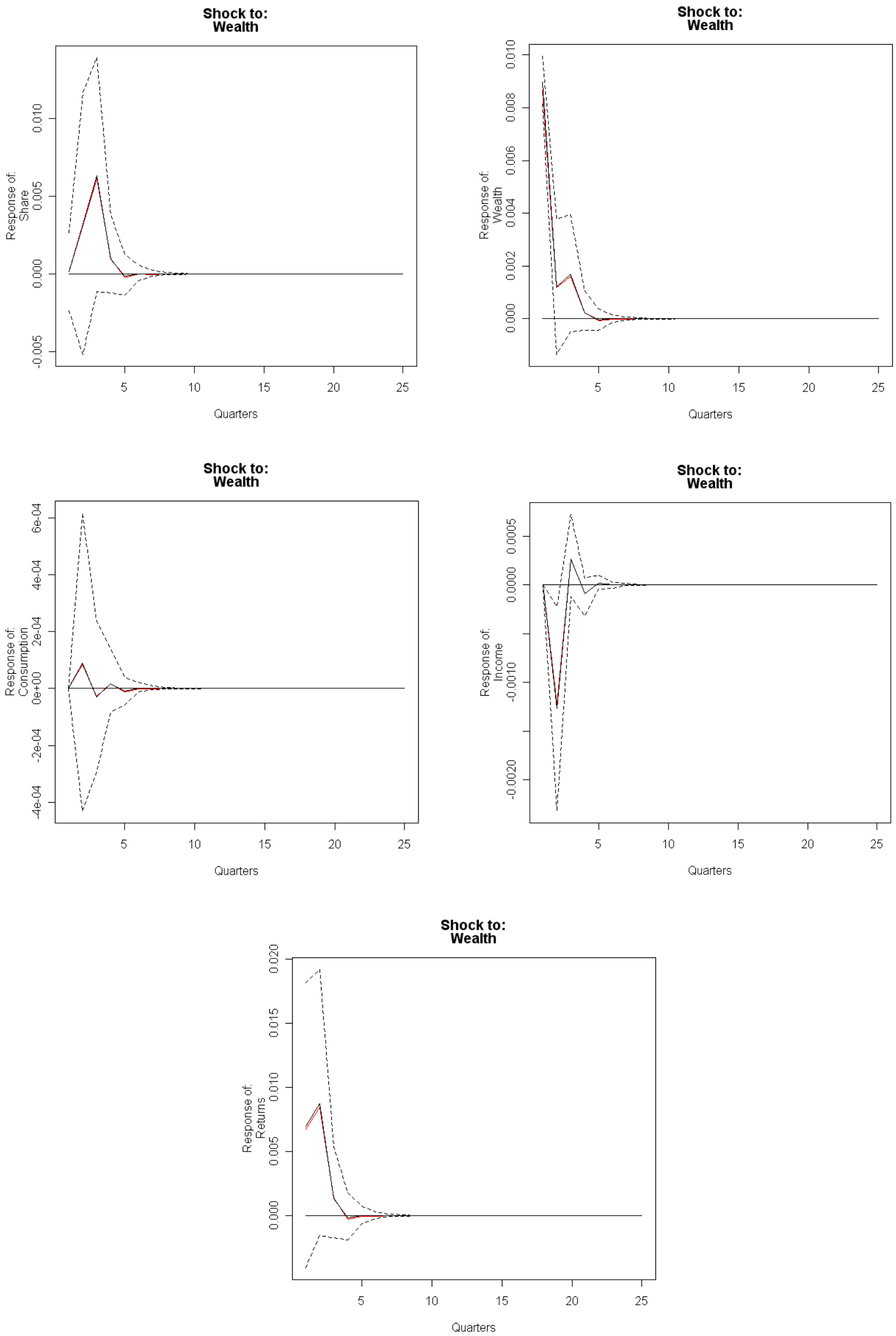
Symbols *, **, *** represent, respectively, significance level of 1%, 5% and 10%.

Newey-West (1987) corrected t-statistics appear in parenthesis. The sample period is 1953:4 to 2004:4.

Figure 2: Impulse-response functions to an aggregate wealth's shock.

The picture depicts the response to a one standard-deviation shock to aggregate wealth.

95% confidence intervals computed using the Markov chain Monte Carlo algorithm.



7 Conclusion

This paper tests the assumption of constant relative risk aversion using U.S. quarterly data for the period 1953:4 - 2004:4. I use macroeconomic data to analyze the role of wealth shocks in generating transitory changes in portfolio composition.

The main finding is that the risky asset share exhibits a cyclical behavior and, unlike Brunnermeier and Nagel (2006), it is significantly (and positively) affected by wealth shocks. There is, therefore, evidence suggesting that risk aversion is countercyclical and supporting the existence of preferences that depart from the assumption of constant relative risk aversion such as habit-formation or wealth-dependent utility functions. Additionally, it is shown that the share of housing wealth in portfolio falls when the agent is faced with a positive wealth shock, i.e. housing is a hedge against unexpected wealth variation.

Looking at the composition of risky asset holdings, the results suggest that wealth effects are slightly stronger for direct holdings than for indirect holdings. This is in accordance with the findings of Samuelson and Zeckhauser (1988), Ameriks and Zeldes (2004), Agnew et al. (2003) and Huberman and Sengmueller (2004), who show that a substantial fraction of agents do not trade at all in some categories of assets such as retirement accounts.

Controlling for changes in expected asset returns, it is shown that consumption-wealth ratio (Lettau and Ludvigson, 2001), the labor income risk (Julliard, 2004) and the labor income-consumption ratio (Santos and Veronesi, 2006) partially explain the changes in risky asset allocation. Nevertheless, wealth shocks remain important determinants of risk aversion.

Finally, considering a variety of wealth definitions, the empirical findings suggest that, although significant, wealth effects on asset allocation are mainly temporary as agents quickly rebalance the portfolio composition. In fact, and contrary to Brunnermeier and Nagel (2006), there is weak evidence of inertia or slow adjustment in asset allocation.

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Appendix

A Data Description

Consumption

Consumption is defined as the expenditure in non-durable consumption goods and services. Data are quarterly, seasonally adjusted at an annual rate, measured in billions of dollars (2000 prices), in per capita terms and expressed in the logarithmic form. Series comprises the period 1947:1-2005:4. The source is U.S. Department of Commerce, Bureau of Economic Analysis, NIPA Table 2.3.5.

Aggregate Wealth

Aggregate wealth is defined as the net worth of households and nonprofit organizations. Data are quarterly, seasonally adjusted at an annual rate, measured in billions of dollars (2000 prices), in per capita terms and expressed in the logarithmic form. Series comprises the period 1952:2-2006:1. The source of information is Board of Governors of Federal Reserve System, Flow of Funds Accounts, Table B.100, line 41 (series FL152090005.Q).

Stock market Wealth

Stock market wealth is defined as the sum of value of stocks, directly and indirectly held, namely: (a) stocks held by households – direct property (line 23 of Table B.100 - series FL153064105.Q); (b) stocks held by private pension funds (line 12 of Table L.118 - series FL573064105.Q); (c) stocks held by state and local government retirement funds (line 13 of Table L.119 - series FL223064105.Q); (d) stocks held by federal government retirement funds (line 6 of Table L. 120 - series FL343064105.Q); (e) stocks held by property-casualty insurance companies (line 10 of Table L.116 - series FL513064003.Q); (f) stocks held by closed-end funds (line 6 of Table L.123 - series FL553064103.Q); (g) stocks held by exchange-traded funds (line 12 of Table L.123 - series FL563064103.Q); (h) stocks held by mutual funds (line 9 of Table L.122 - series FL653064000.Q); and (i) stocks held by life insurance companies (line 12 of Table L.117 - series FL543064105.Q), multiplied by the ratio of reserves of life insurance companies (lines 17 and 18 of Table L.117 - series FL543140003.Q and series FL543150005.Q) to the total final assets of life insurance companies (line 1 of Table L.117 - series FL544090005.Q). This definition follows Davis e Palumbo (2001). Data are quarterly, seasonally adjusted at an annual rate, measured in billions of dollars (2000 prices), in per capita terms and expressed in the logarithmic form. Series comprises the period 1952:2-2006:1. The source of information is Board of Governors of Federal Reserve System, Flow of Funds Accounts.

Stock Market wealth, Directly Held

Stock market wealth (directly held) is defined as the sum of value of stocks held by households (line 23 of Table B.100 - series FL153064105.Q). Data are quarterly, seasonally adjusted at an annual rate, measured in billions of dollars (2000 prices), in per capita terms and expressed in the logarithmic form. Series comprises the period 1952:2-2006:1. The source of information is Board of Governors of Federal Reserve System, Flow of Funds Accounts.

Stock Market Wealth, Indirectly Held

Stock market wealth (indirectly held) is defined as the sum of value of: (a) stocks held by private pension funds (line 12 of Table L.118 - series FL573064105.Q); (b) stocks held by state and local government retirement funds (line 13 of Table L.119 - series FL223064105.Q); (c) stocks held by federal government retirement funds (line 6 of Table L. 120 - series FL343064105.Q); (d) stocks held by property-casualty insurance companies (line 10 of Table L.116 - series FL513064003.Q); (e) stocks held by closed-end funds (line 6 of Table L.123 - series FL553064103.Q); (f) stocks held by exchange-traded funds (line 12 of Table L.123 - series FL563064103.Q); (g) stocks held by mutual funds (line 9 of Table L.122 - series FL653064000.Q); and (h) stocks held by life insurance companies (line 12 of Table L.117 - series FL543064105.Q), multiplied by the ratio of reserves of life insurance companies (lines 17 and 18 of Table L.117 - series FL543140003.Q and series FL543150005.Q) to the total final assets of life insurance companies (line 1 of Table L.117 - series FL544090005.Q). Data are quarterly, seasonally adjusted at an annual rate, measured in billions of dollars (2000 prices), in per capita terms and expressed in the logarithmic form. Series comprises the period 1952:2-2006:1. The source of information is Board of Governors of Federal Reserve System, Flow of Funds Accounts.

Non-Stock Market Wealth

Non-Stock market wealth is defined as the difference between aggregate net wealth, held by households and nonprofit organizations (line 41 of Table B.100 - series FL152090005.Q) and stock market wealth (see previous definition). This definition follows Davis e Palumbo (2001). Data are quarterly, seasonally adjusted at an annual rate, measured in billions of dollars (2000 prices), in per capita terms and expressed in the logarithmic form. Series comprises the period 1952:2-2006:1. The source of information is Board of Governors of Federal Reserve System, Flow of Funds Accounts.

After-Tax Labor Income

After-tax labor income is defined as the sum of wage and salary disbursements (line 3), personal current transfer receipts (line 16) and employer contributions for employee pension and insurance funds (line 7) minus personal contributions for government social insurance (line 24), employer contributions for government social insurance (line 8) and taxes. Taxes are defined as: [(wage and salary disbursements (line 3)) / (wage and salary disbursements (line 3)+ proprietor' income with inventory valuation and capital consumption adjustments (line 9) + rental income of persons with capital consumption adjustment (line 12) + personal dividend income (line 15) + personal interest income (line 14))] * (personal current taxes (line 25)). Data are quarterly, seasonally adjusted at annual rates, measured in billions of dollars (2000 prices), in per capita terms and expressed in the logarithmic form. Series comprises the period 1947:1-2005:4. The source of information is U.S. Department of Commerce, Bureau of Economic Analysis, NIPA Table 2.1..

Financial Returns

The proxy chosen for the market return is the value weighted CRSP (CRSP-VW) market return index. The CRSP index includes NYSE, AMEX and NASDAQ, and should provide a better proxy for market returns than the Standard & Poor (S&P) index since it is a much broader measure. Data are quarterly, deflated by the personal consumption chain-weighted index (2000=100) and expressed in the logarithmic form. Series comprises the period 1947:2-2004:4. The source of information is Robert Shiller's web site.

Housing Returns

In computing housing returns, I follow Lustig and Van Nieuwerburgh (2006). I construct data on the log change in the value of the aggregate housing stock (Δp_{t+1}^h) and the log change in the dividend payments on the aggregate housing stock (Δd_{t+1}^h). The aggregate housing stock is measured as the value of residential real estate of the household sector (Flow of Funds Accounts, Board of Governors of Federal Reserve System, line 4 of Table B.100, series FL155035015.Q). The dividend on aggregate housing is measured as housing services consumption (U.S. Department of Commerce, Bureau of Economic Analysis, NIPA Table 2.3.5., line 14). I construct a log price index p^h by fixing the 1952:1 observation to 0, and using the log change in prices in each quarter. Likewise, we choose an initial log dividend level, and construct the dividend index using log dividend growth. The log dividend price ratio $d^h - p^h$ is the difference of the log dividend and the log price index. The initial dividend index level is chosen to match the mean log dividend price ratio to the one on stocks (-4.6155).(In the model the mean dividend price ratios are the same on all assets.). I use the Campbell-Shiller decomposition:

$$r_t^h = k + \Delta d_t^h + (d_{t-1}^h - p_{t-1}^h) - \upsilon(d_t^h - p_t^h).$$

where υ and k are Campbell Shiller linearization constants. In the model, these constants must be the same for all assets (financial wealth, housing wealth and human wealth). I use stock market data to pin down υ and k: $\upsilon := \frac{1}{1+d^a-p^a} = 0.9906$ and $k := -\log(\upsilon) - (1-\upsilon)\log(\upsilon^{-1}-1) = 0.0534$. To get the log real return, we deflate the nominal log return by the personal income price deflator, the same series used to deflate all other variables. Data are quarterly, deflated by the personal consumption chain-weighted index (2000=100) and expressed in the logarithmic form. Series comprises the period 1952:2-2005:4.

Human Capital Returns

In computing human capital returns, I follow Lustig and Van Nieuwerburgh (2006). The authors use a standard single-agent model and impute the residual of consumption growth innovations that cannot be attributed to either news about financial asset returns or future labor income growth to news about expected future returns on human wealth. This accounting procedure only depends on the agent's willingness to substitute consumption over time, not her consumption risk preferences. The benchmark calibration sets the intertemporal elasticity of substitution to 0.28, a compromise between the estimates of Hall (1988) at the macroeconomic level - close to 0 - and the estimates of Browning, Hansen and Heckman (2000) at the microeconomic level - around 0.5. Data are quarterly, deflated by the personal consumption chain-weighted index (2000=100) and expressed in the logarithmic form. Series comprises the period 1952:1-2002:4.

Housing Collateral

Aggregate stock of housing collateral is computed using the current cost of net stock of owner-occupied and tenant-occupied residential fixed assets for non-farm persons (NIPA Fixed Asset Table 2.1., line 59). It includes 1-4 units and 5+ units and is the sum of new units, additions and alterations, major replacements and mobile homes. The real value of the stock is calculated with a perpetual inventory method and a geometric depreciation pattern (Katz and Herman, 1997). Depreciation rates are estimated on the basis of resale prices of used assets and are 1.1% per annum for 1-4 units and 1.4% per annum for 5+ structures. The net stock corresponds to the stock after taking into account depreciation. The current cost or replacement cost values the real stock refers to market prices. Original data are annual and are converted to a quarterly frequency using data for residential fixed investment (NIPA Table 1.1.5., line 11). Data comprises the period 1947:1 - 2004:4. The source of information is U.S. Department of Commerce, Bureau of Economic Analysis.

Following Lustig and Van Nieuwerburgh (2005), I measure the aggregate stock of housing collateral using the value of residential fixed assets (structures), $hvfa$. Table A.1 reports the results of the vector error correction estimation of the cointegration coefficients:

$$\begin{bmatrix} \Delta hvfa_t \\ \Delta y_t \end{bmatrix} = \alpha \left[hvfa_t + \varpi y_t + \vartheta t + \chi\right] + \sum_{k=1}^{K} D_k \begin{bmatrix} \Delta hvfa_{t-k} \\ \Delta y_{t-k} \end{bmatrix} + \eta_t.$$

The housing collateral ratio, $myfa$, is measured as the deviation from the cointegration relationship between the value of the aggregate housing stock (collateralizable wealth) and the aggregate labor income (noncollateralizable wealth), i.e.: $myfa_t = \log(hvfa_t) + \hat{\varpi}\log(y_t) + \hat{\vartheta} t + \hat{\chi}$. I also estimate the cointegrating relationship while imposing the restriction $\varpi = -1$.

Table A1: Housing collateral ratio: coefficients of myfa_t.

Housing Wealth Measure: Fixed Assets, fa		
ϖ	ϑ	χ
Unrestricted		
-0.224	-0.004	-7.386
(-0.595)	(-1.970)	
Restricted		
-1	-0.019	-32.923
	(-2.375)	

Symbols *, **, *** represent, respectively, significance level of 1%, 5% and 10%.

Newey and West (1987) corrected t-statistics appear in parenthesis.

The sample period is 1953:4 to 2004:4.

Population

Population was defined by dividing aggregate real disposable income (line 35) by per capita disposable income (line 37). Data are quarterly. Series comprises the period 1946:1-2001:4. The source of information is U.S. Department of Commerce, Bureau of Economic Analysis, NIPA Table 2.1.

Price Deflator

The nominal wealth, after-tax income, consumption, and interest rates were deflated by the personal consumption expenditure chain-type price deflator (2000=100), seasonally adjusted. Data are quarterly. Series comprises the period 1947:1-2005:4. The source of information is U.S. Department of Commerce, Bureau of Economic Analysis, NIPA Table 2.3.4., line 1.

Inflation Rate

Inflation rate was computed from price deflator. Data are quarterly. Series comprises the period 1947:2-2005:4. The source of information is U.S. Department of Commerce, Bureau of Economic Analysis, NIPA Table 2.3.4, line 1.

Interest Rate ("Risk-Free Rate")

Risk-free rate is defined as the 3-month U.S. Treasury bills real interest rate. Original data are monthly and are converted to a quarterly frequency by computing the simple arithmetic average of three consecutive months. Additionally, real interest rates are computed as the difference between nominal interest rates and the inflation rate. The 3-month U.S. Treasury bills real interest rate' series comprises the period 1947:2-2005:4, and the source of information is the H.15 publication of the Board of Governors of the Federal Reserve System.

B Derivation of the Risky Asset Share

The dynamics of the linear habit presented in Equation (2) can be written as a differential equation as:

$$dXt = (bC_t - aX_t)\,dt, \tag{13}$$

and the wealth dynamics (Equation (3)) becomes:

$$\frac{dW_t}{W_t} = \left[(r + \alpha_t(\mu_t - r)) - \frac{C_t}{W_t}\right] dt + \sigma_{p,t} dZ_t. \tag{14}$$

Both differential equations involve the consumption term of the agent.

Following Schroder and Skiadas (2002), the agent's consumption can be written in terms of the consumption of an agent without habit. Let $\hat{C}_t/\hat{W}_t$ be the consumption-wealth ratio of an agent without habit. If expected returns are not time-varying, $\hat{C}_t/\hat{W}_t$ is constant. The optimal consumption-wealth ratio of an agent with habit is given by

$$\frac{C_t}{W_t} = \frac{X_t}{W_t} + \left(\frac{r + a - b - \frac{X_t}{W_t}}{r + a - b + 1}\right)\frac{\hat{C}_t}{\hat{W}_t} = f\left(\frac{X_t}{W_t}, \frac{\hat{C}_t}{\hat{W}_t}\right), \tag{15}$$

and is a function of X_t/W_t.

Replacing the drift term of the wealth differential equation with $\mu_W(\alpha_t, \frac{X_t}{W_t}, \frac{\hat{C}_t}{\hat{W}_t}\mu_t) := r + \alpha_t(\mu_t - r) - f(\frac{X_t}{W_t}, \frac{\hat{C}_t}{\hat{W}_t})$, defining $w_t := \log(W_t)$, and applying Ito's lemma, one obtains

$$dw_t = \mu_w\left(\alpha_t, \frac{X_t}{W_t}, \frac{\hat{C}_t}{\hat{W}_t}, \mu_t\right)dt - \sigma_{p,t}dZ_t, \tag{16}$$

where $\mu_w\left(\alpha_t, \frac{X_t}{W_t}, \frac{\hat{C}_t}{\hat{W}_t}, \mu_t\right) := \mu_W\left(\alpha_t, \frac{X_t}{W_t}, \frac{\hat{C}_t}{\hat{W}_t}, \mu_t\right) - \frac{1}{2}\sigma^2_{p,t}$.

Similarly, substituting consumption out of the dX equation yields:

$$dX_t = \left(bW_t f(\frac{X_t}{W_t}, \frac{\hat{C}_t}{\hat{W}_t}) - aX_t\right)dt. \tag{17}$$

Applying Ito's lemma to $x_t := \log(X_t)$, one obtains:

$$dx_t = \left(b\frac{f(\frac{X_t}{W_t}, \frac{\hat{C}_t}{\hat{W}_t})}{\frac{X_t}{W_t}} - a\right)dt =: \mu_x\left(\frac{X_t}{W_t}, \frac{\hat{C}_t}{\hat{W}_t}\right)dt. \tag{18}$$

Defining $y_t := \log\left(\frac{X_t}{W_t}\right) = x_t - w_t$, it follows that:

$$dy_t = \left(\mu_x\left(\frac{X_t}{W_t}, \frac{\hat{C}_t}{\hat{W}_t}\right) - \mu_w\left(\alpha_t, \frac{X_t}{W_t}, \frac{\hat{C}_t}{\hat{W}_t}, \mu_t\right)\right)dt - \sigma_{p,t}dZ_t. \tag{19}$$

Equation (4) can now be written as:

$$\alpha_t = \left(1 - \frac{e^{y_t}}{r + a - b}\right)\hat{\alpha}_t. \tag{20}$$

Applying Ito's lemma again, one gets:

$$d\alpha_t = -\hat{\alpha}_t\frac{e^{y_t}}{r + a - b}\left(dy_t + \frac{1}{2}\sigma^2_{p,t}\right). \tag{21}$$

Using $1 - \frac{\alpha_t}{\hat{\alpha}_t} = \frac{e^{y_t}}{r+a-b}$,

$$d\alpha_t = -\left(\hat{\alpha}_t - \alpha_t\right)\left(dy_t + \frac{1}{2}\sigma^2_{p,t}\right) = \left(\hat{\alpha}_t - \alpha_t\right)\left[dw_t - dx_t - \frac{1}{2}\sigma^2_{p,t}\right] \tag{22}$$

$$= \left(\hat{\alpha}_t - \alpha_t\right)\left\{\left[\mu_w\left(\alpha_t, \frac{X_t}{W_t}, \frac{\hat{C}_t}{\hat{W}_t}, \mu_t\right) - \mu_x\left(\frac{X_t}{W_t}, \frac{\hat{C}_t}{\hat{W}_t}\right) - \frac{1}{2}\sigma^2_{p,t}\right]dt + \sigma_{p,t}dZ_t\right\}. \tag{23}$$

Finally, defining $\rho_t := log(\alpha_t)$, and from Ito's lemma Equation (5), it follows that:

$$d\rho_t = \left(\frac{\hat{\alpha}_t}{\alpha_t} - 1\right)\left\{\left[\mu_w\left(\alpha_t, \frac{X_t}{W_t}, \frac{\hat{C}_t}{\hat{W}_t}, \mu_t\right) - \mu_x\left(\frac{X_t}{W_t}, \frac{\hat{C}_t}{\hat{W}_t}\right) - \frac{1}{2}\sigma^2_{p,t} - \frac{1}{2}\left(\frac{\hat{\alpha}_t - \alpha_t}{\alpha_t}\right)\sigma^2_{p,t}\right]dt + \sigma_{p,t}dZ_t\right\} \tag{24}$$

$$= \left(\frac{\hat{\alpha}_t}{\alpha_t} - 1\right)\left\{\left[\mu_w\left(\alpha_t, \frac{X_t}{W_t}, \frac{\hat{C}_t}{\hat{W}_t}, \mu_t\right) - \mu_x\left(\frac{X_t}{W_t}, \frac{\hat{C}_t}{\hat{W}_t}\right) - \frac{\hat{\alpha}_t}{2\alpha_t}\sigma^2_{p,t}\right] dt + \sigma_{p,t} dZ_t\right\}. \quad (25)$$

C Estimation of Wealth Shocks

In order to model the wealth process, I experimented with several specifications in the ARIMA class, and performed the standard set of Box-Jenkins selection procedures. In particular, among the models considered, ARMA(2,3) process fits well to first differences of log wealth and hence I restricted attention to the ARIMA(2,1,3) specification for log wealth. Thus, the fitted wealth specification is:

$$\Delta w_t = \mu_w + \nu_1 \Delta w_{t-1} + \nu_2 \Delta w_{t-2} + \eta_t + \vartheta_1 \eta_{t-1} + \vartheta_2 \eta_{t-2} + \vartheta_3 \eta_{t-3}$$

where η_t is the time t innovation, ν's are auto-regressive coefficients and ϑ's are moving average coefficients. The estimated coefficients are reported in Table C.1.

Table C1: Estimated wealth process.

$\hat{\mu}_w$	$\hat{\nu}_1$	$\hat{\nu}_2$	$\hat{\vartheta}_1$	$\hat{\vartheta}_2$	$\hat{\vartheta}_3$
0.006	0.379	-0.896	-0.320	0.943	0.110
(0.0016)	(0.0336)	(0.0371)	(0.0868)	(0.0394)	(0.0817)

Newey-West standard errors appear in parenthesis.

D Human Wealth

Julliard (2004) points out that claims on non-traded labor income represent roughly two thirds of overall wealth in the major industrialized countries. Following Roll (1977)'s critique, the literature has recognized the importance of human wealth returns as part of the market return (Shiller, 1995; Campbell, 1996; Jagannathan and Wang, 1996).

If labor income was riskless, then human wealth, H_t, would be considered as a riskless asset. Additionally, since human wealth is non-tradeable, the optimal portfolio shares, α_t and $\hat{\alpha}_t$, would be the shares of risky assets in total wealth including human wealth (Campbell and Viceira, 2002). Denoting non-human wealth by W_t, and defining $\alpha_{N,t}$ as the share of risky assets in non-human wealth, then:

$$\alpha_{N,t} W_t = \alpha_t (W_t + H_t). \quad (26)$$

With $\rho_{N,t} := \log(\alpha_{N,t})$, it is possible to derive:

$$d\rho_{N,t} = d\rho_t + d\log(Wt + Ht) - d\log(Wt). \quad (27)$$

Using Ito's Lemma, one obtains

$$d\rho_{N,t} = d\rho_t + \psi_t dt - \theta_t \sigma_{p,t} dZ_t, \tag{28}$$

where $\theta_t := \frac{H_t}{W_t + H_t}$, and ψ_t is a time-varying drift term. Therefore, even though a positive shock to non-human wealth ($dZ_t > 0$) leads to $d\rho_t > 0$, it is not clear that $d\rho_{N,t} > 0$, because there is a countervailing effect ($-\theta_t \sigma_{p,t} dZ_t < 0$). Consequently, the wealth shock should be interacted with θ_t, which is related to the human wealth/total wealth ratio H_t/W_t. Human wealth is approximated to current labor income, Y_t, times a (growing) annuity factor, A, as it is not directly observable, i.e. $\theta_t \approx a_0 + a_1 (y_t - w_t) + log(A)$, where y_t is the log labor income. Table D.1 summarizes the estimations for which income growth is included as an explanatory variable, suggesting that it is not an important determinant of portfolio composition.

On the other hand, if labor income is risky but uncorrelated with risky asset returns, the direction of the effect would be the same but smaller in magnitude. By its turn, if labor income is positively correlated with asset returns, the effects of labor income can go in the opposite direction and the effects of wealth shocks could be amplified rather than dampened. As a robustness check, I replace income growth by income shocks - proxied by the residuals of the labor income growth equation from the reduced-form vector auto-regression model (VAR) - as an explanatory variable. Table D.2 shows that the coefficients associated to income shocks are small in magnitude and not significant. Therefore, the risky labor income story does not change the previous results.

Table D1: Asset allocation and human wealth.

	Financial Wealth $\Delta\rho_t^1$	Home Wealth $\Delta\rho_t^2$	Stock Market Wealth $\Delta\rho_t^3$	Stock Market Wealth Directly held $\Delta\rho_t^4$	Stock Market Wealth Indirectly held $\Delta\rho_t^5$
Constant	0.000	-0.000	0.005	0.001	0.014*
	(0.206)	(-0.256)	(1.394)	(0.238)	(4.551)
ε_t	0.163*	-0.785*	2.697*	2.819*	2.305*
	(7.547)	(-7.697)	(11.747)	(12.102)	(10.349)
Δy_t	-0.028	0.135	-0.134	-0.089	-0.121
	(-1.031)	(1.098)	(-0.443)	(-0.268)	(-0.419)
$\bar{R}^2$	[0.41]	[0.45]	[0.69]	[0.68]	[0.57]

Symbols *, **, *** represent, respectively, significance level of 1%, 5% and 10%.

Newey and West (1987) corrected t-statistics appear in parenthesis.

The sample period is 1953:4 to 2004:4.

Table D2: Asset allocation and income risk - labor income shocks from VAR system.

	Financial Wealth $\Delta\rho_t^1$	Home Wealth $\Delta\rho_t^2$	Stock Market Wealth $\Delta\rho_t^3$	Stock Market Wealth Directly held $\Delta\rho_t^4$	Stock Market Wealth Indirectly held $\Delta\rho_t^5$
Constant	-0.000	0.000	0.004	0.000	0.013*
	(-0.238)	(0.220)	(1.405)	(0.129)	(4.689)
ε_t	0.158*	-0.761*	2.663*	2.790*	2.272*
	(7.327)	(-7.476)	(11.409)	(11.798)	(10.091)
ξ_t^y	0.026	-0.117	0.255	0.269	0.265
	(0.894)	(-0.930)	(0.819)	(0.746)	(0.953)
$\bar{R}^2$	[0.41]	[0.45]	[0.69]	[0.68]	[0.57]

Symbols *, **, *** represent, respectively, significance level of 1%, 5% and 10%.

Newey and West (1987) corrected t-statistics appear in parenthesis.

The sample period is 1953:4 to 2004:4.

Finally, Table D. 3 estimates the role of human capital returns on asset allocation, following the computation described in Appendix A. The results show that returns on human capital are not important determinants of the changes in portfolio composition: the coefficients are small in magnitude and not significant.

Table D3: Asset allocation and returns on human capital.

	Financial Wealth $\Delta\rho_t^1$	Home Wealth $\Delta\rho_t^2$	Stock Market Wealth $\Delta\rho_t^3$	Stock Market Wealth Directly held $\Delta\rho_t^4$	Stock Market Wealth Indirectly held $\Delta\rho_t^5$
Constant	-0.000	0.000	0.003	-0.017*	0.011*
	(-0.129)	(0.050)	(0.882)	(-4.709)	(3.875)
ε_t	0.160*	-0.776*	2.693*	2.844*	2.275*
	(7.094)	(-7.260)	(11.280)	(12.227)	(9.994)
r_t^h	0.006	-0.005	0.462	0.224	0.606**
	(0.215)	(-0.039)	(1.614)	(0.777)	(2.336)
$\bar{R}^2$	[0.41]	[0.45]	[0.69]	[0.72]	[0.58]

Symbols *, **, *** represent, respectively, significance level of 1%, 5% and 10%.

Newey and West (1987) corrected t-statistics appear in parenthesis.

The sample period is 1953:4 to 2002:4.

E Assessing Uncertainty

To assess uncertainty in the regression results in Table 21, I report 95 percent confidence intervals for the estimated slope coefficients constructed via Monte Carlo integration by drawing from the posterior distribution of the estimated VAR coefficients. I proceed as follows:

1. I draw covariance matrices $\grave{\Sigma}$ from the inverse Wishart with parameters $(n\hat{\Sigma})^{-1}$ and $n - m$.
2. Conditional on $\grave{\Sigma}$, I draw a vector of coefficients for the VAR, $\grave{\beta}$, from $\grave{\beta} \sim N(\hat{\beta}, \grave{\Sigma} \otimes (X'X)^{-1})$.
3. I repeat this procedure 50,000 times and construct the median and slope OLS coefficients associated to the VAR, and the 95 percent confidence intervals from the Monte Carlo iterations.

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