

The Returns on Human Capital: Good News on Wall Street is Bad News on Main Street

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ABSTRACT

We use a standard single-agent model to conduct a simple consumption growth accounting exercise. Consumption growth is driven by news about current and expected future returns on the market portfolio. The market portfolio includes financial and human wealth. We 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, and we back out the implied human wealth and market return process. This accounting procedure only depends on the agent's willingness to substitute consumption over time, not her consumption risk preferences. We find that innovations in current and future human wealth returns are *negatively* correlated with innovations in current and future financial asset returns, regardless of the elasticity of intertemporal substitution. The evidence from the cross-section of stock returns suggests the market return we backed out of aggregate consumption innovations is a better measure of aggregate risk than the return on the stock market.

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I. Introduction

A standard single-agent model puts tight restrictions on the joint distribution of market returns and aggregate consumption. We exploit these restrictions to account for aggregate consumption growth, and we impute that part of consumption innovations not due to news about financial asset returns to human wealth returns.

To do so, we confront a single agent with the observed market returns on US household wealth and back out her implied consumption innovations. These consumption innovations are determined by news about current returns and by news about expected future returns on the market portfolio (section II). The effect of news about future market returns on consumption depends only on how willing this agent is to substitute over time, not on her risk preferences (Campbell (1993)).

If her portfolio only includes financial wealth, the model-implied consumption innovations are radically different from those in the data. The agent's consumption innovations are at least eight times too volatile relative to US aggregate consumption innovations and the implied correlation of her consumption innovations with news about stock returns is three times higher than in the data, even for values of the intertemporal elasticity of substitution EIS close to zero. We call this the consumption correlation and volatility puzzle (section IV).

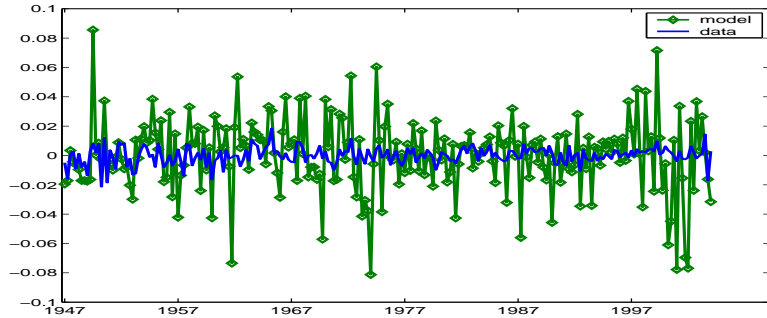
These two moments of aggregate consumption growth are also at the heart of Mehra & Prescott (1985)'s equity premium puzzle. However, the volatility and correlation puzzles only depend on the agent's willingness to transfer consumption between different periods in response to news about future returns; the equity premium puzzle only depends on the agent's aversion to consumption bets. In a model with only financial wealth, there is no value of the EIS that closes the gap between the model and the data, but large values definitely make matters worse.

In addition, the budget constraint also implies that the present discounted value of aggregate consumption growth responds one-for-one to news about current and future market returns, regardless of the agent's preferences. In US data the present discounted value of consumption growth and future market returns are negatively correlated if the market portfolio only includes financial wealth. Clearly, financial wealth is not a good proxy for total wealth.

Next, we explicitly introduce human wealth in our single agent's portfolio (section V). Following Roll (1977)'s critique, the literature has recognized the importance of including human wealth returns as part of the market return (e.g. Shiller (1993), Campbell (1996), and Jagannathan & Wang (1996)). One challenge is that returns on human wealth are unobserved, we observe the dividend component on human wealth, but not the expected future returns (the discount rate). In a first step, we show that a model in which the expected returns on human wealth and financial wealth are perfectly correlated, as in Campbell (1996), cannot match the consumption moments in the data. Figure 1 plots the model-implied against the actual consumption innovations in Campbell's model for a low EIS . Models in which the expected return on human wealth is constant such as in Shiller (1993), or where the expected return on human wealth is perfectly correlated with expected labor income

Figure 1. *Campbell* Model-Implied and Actual Consumption Innovations

The labor income share is .7 and the intertemporal elasticity of substitution is .27. The sample is 1947.I-2004.IV.



growth, as in Jagannathan & Wang (1996), do better, but still over-predict the volatility of consumption innovations and their correlation with financial returns (section V.A).

In a second step, we conduct a basic *consumption growth accounting* exercise. We impute that part of the consumption innovations that cannot be attributed to news about current or future financial returns to the returns on human wealth. This approach enables us to back out a process for the expected return on human wealth that matches the moments of aggregate consumption innovations in the data.

We find that (1) good news (for current returns) in financial markets is bad news in (for current returns) in labor markets, regardless of the intertemporal elasticity of substitution (EIS), and (2) the implied total market return is negatively correlated with the returns on financial wealth if the EIS is smaller than one. This reflects two forces: the correlation of cash-flow news and discount rate news for human and financial wealth. First, good news about future labor income growth tends to be bad news for the growth rate of pay-outs (dividends etc.) to securities holders. Even in a model with constant discount rates, Second, positive innovations to future risk premia on financial wealth tend to coincide with negative innovations to expected future returns on human wealth. For low EIS , the implied volatility of human wealth return innovations is similar to that of financial returns, but it is much smaller for EIS closer to one (section V.C).

The negative correlation between the discount rates on these two assets is not surprising (see Santos & Veronesi (2004)). In the two-tree Lucas endowment model of Cochrane, Longstaff, & Santa-Clara (2004) with i.i.d dividend growth and log preferences, when the dividend share of the first tree increases, its expected return must go up to induce investors to hold it despite its larger share. Because the overall price-dividend ratio stays constant, the expected return on the second tree has to decrease.

In a third step, we generalize the exercise and allow for time-varying wealth shares (section V.B). We estimate a linear factor model: The expected return on human wealth and the human wealth share are linear functions of the state. The factor loadings are chosen to minimize the distance between the consumption innovation moments in the model and the data. These estimates corroborate our earlier findings (section V.D). In addition, news

about the PDV of future consumption growth and news about the PDV of future market returns line up much better; the correlation increases to .7 at annual frequencies.

While Campbell's work aimed to substitute consumption out of the asset pricing equations, we obtain better measures of market risk when the market return is forced to be consistent with the moments of aggregate consumption. We revisit the Roll critique, and ask whether our consumption-consistent capital asset pricing model improves the pricing of assets in the cross-section. Using model-implied consumption and market returns, we find that our model gives the lowest pricing errors for size and value stock portfolios among the models that include human wealth in the market portfolio (section VI). Growth stocks provide better insurance against future human capital risk and therefore trade at a risk premium discount relative to value stocks.

Work by Tallarini (2000) and others suggests a dichotomy between finance and macroeconomics. In an Epstein-Zin production economy, Tallarini shows that changing the risk preferences has little or no effect on real quantities in equilibrium. Quantities are pinned down by the willingness of agents to substitute consumption over time, while the risk premia are governed by risk aversion (see Cochrane (2005) for a clear exposition of this view). Our work suggests that standard macro models cannot match consumption moments at any *EIS* if its equilibrium returns are as volatile as in the data, because the returns on human capital are too correlated with the returns on physical capital.

Our finding that the return on physical capital and human capital must be negatively correlated represents a challenge to the workhorse model of modern business cycle theory because it predicts close to perfect correlation between physical and human capital returns (Baxter & Jermann (1997)). Models with time-varying factor elasticities, such as the one of Young (2004), seem like the way forward.

Other Explanations We attribute the component of aggregate consumption growth that is not accounted for by financial asset returns to human wealth returns. Other labels come to mind for this residual. In the paper, we consider four in detail (section VII). First, if the agent's preferences display habit formation, the volatility puzzle can be resolved, but the correlation puzzle cannot unless through heteroscedasticity in the market return. In a second step, we test for this possibility by checking if our consumption growth residual predicts the future volatility of stock returns, and it does not. Third, we argue that heterogeneity makes matters worse, if anything, because stock and bond holders seem to have a higher *EIS*. Finally, we include housing wealth into the portfolio of the agent and repeat the analysis. The residual has the same properties as in the model without housing wealth.

Related Literature While there is a huge literature on the risk-return trade-off in financial markets, the role of risk is usually ignored when economists model human capital investment decisions. In a series of papers, Palacios-Huerta uses individual labor-income based measures of human capital returns to examine the risk-return trade-off in human capital markets (Palacios-Huerta (2001), Palacios-Huerta (2003a) and Palacios-Huerta (2003b)). We use the information in aggregate consumption innovations instead to learn about the

aggregate human wealth returns.

Our work is closely related to Santos & Veronesi (2004). They set up two-sector-model, a labor-income and a capital-income generating sector; assets are priced off a conditional CAPM in which the labor income share is the conditioning variable. While the labor income share works well as a conditioning variable in explaining the cross-section of returns, they find that innovations to future labor income growth do not help much in pricing. We find that future human capital risk is priced, and that growth firms provide a better hedge against this risk.

Bansal & Yaron (2004) are the first to attribute a key role to long-run consumption risk in explaining the time series and cross-section properties of the risk premia on stocks; they back out a consumption and dividend process that can match expected returns on financial wealth. Instead, we back out a (human wealth) return process that implies the right aggregate consumption behavior.

Lettau & Ludvigson (2001a) and Lettau & Ludvigson (2001b) find that the single agent's budget constraint provides useful aggregate risk information: Lettau & Ludvigson (2001a) use a linearized version of the household budget constraint to show that the consumption-wealth ratio predicts stock returns. Lettau & Ludvigson (2001b) derive a scaled version of the Consumption CAPM from this budget constraint. In fact, we use the budget constraint *and* the Euler equation to derive a consumption-consistent version of the CAPM. Our market return process, derived from actual US aggregate consumption innovations, actually does better in explaining the cross-section of asset returns than the standard CAPM return on the stock market. Lewellen & Nagel (2004) argue the CAPM betas do not vary enough in order for a conditional version of the CAPM to explain the variation in returns. Our results shed some light on these findings; stock market risk is a very poor measure of aggregate market risk.

In addition, our market return is consistent with household portfolio evidence. US household portfolios are biased towards US securities, and our model implies that domestic financial securities provide US investors with a hedge against human capital risk. Baxter & Jermann (1997) reach the opposite conclusion. In their results, introducing labor income risk unambiguously worsens the international diversification puzzle, but they do not use the information embedded in aggregate consumption. In recent work, Julliard (2003) and Palacios-Huerta (2001) qualify the Baxter-Jermann result.

We start by briefly reviewing the Campbell (1993) framework in section II. In section III, we describe the data we use and how to operationalize the model.

II. Environment

We adopt the environment of Campbell (1993) and consider a single agent decision problem.

A. Preferences

The agent ranks consumption streams $\{C_t\}$ using the following utility index U_t , which is defined recursively:

$$U_t = \left((1 - \beta)C_t^{(1-\gamma)/\theta} + \beta (E_t U_{t+1}^{1-\gamma})^{1/\theta} \right)^{\theta/(1-\gamma)},$$

where γ is the coefficient of relative risk aversion and σ is the intertemporal elasticity of substitution (*EIS*). Finally, θ is defined as $\theta = \frac{1-\gamma}{1-(1/\sigma)}$. In the case of separable utility, the *EIS* equals the inverse of the coefficient of risk aversion and θ is one. Distinguishing between the coefficient of risk aversion and the inverse of the *EIS* will prove important later on. Our results on the correlation structure between financial asset returns and human wealth returns only depend on the *EIS*, not on the coefficient of risk aversion. Epstein & Zin (1989) preferences impute a concern for long run risk to the agent. This plays potentially an important role in understanding risk premia (Bansal & Yaron (2004)).

B. Trading Assets

All wealth, including human wealth, is tradable. We adopt Campbell's notation: W_t denotes the representative agent's total wealth at the start of period t , and R_{t+1}^m is the gross return on wealth invested from t to $t + 1$. This representative agent's budget constraint is:

$$W_{t+1} = R_{t+1}^m (W_t - C_t). \quad (1)$$

Our single agent takes the returns on the market $\{R_t^m\}$ as given, and decides how much to consume. Instead of imposing market clearing, forcing the agent to consume aggregate dividends and labor income, we simply let her choose the optimal aggregate consumption process, taking the market return process $\{R_t^m\}$ as given. No equilibrium or market clearing conditions are imposed.

C. The Joint Distribution of Consumption and Asset Returns

Campbell (1993) linearizes the budget constraint and uses the Euler equation to obtain an expression for consumption innovations as a function of innovations to current and future expected returns.

First, Campbell linearizes the budget constraint around the mean log consumption/wealth ratio $c - w$. Lowercase letters denote logs. If the consumption-wealth ratio is stationary, in the sense that $\lim_{j \rightarrow \infty} \rho^j (c_{t+j} - w_{t+j}) = 0$, this approximation implies that:

$$c_{t+1} - E_t c_{t+1} = (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j r_{t+1+j}^m - (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j \Delta c_{t+1+j}, \quad (2)$$

where $r^m = \log(1 + R^m)$ and ρ is defined as $1 - \exp(c - w)$.¹ Innovations to consumption today reflect innovations to current and future expected returns, and innovations to future

¹Campbell (1993) shows that this approximation is accurate for values of the *EIS* between 0 and 4.

expected consumption growth. Consumption and returns are assumed to be conditionally homoscedastic and jointly log normal.

Second, Campbell substitutes the consumption Euler equation:

$$E_t \Delta c_{t+1} = \mu_m + \sigma E_t r_{t+1}^m, \quad (3)$$

where μ_m is a constant that includes the variance and covariance terms for consumption and market innovations, back into the consumption innovation equation in (2), to obtain an expression with only returns on the right hand side:

$$c_{t+1} - E_t c_{t+1} = r_{t+1}^m - E_t r_{t+1}^m + (1 - \sigma)(E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{t+1+j}^m, \quad (4)$$

Campbell shows this agent incurs relatively small welfare losses from using this linear consumption rule. We will use this linear version of the model as our actual model.

Innovations to the representative agent's consumption are determined by (1) the unexpected part of this period's market return and (2) the innovation to expected future market returns. There is a one-for-one relation between current return and consumption innovations, regardless of the *EIS*, but the relation with between consumption innovations and innovations to expected future returns depends on the *EIS*. If the agent has log utility over deterministic consumption streams and σ is one, the consumption innovations exactly equal the unanticipated return in this period. If σ is larger than one, the representative agent lowers her consumption to take advantage of higher expected future returns, while, if σ is smaller than one, she chooses to increase her consumption because the income effect dominates the substitution effect.

Equation (4) puts tight restrictions on the joint distribution of aggregate consumption innovations and total wealth return innovations. Our aim is to study the properties of aggregate consumption implied by this restriction. More specifically, we are interested in two moments of the consumption innovations: (1) the correlation of consumption innovations with return innovations, and, (2), the variance of consumption innovations. Matching these moments of the data is a major hurdle for this model, because in the data stock returns and consumption innovations have a low correlation, and because consumption innovations are much less volatile than return innovations.

D. Long-Run Restriction

The household budget constraint also imposes a restriction on the long-run effect of news about market returns and consumption growth:

$$(E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j r_{t+1+j}^m = (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta c_{t+1+j}, \quad (5)$$

The force of this restriction is that it does not depend on preferences, only on the budget constraint. When we later back out a process for human wealth returns that matches aggregate consumption innovations, we will check whether the news about future consumption innovations in the data and the news about future market return innovations are consistent.

III. Data and Model Implementation

This section discusses the measurement of financial asset returns, the computation of all the innovations that feed into consumption innovations, and finally, the relevant moments of the data.

A. Measuring Financial Asset Returns

We use two measures of financial asset returns. The first measure is the return on the value-weighted CRSP stock market portfolio: $R_{t+1}^a = \frac{P_{t+1} + D_{t+1}}{P_t}$, where D_t is the quarterly dividend in period t and P_t is the ex-dividend price. To remove the seasonal component in dividends, we define the log dividend price ratio as

$$dp_t^a = \log \left(\frac{.25D_t + .25D_{t-1} + .25D_{t-2} + .25D_{t-3}}{P_t} \right).$$

The full line in figure 2 shows the dividend-price ratio, $\exp(dp_t^a)$. We follow the literature on repurchases (Fama & French (2001) and Grullon & Michaely (2002)), and adjust the dividend yield for repurchases of equity, to ensure its stationarity. The repurchase data are from Boudoukh, Michaely, Richardson, & Roberts (2004). This is the dotted line in figure 2. Consistent with the literature on repurchases (Fama & French (2001) and Grullon & Michaely (2002)), the dividend-price ratio adjusted for repurchases is similar to the unadjusted series until 1980, and consistently higher afterwards.

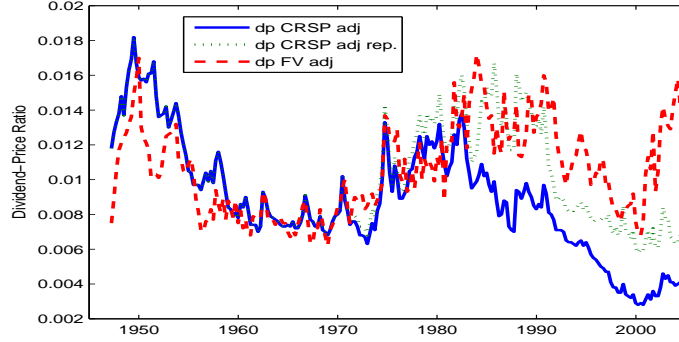
Our second measure of financial asset returns takes a broader perspective by including corporate debt and private companies: we value a claim to US non-financial, non-farm corporations and compute the total pay-outs to the owners of this claim. The value of US corporations is the market value of all financial liabilities plus the market value of equity less the market value of financial assets. The payout measure includes all corporate pay-outs to securities holders, both stock holders and bond holders (see appendix A for details).

The dashed line in figure 2 shows the pay-out to securities holders to market value of firms ratio. Over the last two decades, the dividend yield for the firm-value measure has been much higher than the dividend yield on stocks. This is consistent with the findings of Hall (2001). The firm value dividend yield departs from the CRSP-based repurchase adjusted series after the stock market crash of 2001.

B. Computing Innovations

We follow Campbell (1996) and estimate a VAR with real financial asset returns (r_{t+1}^a), real per capita labor income growth (Δy_{t+1}), and three return predictors: the log dividend yield on financial assets (dp_{t+1}^a), the relative T-bill return (rtb_{t+1}), and the yield spread (ysp_{t+1}). To be consistent with our exercises in the next section, we add the labor income share s_{t+1} and real per capita consumption growth on non-durables and services to the system Δc_{t+1} . We stack the $N = 7$ state variables into a vector z . The VAR describes a linear law of

Figure 2. Dividend Yield on CRSP Value-Weighted Stock Market Index and Payout-Yield on Total Firm Value



motion for the state:

$$z_{t+1} = Az_t + \varepsilon_{t+1},$$

with innovation covariance matrix $E[\varepsilon\varepsilon'] = \Sigma$. The dimensions of Σ and A are $N \times N$, the dimensions of ε and z are $N \times T$. Finally, we also define e_k as the k^{th} column of an identity matrix of the same dimension as A . Table VII in appendix D reports the VAR-estimates. The top panel uses firm value returns as the measure of financial asset returns, the bottom panel uses the value-weighted stock market return instead.

Once the VAR has been estimated, we can extract the news components that drive the consumption growth innovations: we define innovations in current financial asset returns $\{(a)_t\}$, innovations in current labor income growth $\{(f^y)_t\}$, news about current and future labor income growth $\{(d^y)_t\}$, and news about future financial asset returns $\{(h^a)_t\}$ and human capital returns $\{(h^y)_t\}$:

$$\begin{aligned} (a)_{t+1} &= r_{t+1}^a - E_t[r_{t+1}^a] = e_1' \varepsilon_{t+1} \\ (f^y)_{t+1} &= \Delta y_{t+1} - E_t[\Delta y_{t+1}] = e_2' \varepsilon_{t+1} \\ (d^y)_{t+1} &= (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta y_{t+1+j} = e_2' (I - \rho A)^{-1} \varepsilon_{t+1} \\ (h^a)_{t+1} &= (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{t+1+j}^a = e_1' \rho A (I - \rho A)^{-1} \varepsilon_{t+1} \\ (h^y)_{t+1} &= (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{t+1+j}^y. \end{aligned}$$

Finally, we can back out news about current and future dividend growth from the news about asset returns:

$$(d^d)_{t+1} = (h^a)_{t+1} + (a)_{t+1}.$$

The moments of these innovations will be denoted using $V_{i,j}$ and $Corr_{i,j}$ notation for variances and correlations respectively.

C. Stylized Facts

Table I summarizes the moments from the data at quarterly frequencies for the full post-war sample (1947.II-2004.III). The left panel uses the firm value returns as the measure of financial asset returns; the right panel uses stock market returns. Our benchmark case, a VAR with 1 lag, is reported in column 1. As a robustness check, we also report results obtained using a 2-lag VAR in column 2 and an annual VAR(1) in column 3.² All variances are multiplied by 10,000. Six key stylized facts deserve mention.

- Firm value return innovations are about 13 times as volatile as consumption innovations.³ In annualized terms, the standard deviation of news about financial returns is 14% for firm value returns and 16% for stock returns; the same number for consumption is 1.15% (V_a versus V_c). News about future financial returns is also volatile. In annualized terms, the standard deviation is 11% for firm value and 20% for stock returns (V_{h^a}).
- Consumption innovations and return innovations are only weakly correlated: $Corr_{c,a} = 0.17$ for firm value returns and 0.185 for stock returns.
- Current return innovations are negatively correlated with news about future expected returns: there is strong (multivariate) mean reversion in returns on firm value ($Corr_{a,h^a} = -.48$). Stock returns display even more mean reversion $Corr_{a,h^a}$ is $-.92$.
- News about future dividend growth and news about future labor income growth are negatively correlated ($Corr_{dy,dd}$) and news about current labor income growth and current dividend growth are not correlated or negatively correlated ($Corr_{fy,fd}$) for firm value returns.

The first three facts are well-documented (at least for stock returns); the last one is not. The last fact indicates that good cash flow news for securities holders (all securities' holders, including debt holders) may not necessarily be good cash flow news for workers. For stock returns these correlations are positive, but small. All of these stylized facts are robust to inclusion of additional forecasting variables in the VAR.

They are also robust to different measures of labor income. Our benchmark measure for labor income is real, per capita compensation of all employees from the Bureau of Economic Analysis (Table 2.1 line 2). This measure excludes proprietor's income, but includes wages

²The signs and relative magnitudes correspond to the ones reported in Campbell (1996) for monthly and annual data.

³Our measure of consumption is real per capita non-durables and services consumption. All results go through using total personal consumption. For total consumption V_c is .7 and $Corr_{c,a}$ is 0.1.

Table I
Moments from Data: Returns on Firm Value

The table reports variances (V) and correlations $Corr$ in the data. The sample covers 1947.II-2004.III. In the left panel, the asset return is the return on firm value (own computation). In the right panel, it is the return on the value-weighted CRSP stock index. The first column reports results for a 1-lag VAR with quarterly data. The second column reports results for a 2-lag VAR with quarterly data. The third column reports the results for annual data over the same period 1947-2004. The subscript a denotes innovations in current financial asset returns; d^y denotes news in current and future labor income growth; h^a denotes news in future financial market returns; d^d denotes news in current and future financial dividend growth; and c denotes innovations to non-durable and services consumption.

| <i>Moments</i> | Firm Value Returns | | | Stock Return Returns | | |
|------------------|--------------------|---------------|---------------|----------------------|---------------|---------------|
| | <i>1 Lag</i> | <i>2 Lags</i> | <i>Annual</i> | <i>1 Lag</i> | <i>2 Lags</i> | <i>Annual</i> |
| V_a | 48.31 | 47.74 | 185.12 | 63.54 | 62.74 | 242.96 |
| V_{d^y} | 1.61 | 1.90 | 6.67 | 1.65 | 1.92 | 6.95 |
| V_{h^a} | 32.67 | 32.97 | 47.44 | 103.07 | 98.37 | 231.85 |
| $Corr_{a,h^a}$ | -.477 | -.625 | -0.487 | -.918 | -.805 | -0.760 |
| $Corr_{a,d^y}$ | .337 | .377 | 0.599 | .491 | .473 | 0.329 |
| $Corr_{d^y,h^a}$ | -.525 | -.656 | -0.818 | -.336 | -.208 | -0.196 |
| V_c | .333 | .325 | 0.681 | .328 | .321 | 0.642 |
| $Corr_{c,a}$ | .168 | .168 | 0.163 | .185 | .175 | 0.208 |
| $Corr_{d^y,d^d}$ | -.101 | -.209 | 0.166 | .118 | .286 | 0.200 |
| $Corr_{f^y,f^d}$ | -.092 | -.081 | -0.259 | .173 | .114 | 0.139 |

and salaries to government employees. Table VIII in the appendix uses (1) a measure of pay-outs to employees of non-financial corporate businesses in the left panel and (2) a measure that includes proprietor's income (from the BEA) into the labor income measure in the right panel. The first measure is consistent with our measure of pay-outs to securities holders of non-financial corporate business. Most moments are virtually unchanged relative to table I.

IV. Model 1: Financial Wealth Only

We start by abstracting from non-financial wealth, and we compare the model-implied consumption innovation behavior to aggregate US data. We call the model with financial wealth only *Model 1*. This is a natural starting point, because (1) standard business cycle models imply that the returns on human and other assets are highly or even perfectly correlated (e.g. Baxter & Jermann (1997))⁴, and (2) in finance, it is standard practice to consider the stock market return r_t^a a good measure for the market return r_t^m (Black (1987)).

We analyze the moments of the model-implied consumption innovations in (4) with $r^m = r^a$, simply by feeding the actual innovations to financial asset returns and news about future returns into the linearized policy function of our single agent. The procedure delivers a

⁴The capital and labor dividend streams are perfectly correlated in a Cobb-Douglas production economy in which the entire, random, capital stock process is fixed exogenously (i.e. no investment choice and no depreciation). Even with investment and depreciation, standard business cycle models imply a very high correlation between human wealth and physical capital returns.

time series for the model-implied consumption innovations. We focus on two moments in particular: the variance of consumption innovations, $V_c = \text{var}(c_{t+1} - E_t c_{t+1})$, given by

$$V_c = V_a + (1 - \sigma)^2 V_{h^a} + 2(1 - \sigma) V_{a,h^a}, \quad (6)$$

and their correlation with innovations to the current market return, $V_{c,a} = \text{cov}(c_{t+1} - E_t c_{t+1}, r_{t+1}^a - E_t r_{t+1}^a)$,

$$V_{c,a} = V_a + (1 - \sigma) V_{a,h^a}. \quad (7)$$

A. Fails to Match The Variance and Correlation Moments

Figure 3 plots the standard deviation of the model-implied consumption innovations and in the bottom panel plots their correlation with current firm value return innovations. In both panels we vary the *EIS* between 0 and 1.5.

In the data, the standard deviation of consumption innovations is only 0.58% per quarter, compared to 6.95% per quarter for firm return innovations, and the correlation with return innovations is .17 (see Table I). Model 1 fails miserably to match either moment *for all values of EIS*. In the log case ($\sigma = 1$), consumption responds one-for-one to current return innovations. The standard deviation of consumption innovations equals the standard deviation of news about current financial returns, which is 0.0695 (see equation 6). The correlation of consumption innovations with financial asset return innovations is 1 (see equation 7).

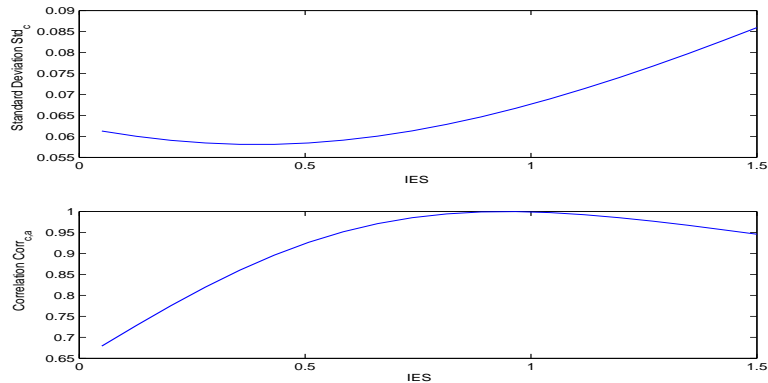
As the *EIS* decreases below 1, consumption absorbs part of the volatility of shocks to future asset returns V_{h^a} , but this effect on the variance of consumption innovations can be mitigated by the mean-reversion in returns ($V_{h^a,a} < 0$). If $\sigma < 1$, a negative covariance of current and future return innovations also lowers the covariance of consumption with current return innovations: the agent adjusts her consumption by less in response to a positive surprise if the same news lowers her expectation about future asset returns. Indeed, figure 3 illustrates that the mean reversion in returns helps to lower the implied volatility and correlation of consumption innovations somewhat, but not nearly enough. In the bottom panel we see that the correlation goes down as the *EIS* declines below 1, but it never reaches the observed correlation of 0.17. Even if σ is zero - this value of the *EIS* maximizes the effect of the mean reversion on the volatility of consumption innovations and on their correlation with return innovations- Model 1 does not even come to close to matching the moments of the data. The standard deviation of consumption innovations is off by a factor of 10 and the correlation by a factor of almost 4.

Mean reversion in returns actually increases the volatility of consumption if the *EIS* exceeds one; in response to good news, the agent increases his consumption, but this effect is reinforced because the agent anticipated lower returns in the future and decides to save less as a result! As the *EIS* increases beyond the log case, the variance of consumption indeed increases in the top panel. The correlation between consumption and stock market return innovations never falls below 0.9.⁵

⁵There is little evidence for an *EIS* in excess of one. Browning, Hansen, & Heckman (2000) conduct an extensive survey of the consumption literature that estimates the *EIS* off household data; they conclude

Figure 3. Matching Moments of Consumption Innovations

The first panel plots the quarterly model-implied standard deviation of consumption innovations against the *EIS* σ , while the second panel plots the model-implied correlation of consumption innovations. We use the returns on total firm value. The sample is 1947-II-2004.III.



If we use stock returns instead of firm value returns, model 1 can match the correlation moment for $\sigma = 0.2$, because of the large mean-reversion in stock returns (-0.92, see table I). However, the volatility of consumption innovations is off by the same order of magnitude. Also, the mean reversion of stock returns is lower in the VAR(2) model and at annual frequencies. Figure 9 in the appendix shows Model 1’s consumption moments for annual data using stock returns. The implied correlation between consumption and financial asset return innovations never goes below 0.4, twice the value in the data.

We refer to these first two facts, respectively, as the consumption volatility and the consumption correlation puzzle. These are both tied to the lack of a large financial *wealth effect* on aggregate consumption.

B. Violates Long-Run Restriction

The budget constraint imposes that the revision of expected future consumption growth has to be identical to the revision of expected current and future market returns: $(m)_t + (h^m)_t = (d^c)_t$ (see equation 5). The the long-run response of consumption growth can be computed from the VAR, where consumption is the 7th element:

$$(d^c)_{t+1} = (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta c_{t+1+j} = e'_7 (I - \rho A)^{-1} \varepsilon_{t+1}.$$

Because the market returns only includes financial assets, $(m) + (h^m)$ equals news about current and future dividend growth (d^d) . These two objects should be perfectly correlated.

the consensus estimate is less than one, around .5 for food consumption. The estimates from macro data are much lower. Hall (1988) concludes the *EIS* is close to zero. Finally, Vissing-Jorgensen (2002) finds *EIS* estimates of around .3-.4 for stockholders and .8-.9 for bondholders; these are larger than the *EIS* estimates for non-asset holders.

However, for Model 1 at quarterly frequencies, the correlation is negative: -28 for stock returns and -.18 for firm value returns. At annual frequencies, the correlation between these two objects is basically zero: .03 for stock returns and .05 for firm value returns. This would amount to a severe violation of the household budget constraint if the household only had financial wealth. We conclude that the returns on financial wealth do an even worse job of measuring market risk in the long run! The logical next step is to include human wealth into the analysis.

V. Adding Human Wealth

The market portfolio now includes a claim to the entire aggregate labor income stream. The total market return can be decomposed into the return on financial assets R^a and returns on human capital R^y . For log returns, we have:

$$r_{t+1}^m = (1 - \nu_t)r_{t+1}^a + \nu_t r_{t+1}^y, \quad (8)$$

where ν_t is the ratio of human wealth to total wealth.

The innovation to the return on human capital equals the innovation to the expected present discounted value of labor income less the innovation the present discounted value of future returns. The Campbell (1991) decomposition gives:

$$r_{t+1}^y - E_t[r_{t+1}^y] = (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta y_{t+1+j} - (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{t+1+j}^y. \quad (9)$$

A windfall in human wealth returns is driven by higher expected labor income (“dividend”) growth or by lower expected risk premia on human wealth. In the notation of the previous section: $(y)_{t+1} = (d^y)_{t+1} - (h^y)_{t+1}$.

To the econometrician, the process $\{(h^y)\}$ is unobserved, and therefore so is $\{(y)\}$. In section A, we introduce three benchmark models (Models 2, 3, and 4) that make assumptions on $\{(h^y)\}$ to render $\{(y)\}$ observable. Each of these models specifies a h^y process as a particular linear function of the state. We will show that all three imply consumption moments that are at odds with the data. They don’t solve the two puzzles illustrated for Model 1 above. Our strategy is to stay within the class of linear models for $\{(h^y)\}$, but to find within this class the $\{(h^y)\}$ process that implies consumption moments consistent with the data (Model 5 in section B).

Campbell (1996) assumes that the human wealth share is constant: $\nu_t = \bar{\nu}$. The constant human wealth share then equals the constant labor income share: $\bar{\nu} = \bar{s}$. Before presenting the results, we generalize the analysis to time-varying wealth shares. The results for constant wealth shares are presented as a special case (section C).

A. Models 2, 3, and 4: Benchmark Models of Expected Human Wealth Returns

Each of the three benchmark models differ only in the $N \times 1$ vector C which measures how the innovations to the expected human wealth returns relate to the state vector z :

$$E_t[r_{t+1}^y] = C' z_t.$$

In *Model 2*, the model of Campbell (1996), expected future human wealth returns are assumed to equal expected future asset returns: $E_t[r_{t+1}^y] = E_t[r_{t+1}^a]$, $\forall t$. Because asset returns are the first element of the VAR, we have $C' = e_1' A$. The second term in equation (9) is $-(h^a)_{t+1}$. In *Model 3*, the model of Shiller (1993), the discount rate on human capital is constant $E_t[r_{t+1}^y] = 0$, $\forall t$, and therefore $C' = 0$. The second term in equation (9) is zero. Finally, in *Model 4*, the model of Jagannathan & Wang (1996), the innovation to human wealth return equals the innovation to the labor income growth rate. the underlying assumptions are that (i) the discount rate on human capital is constant, implying that the second term in equation (9) is zero, and (ii) labor income growth is unpredictable, so that the first term in equation (9) is $\Delta y_{t+1} - E_t \Delta y_{t+1}$. The corresponding vector is $C' = e_2' A$.

Having specified three different models for the expected returns on human wealth, or equivalently a C vector, we immediately obtain a process for $\{(h^y)_t\}$, the innovations to expected future returns on human wealth:

$$(h^y)_t = C' \rho (I - \rho A)^{-1} \varepsilon_t, \quad (10)$$

and a process for $\{(y)_t\}$, the current innovation to the return on human wealth:

$$\begin{aligned} (y)_t &= (d^y)_t - (h^y)_t, \\ &= e_2' (I - \rho A)^{-1} \varepsilon_t - C' \rho (I - \rho A)^{-1} \varepsilon_t. \end{aligned} \quad (11)$$

For example, in the *JW* model, equation (11) implies that C' needs to equal $e_2' A$ for $(y)_{t+1}$ to equal $\Delta y_{t+1} - E_t \Delta y_{t+1} = e_2' \varepsilon_{t+1}$. We can now back out the moments of the implied aggregate consumption innovations. In the next section, we do this in the context of a model with time-varying wealth shares.

B. Incorporating Time-Varying Wealth Shares

Holding the share of human wealth in the market portfolio constant may introduce approximation errors. These errors are small in Campbell's model because the risk premia on the two assets are perfectly correlated, but in general, these errors could be large.

The human wealth share ν_t in equation (8) depends on all the state variables in z : $\nu_t(z_t)$. We first derive a linear expression for the human wealth share, and then show how to compute consumption innovations.

B.1. Computing the Human Wealth Share

When the expected return on human wealth is a linear function of the state (with loading vector C), the log dividend-price ratio on human wealth is also linear in the state. In particular, the demeaned log dividend-price ratio on human wealth is a linear function of the state z with a $N \times 1$ loading vector B :

$$\begin{aligned} dp_t^y - E[dp_t^y] &= E_t \sum_{j=1}^{\infty} \rho^j (r_{t+j}^y - \Delta y_{t+j}) \\ &= \rho(C' - e_2' A)(I - \rho A)^{-1} z_t = B' z_t. \end{aligned} \quad (12)$$

The demeaned log dividend-price ratio on financial assets is also a linear function of the state, because it is simply the third element in the VAR: $dp_t^a - E[dp_t^a] = e_3' z_t$.

The price-dividend ratio for the market is the wealth-consumption ratio; it is a weighted average of the price-dividend ratio for human wealth and for financial wealth:

$$\frac{W}{C} C = \frac{P^a}{D} D + \frac{P^y}{Y} Y.$$

The human wealth to total wealth ratio is given by:

$$\nu_t = \frac{\frac{P^y}{Y} Y}{\frac{W}{C} C} = \frac{e^{-dp_t^y} s_t}{e^{-dp_t^y} s_t + e^{-dp_t^a} (1 - s_t)} = \frac{1}{1 + e^{x_t}}, \quad (13)$$

which is a logistic function of $x_t = dp_t^y - dp_t^a + \log\left(\frac{1-s_t}{s_t}\right)$, where $dp^y = -\log\left(\frac{P^y}{Y}\right)$. We recall that s denotes the labor income share $s_t = Y_t/C_t$ and has mean \bar{s} . When $dp_t^a = dp_t^y$, the human wealth share equals the labor income share $\nu_t = s_t$. In general, ν_t moves around not only when the labor income share changes, but also when the difference between the log dividend price ratios on human wealth and financial market wealth changes. It is increasing in the former, and decreasing in the latter.

In section B.2 of the appendix, we derive a linear approximation to the logistic function in (13). The demeaned human wealth share $\tilde{\nu}_t \equiv \nu_t - \bar{\nu} = D' z_t$ is a linear function of the state, with loading vector D that solves:

$$D = e_6 - \bar{s}(1 - \bar{s})B + \bar{s}(1 - \bar{s})e_3. \quad (14)$$

B.2. Computing Consumption Innovations

When wealth shares are time-varying the agent considers the effect of (future) changes in the portfolio share of each asset when she adjusts consumption to news about returns. Combining equations (4), (8), and (9), the expression for consumption innovations with time-varying

human wealth share is:

$$\begin{aligned}
(c)_{t+1} &= (1 - \nu_t)(a)_{t+1} + \nu_t(d^y)_{t+1} - \nu_t(h^y)_{t+1} \\
&+ (1 - \sigma)(E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j (1 - \nu_{t+j}) r_{t+1+j}^a \\
&+ (1 - \sigma)(E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j \nu_{t+j} r_{t+1+j}^y
\end{aligned} \tag{15}$$

Define the news about weighted future financial asset returns and human wealth returns as:

$$\begin{aligned}
W_{t+1}^1 &= (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j \tilde{\nu}_{t+j} r_{t+1+j}^a \\
W_{t+1}^2 &= (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j \tilde{\nu}_{t+j} r_{t+1+j}^y.
\end{aligned}$$

Using these definitions, the expression for consumption innovations $(c)_{t+1} = c_{t+1} - E_t c_{t+1}$ reduces to:

$$\begin{aligned}
(c)_{t+1} &= (1 - \bar{\nu} - \tilde{\nu}_t)(a)_{t+1} + (\tilde{\nu}_t + \bar{\nu})(d^y)_{t+1} - (\tilde{\nu}_t + \sigma\bar{\nu})(h^y)_{t+1} \\
&+ (1 - \sigma)(1 - \bar{\nu})(h^a)_{t+1} - (1 - \sigma)(W_{t+1}^1 - W_{t+1}^2).
\end{aligned} \tag{16}$$

When the human wealth share is constant ($\nu_t = \bar{\nu}$ or $\tilde{\nu} = 0$), we obtain the simpler expression

$$(c)_{t+1} = (1 - \bar{\nu})(a)_{t+1} + \bar{\nu}(d^y)_{t+1} - \sigma\bar{\nu}(h^y)_{t+1} + (1 - \sigma)(1 - \bar{\nu})(h^a)_{t+1}. \tag{17}$$

Consumption responds one-for-one to news about current asset returns, weighted with the capital income share, and to news about discounted current and future labor income growth, weighted with the labor income share, regardless of the *EIS*. As in *Model 1*, the response to news about future asset returns is governed by $1 - \sigma$. But the response to news about future human wealth returns is governed by $-\sigma$. This reflects the direct effect of future human wealth risk premia on consumption and the indirect effect on the current human wealth returns (see equation 9).⁶ In the log case ($\sigma = 1$), variation in future returns or in future human wealth shares has no bearing on consumption innovations today. In any other case, our single agent responds to news about future returns weighted by the portfolio shares.

We compute the function W_{t+1}^1 and W_{t+1}^2 , using value function iteration. Define the news about weighted future asset returns as $\widetilde{W}_{t+1}^1 = E_{t+1} \sum_{j=1}^{\infty} \rho^j \tilde{\nu}_{t+j} r_{t+1+j}^a$ and $\widetilde{W}_{t+1}^2 = E_{t+1} \sum_{j=1}^{\infty} \rho^j \tilde{\nu}_{t+j} r_{t+1+j}^y$. In section B.3 of the appendix we exploit the recursive structure of \widetilde{W}^1 (and \widetilde{W}^2) to show that \widetilde{W}^1 can be stated as a quadratic function of the state:

$$\widetilde{W}_{t+1}^1(z_{t+1}) = z'_{t+1} P z_{t+1} + d,$$

⁶There is an asymmetry in how Campbell (and we) deal with the returns on financial assets and human capital. Because the returns on human capital are not observable, we use equation (9), which makes explicit the dividend part.

where P solves the matrix Sylvester equation

$$P_{j+1} = R + \rho A' P_j A. \quad (18)$$

We solve this equation by iteration, starting from $P_0 = 0$, and $R = \rho D e_1' A$. The linear expression for the wealth shares, $\tilde{v} = D' z_t$, produces a quadratic form for the value function. The constant d in the value function equals $d = \frac{\rho}{1-\rho} \text{tr}(P\Sigma)$. This also implies that the news about future returns is a quadratic function of the VAR innovations and the matrix P :

$$W^1(z_{t+1}) = (E_{t+1} - E_t) \widetilde{W}_{t+1}^1(z_{t+1}) = \varepsilon_{t+1}' P \varepsilon_{t+1} - \sum_{i=1}^N \sum_{j=1}^N \Sigma_{ij} P_{ij}.$$

which turns out to be a simple quadratic function of the VAR shocks, their covariance matrix Σ , and the matrix P . In the same manner we calculate W^2 , replacing R in equation (18) by $S = \rho DC'$.

C. Results With Constant Wealth Shares

To gain intuition, we first shut down the time-variation in the human wealth share and estimate equation (17) for the three benchmark models. As was the case for *Model 1*, *Models 2, 3, & 4* cannot match the low volatility of consumption innovations and their low correlation with financial asset return innovations. To understand the problem, we must study these models' implications for human wealth returns. One particularly useful way is to reverse the logic and to impute the part of actual innovations in consumption that is not due to news about financial returns or labor income growth, to news about future human wealth returns. We fix a value for the *EIS* parameter σ and back out the innovations to future human capital returns that are implied by the observed aggregate consumption innovations. We now match the moments of consumption by construction. We can now compare trace back the failure of the benchmark models to the difference in the moments of human wealth returns between the benchmark models and moments that are consistent with consumption. Our main finding is that the data require that good news for current financial wealth returns is bad news for current human wealth returns. The benchmark models imply a positive correlation instead.

Table II summarizes the moments of consumption and human capital return innovations for quarterly data, and for a calibration with constant human wealth share $\bar{v} = \bar{s} = .7$, and *EIS* of $\sigma = .28$. The left panel reports the results using firm value returns; the right panel is for stock returns. Columns 1-3 in each panel report the properties of human wealth returns and consumption for *Model 2* ('Campbell'), *Model 3* ('Shiller'), and *Model 4* ('JW').

Because it equates expected future human wealth and financial wealth returns, *Model 2* sets: $V_{hy} = V_{ha}$, $\text{Corr}_{a,hy} = \text{Corr}_{a,ha}$, $\text{Corr}_{dy,hy} = \text{Corr}_{dy,ha}$, $\text{Corr}_{h^a,hy} = 1$. Table III is useful in understanding the implications of these assumptions on the variance of consumption V_c and the correlation between consumption and financial asset return innovations $V_{c,a}$. The news about future expected returns on human capital is as volatile as the news about financial

Table II
Moments for Consumption Growth and Human Capital Returns - Constant Wealth Shares.

The left panel uses firm value returns, the right panel uses stock returns. All results are for the full sample 1947.II-2004.III. In each panel, the first column represents the *Campbell* specification for human capital returns ($C' = e'_1 A$). The second column represents the constant discounter model ($C' = 0$), and the third column represents the autarkic model ($C' = e'_2 A$). The last column gives the moments of human wealth returns that are consistent with consumption data (equations 19 and 20). Computations are done for $\bar{v} = .7000$ and $\sigma = .2789$. In the data, $V_c = .33$ and $Corr_{c,a} = 0.168$ in panel A and $V_c = .33$ and $Corr_{c,a} = 0.185$ in panel B.

| Moments | Campbell | Shiller | JW | Reverse | Campbell | Shiller | JW | Reverse |
|------------------|------------------------------------|---------|-------|---------|-------------------------------|---------|-------|---------|
| | <i>Panel A: Firm Value Returns</i> | | | | <i>Panel B: Stock Returns</i> | | | |
| V_{h^y} | 32.67 | 0 | .54 | 107.38 | 103.7 | 0 | .79 | 58.37 |
| $Corr_{a,h^y}$ | -.477 | 0 | .485 | .839 | -.918 | 0 | .644 | .476 |
| $Corr_{d^y,h^y}$ | -.525 | 0 | .752 | .324 | -.336 | 0 | .735 | .704 |
| $Corr_{h^a,h^y}$ | 1.000 | 0 | -.306 | -.037 | 1.000 | 0 | -.453 | -.137 |
| V_y | 41.91 | 1.61 | .75 | 100.46 | 113.48 | 1.65 | .76 | 46.22 |
| $Corr_{y,a}$ | .487 | .337 | .081 | -.825 | .934 | .491 | .065 | -.443 |
| $Corr_{y,h^a}$ | -.986 | -.525 | -.511 | -.029 | -.994 | -.336 | -.032 | .091 |
| V_c | 6.05 | 4.30 | 3.95 | 0.33 | 7.61 | 2.49 | 2.10 | .33 |
| $Corr_{c,a}$ | .946 | .865 | .868 | .168 | .955 | .518 | .486 | .185 |
| V_m | 34.52 | 5.51 | 4.07 | 29.45 | 96.47 | 7.43 | 5.16 | 18.29 |
| $Corr_{m,a}$ | .710 | .928 | .950 | -.682 | .959 | .954 | .960 | .066 |
| $Corr_{m,y}$ | .961 | .664 | .389 | .976 | .997 | .730 | .342 | .865 |
| $Corr_{m,h^m}$ | -.946 | -.587 | -.436 | -.994 | -.988 | -.836 | -.790 | -.991 |

returns. This volatility increases the variance of consumption V_c (the (4, 4) entry in the top panel of table III is positive). The negative (1, 4) entries in the top and bottom panels show that $Corr_{a,h^y}$ has a negative effect on V_c and $Corr_{c,a}$. But since this model sets it equal to $Corr_{a,h^a}$, the mean reversion in the financial return data acts to increase the variance of consumption innovations and the correlation of financial return innovations and consumption innovations. Likewise, $Corr_{d^y,h^y}$ negatively affects V_c and $Corr_{c,a}$, but because h^a and d^y are negatively correlated in the data, the assumption $Corr_{d^y,h^y} = Corr_{d^y,h^a}$ again increases V_c and $Corr_{c,a}$. The only assumption that helps to reduce the variance of consumption and the correlation with financial asset returns is $Corr_{h^a,h^y} = 1$. The net result is that aggregate consumption innovations in *Model 2* are much too volatile (by a factor of 4.3 in panel A and 4.8 in panel B) and much too highly correlated with return innovations (by a factor of 5.6 in panel A and 5.2 in panel B).

We expect *Model 3* to do better by assuming a constant discount rate for human capital, because this implies that $V_{h^y} = Corr_{a,h^y} = Corr_{d^y,h^y} = Corr_{a,h^a} = 0$, all of which help to lower the variance and correlation moment compared to *Model 2*. Indeed, the variance of consumption is 4.30 and the correlation moments is 0.865 in *model 3*, lower than the 6.05 and 0.946 of *Model 2*. However, they are still far way from the observed magnitudes. When we use stock returns instead of the returns on firm value (panel B), the predicted correlation of innovations in consumption decreases to 0.518, because stock market returns display so

much more mean reversion. The variance of consumption news is still off by an order of magnitude, and the correlation by a factor of 2.8.

Model 4 further improves the results. News in future human wealth returns equals news in future labor income growth. This means $V_{h^y} \approx V_{d^y}$.⁷ In the data, news in future labor income growth is not very volatile, especially compared to news in future financial asset returns. Also $Corr_{h^y,a} \approx Corr_{d^y,a} > 0$, a good assumption, because we know from table III that $Corr_{h^y,a} > 0$ helps to lower the volatility and correlation of consumption innovations when the IES is smaller than one. Yet, quantitatively, these correlations are too small in absolute magnitude to improve on *Model 3*.

Model 2 model does worse than the other two because the high implied correlation between innovations in financial asset returns and human capital returns imputes too much volatility to consumption. The difference is especially stark using stock returns (panel B): $Corr_{y,a} = .93$ for *Model 2*, 0.49 for *Model 3*, and 0.07 for *Model 4*.

Table III
Matching Consumption Moments when $\sigma < 1$

In the first panel, the entries show the sign of the effect of the variance/covariance of (i, j) on the variance of consumption V_c . In the second panel, the entries show the sign of the effect of the variance/covariance of (i, j) on the covariance of consumption $V_{c,a}$.

| | a | d^y | h^a | h^y |
|-----------|-----|-------|-------|-------|
| V_c | | | | |
| a | + | + | + | - |
| d^y | | + | + | - |
| h^a | | | + | - |
| h^y | | | | + |
| $V_{c,a}$ | | | | |
| a | + | + | + | - |

Varying the IES and the Labor Income Share These results are robust to plausible changes in parameter values. Figure 10 in appendix D plots the model-implied standard deviation of consumption innovations and the correlation of consumption innovations with innovations in financial market returns for different values of σ for the full sample; the labor share $\bar{\nu}$ is .7. None of the models comes close to matching the variance and correlation, even for very low σ . Figure 11 in appendix D shows that a labor income share of close to 1 is needed to match both consumption moments. An increase in the average labor income share to .85 brings the standard deviation of consumption in *Model 4* down to 2.3 times its value in the data; the correlation is still much too high (0.78).

Annual Data The same exercise using annual data produces similar results; the discrepancy between the model and the data increases at annual frequencies because the mean

⁷More precisely: $V_{h^y} = V[(E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j \Delta y_{t+1+j}]$. Note that $(E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j \Delta y_{t+1+j} \neq d^y$ because of the summation index that starts at 1 instead of 0.

reversion in stock returns decreases. The lowest standard deviation for consumption news is 3.74 percent for *Model 4*, compared to .8 percent in the data. The results are in Table IX in appendix D.

Consumption-Consistent Human Wealth Returns Sofar we have been unable to bring the model’s moments closer to matching those in the data. We now treat the expected returns component of human wealth return innovations as a residual and we reverse-engineer a human wealth return process that can match the consumption data. More precisely, innovations in current consumption growth can be recovered from the VAR residuals:

$$(c)_t \equiv c_{t+1} - E_t[c_{t+1}] = e'_7 \varepsilon'_{t+1}. \quad (19)$$

Plugging these consumption innovations back in the household’s linear policy rule (17), we can back out the implied news in future human capital returns:

$$(h^y)_{t+1} \equiv \frac{1}{\sigma \bar{\nu}} [(1 - \bar{\nu})(a)_{t+1} + \bar{\nu}(d^y)_{t+1} + (1 - \sigma)(1 - \bar{\nu})(h^a)_{t+1} - (c)_{t+1}]. \quad (20)$$

From this (h^y) and the data on labor income growth, we form innovations in current human wealth returns $(y)_{t+1} = (d^y)_{t+1} - (h^y)_{t+1}$.

The fourth column of each panel of Table II reports the properties of human wealth returns implied by consumption data and the baseline parameter calibration $\bar{\nu} = .70$ and $\sigma = .28$ (label *Reverse*). In panel A, the implied variance of shocks to expected future returns on human wealth V_{h^y} is 107.4, its correlation with current asset return innovations $Corr_{a,h^y}$ is .84, its correlation with innovations to future labor income growth $Corr_{h^y,dy}$ is .32, and its correlation with news in future returns $Corr_{h^a,h^y}$ is $-.04$. Good news about expected future financial market returns implies bad news about future expected human wealth returns. The main finding of the paper is that innovations in current financial asset and human wealth returns are **negatively** correlated ($Corr_{y,a} < 0$). Intuitively, if good news in the stock market coincides with higher future risk premia on human wealth ($Corr_{a,h^y} > 0$) and lower expected future labor income growth ($Corr_{a,dy} < 0$), the innovation to the current human wealth returns will be negative ($Corr_{a,y} < 0$), offsetting the effect of good news in the stock market on consumption. This is the only way to match the low volatility of consumption innovations and their low correlation with financial asset return innovations. In the data we found $Corr_{a,dy} > 0$ instead (around 0.4), which works against a low consumption variance and a low correlation between (c) and (a) . The correlation between financial asset return innovations and future risk premia on human wealth must then be high enough to dampen the cash-flow effect ($Corr_{a,h^y} = .84$).

The negative correlations between *current* and *future* human wealth and financial wealth return innovations are robust: regardless of the *EIS* and the labor income share, $Corr_{a,y} < 0$ and $Corr_{h^y,h^a} < 0$. Both correlations become more negative for larger σ . Looking back at the three benchmark models, only *Model 4* generates the same correlation pattern as in column *Reverse*: $Corr_{a,h^y}$ and $Corr_{h^y,dy}$ are positive and $Corr_{h^a,h^y}$ is negative, but none of them imply $Corr_{a,y} < 0$.

For the benchmark parameters and firm value returns, innovations to current and future human wealth returns V_y and V_{hy} are highly volatile, 1.4 and 1.8 times as volatile as the innovations to current and future financial asset returns respectively. If we use stock returns instead, human wealth returns are less volatile because stock returns are more strongly mean reverting. The volatility proportionality factors are .85 and .75. Also, the implied volatility of human wealth returns declines with the *EIS*. For $\sigma = .73$ and firm value returns, $V_y = 14.5$, half as volatile as financial return innovations.

The Return on the Market Portfolio In the model with constant wealth shares, innovations in the current market return are $(m)_{t+1} = (1 - \bar{\nu})(a)_{t+1} + \bar{\nu}(y)_{t+1}$ and news in future market returns are given by $(h^m)_{t+1} = (1 - \bar{\nu})(h^a)_{t+1} + \bar{\nu}(h^y)_{t+1}$ (see equation 8). The bottom three rows of Table II display the moments of the market return.

In the three benchmark models, innovations in the market return are positively correlated with innovations in financial asset returns and human wealth returns. In contrast, in column *Reverse*, good news in financial markets is bad news for the market return $Corr_{m,a} < 0$. The reason of course is that $Corr_{y,a} < 0$ and human wealth represents 70% of the market portfolio. The consumption-consistent market return is strongly positively correlated with human wealth returns and negatively correlated with firm value returns. In panel B, where we use stock returns instead, $Corr_{m,a}$ is slightly positive. In both cases, the market return is strongly mean reverting $Corr_{m,a} < -.99$. This can be traced back to the mean reversion in human wealth returns ($Corr_{y,hy} = -.90$ or lower) and the mean reversion in financial asset returns. We find the same results for annual data (Table IX in appendix D). The only difference is that $Corr_{m,a}$ is now also negative for stock returns.

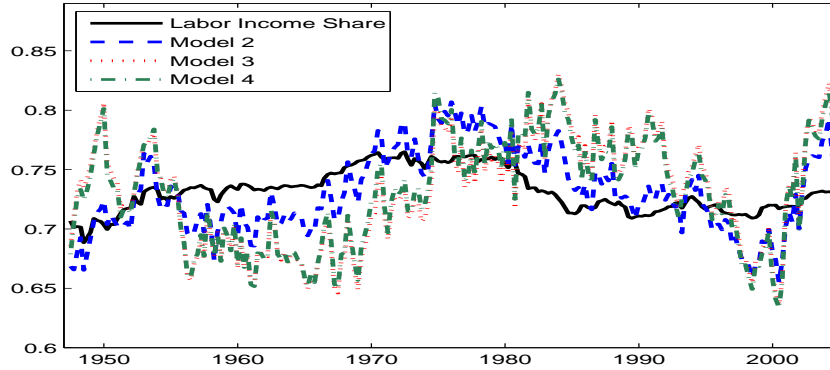
D. Results with Time-Varying Wealth Shares

In this section, we show that the previous results are preserved when the human wealth share moves over time (as described in section B). We briefly revisit the three benchmark sections, and show that accounting for time-varying wealth shares does not help much. Then, we estimate the vector C , which determines expected returns on human wealth, that most closely matches the moments of consumption. As before, the resulting human wealth returns are negatively correlated with financial asset returns.

Figure 4 plots the human wealth share over time for the three benchmark models, alongside the labor income share. *Models 3 & 4* imply quite some variation in the human wealth share, because the risk premia on human wealth and financial wealth are not correlated; e.g. in the 90's, the human wealth share is very low, while it is much higher in the 80's. In *Model 1*, the human wealth share follows the exact opposite pattern.

Columns 1-3 of Table D report the model-implied moments of consumption, human wealth returns and the market return for the three benchmark models. The table has the same structure as Table II, but switches on time-varying wealth shares. As is clear from equations (10) and (11), the processes for news in future and current human wealth returns only depend on the vector C , and not the human wealth share (vector D). Since C is fixed

Figure 4. Labor Income Share and Human Wealth Share for Models 2, 3, and 4
The return on financial assets is return on Firm Value.



for the benchmark models, the first seven rows of Table D are identical to the first six rows of Table II. Model implied consumption innovations, specified in equation (16), do depend on the wealth shares. In *Model 2*, the conditional moments of future asset returns and human wealth returns are identical. As a result, $(h^y)_t = (h^a)_t$, which implies $W_t^1 - W_t^2 = 0$ for all t . The latter can be shown by applying the law of iterated expectations. In *Model 3*, $h^y = 0$ and $W_t^2 = 0$. In *Model 4* model, $W_2 = (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j \tilde{v}_{t+j} \Delta y_{t+1+j}$. Rows 8 and 9 show that allowing for time-varying human wealth shares does not help to bring the benchmark models' consumption moments closer to the data. In panel A (firm value returns), V_c and $Corr_{c,a}$ are slightly lower, but in panel B they are slightly higher. As before, the reason is that all three models imply a high correlation between financial asset returns and the market return (row 11). Because financial market returns are so volatile, consumption ends up too volatile and too highly correlated with financial asset returns.

Model 5: Consumption Growth Accounting As we did in section C, we now ask what properties human wealth returns must have to imply consumption moments consistent with the data. When human wealth shares vary over time, the procedure of backing out those properties directly from consumption data (equation 20) is no longer available. Instead, we choose the vector C , which relates the expected return on human wealth to the state vector, $E_t[r_{t+1}^y] = C' z_t$, to minimize the distance between the model-implied consumption volatility and correlation moments and the same moments in the data. This vector then delivers human wealth return processes $\{h_t^y\}$ and $\{y_t\}$ from equations (10) and (11). Once we pinned down the vector C , we can also solve for the human wealth share from equations (12) and (14). For a given value of the *EIS*, equation 16 delivers the consumption innovations. We form the volatility of model-implied consumption innovations, and their correlation with financial asset return innovations.⁸ We label the resulting model *Model 5*; it is reported in

⁸We use a non-linear least squares algorithm to find the vector C that minimizes the distance between the two model-implied and the two observed consumption moments. Because the moments are highly non-linear

Table IV
Moments for Consumption Growth and Human Capital Returns -
Time-Varying Wealth Shares

This table has the same structure as Table II, but here computations are done for a time-varying human wealth share ν_t and $\sigma = .2789$.

| Moments | Campbell | Shiller | JW | Model 5 | Campbell | Shiller | JW | Model 5 |
|------------------|------------------------------------|---------|-------|---------|-------------------------------|---------|-------|---------|
| | <i>Panel A: Firm Value Returns</i> | | | | <i>Panel B: Stock Returns</i> | | | |
| V_{h^y} | 32.67 | 0 | .54 | 69.05 | 103.07 | 0 | .79 | 36.38 |
| $Corr_{a,h^y}$ | -.477 | 0 | .485 | .897 | -.918 | 0 | .644 | .504 |
| $Corr_{d^y,h^y}$ | -.525 | 0 | .752 | .452 | -.336 | 0 | .735 | .874 |
| $Corr_{h^a,h^y}$ | 1.000 | 0 | -.306 | -.152 | 1.000 | 0 | -.453 | -.209 |
| V_y | 41.91 | 1.61 | .75 | 61.13 | 113.48 | 1.65 | .76 | 24.50 |
| $Corr_{y,a}$ | .487 | .337 | .081 | -.880 | .934 | .491 | .065 | -.487 |
| $Corr_{y,h^a}$ | -.986 | -.525 | -.511 | .076 | -.994 | -.336 | -.032 | .168 |
| V_c | 5.65 | 3.84 | 3.46 | .52 | 8.00 | 2.77 | 2.41 | .47 |
| $Corr_{c,a}$ | .922 | .848 | .853 | .168 | .955 | .511 | .473 | .185 |
| V_m | 34.62 | 5.69 | 4.21 | 18.92 | 96.09 | 7.75 | 5.46 | 10.10 |
| $Corr_{m,a}$ | .707 | .917 | .937 | -.759 | .961 | .939 | .937 | .067 |
| $Corr_{m,y}$ | .961 | .667 | .392 | .971 | .996 | .736 | .353 | .825 |
| $Corr_{m,h^m}$ | -.948 | -.584 | -.430 | -.987 | -.987 | -.810 | -.748 | -.980 |

the fourth column of Table D for $\sigma = .28$.

Whereas time-varying wealth shares did not change the results for *Models 2, 3, & 4* much, the results for *Model 5* are somewhat different from the ones in column *Reverse* of Table II. Especially, time-variation in the human wealth share allows the model to match the moments of consumption (rows 8 and 9) for human wealth returns that are twenty percent less volatile in panels A and B. As a result, the market return processes are much less volatile as well. When the dividend yield on human wealth increases relative to the dividend yield on financial wealth, future returns on human wealth are predicted to be higher than future returns on financial wealth. But, this is counteracted by the lower human wealth share (ν_t decreases in $dp_t^y - dp_t^a$). Time variation in the human wealth share acts to reduce the volatility of consumption. Figure 5 plots the model-implied human wealth share at the optimal parameter values, alongside the observed labor income share. The human wealth share is more than twice as volatile as the labor income share.

The main findings are further strengthened: The consumption-consistent human wealth return process is consistently negatively correlated with financial asset returns ($Corr_{h^y,h^a} < 0$ and especially $Corr_{y,a} < 0$). Good news on Wall street is bad news on Main street. These correlations are more negative than with constant wealth shares. Figure 6 plots the innovations in current asset returns $(a)_t$ and the innovations in current human wealth returns $(y)_t$. The two are strongly negatively correlated.

in the $N \times 1$ vector C , we cannot rule out that the C vector is not uniquely identified.

Figure 5. Human Wealth Share in Model 5.

The return on financial assets is the return on firm value.

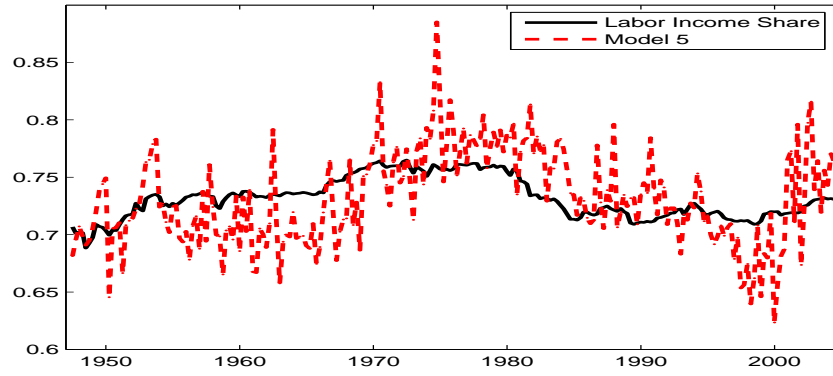


Figure 6. Innovations in Current Financial Asset and Human Wealth Returns Implied by Consumption Moments.

The return on financial assets is the return on firm value.

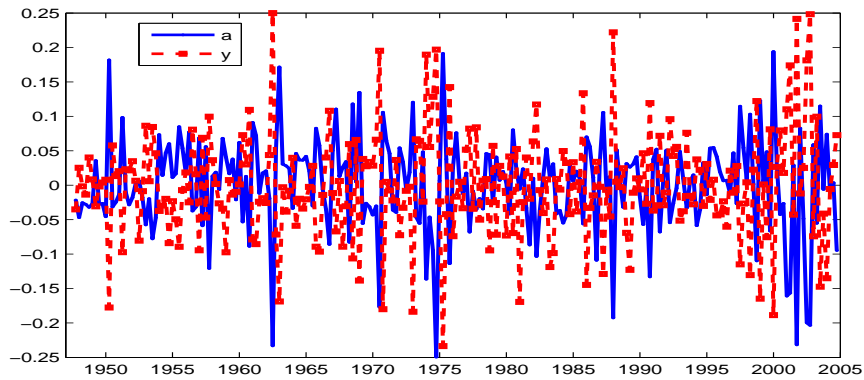
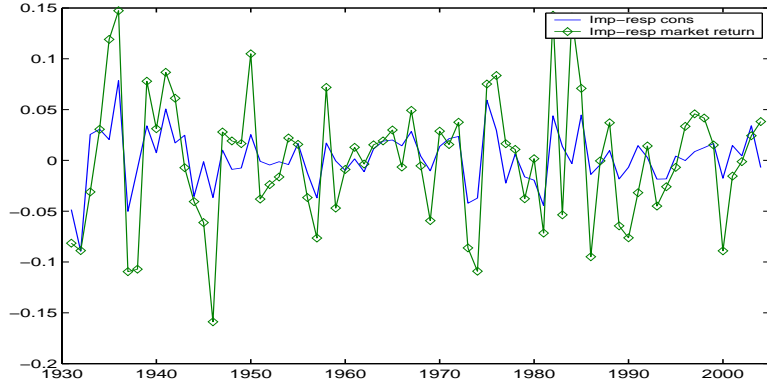


Figure 7. Long-Run Response of the Market Return and Consumption Growth

The return on financial assets is the return on stocks. The sample is 1930-2004. The figure plots the long-run response of consumption (d^c) as implied by the VAR, and the long-run response of the market return (m) + (h^m) as implied by the model. The correlation between the two series is 0.69. The EIS is $\sigma = .2789$.



Long Run Restriction We recall that the model implies a restriction on the long-run responses of consumption and the market return to innovations in the state (see equation 5). In quarterly data, the correlation between $(m)_t + (h^m)_t$ and $(d^c)_t$ is .11 for firm value returns and .12 for stock returns, but the market response is about twice as volatile. This correlation is .39 at annual frequencies for firm value returns and .36 for stock returns over the 1947-2004 sample and even .69 for stock returns over the 1930-2004 sample (see figure 7). In *Model 1* with financial wealth only, these correlations were negative for quarterly data and zero for annual data. Introducing human wealth dramatically improves the match between the long-run response of consumption growth and the market return, compared to the no human wealth benchmark.

Varying the EIS In Table X in appendix D, we investigate the sensitivity of the results to the choice of the *EIS* parameter σ . Reading across the columns, for each of the calibrations, we get a strong negative correlations between news about current and future financial and human wealth returns, as well as high and positive correlations $Corr_{a,hy}$ and $Corr_{y,ha}$. Good news about current financial asset returns raises risk premia on future human wealth returns and good news about current human wealth returns increases future risk premia on financial assets. These features enable *Model 5* to match the smooth consumption series and its low correlation with financial asset returns (rows 8 and 9). The volatility of human wealth returns decreases in σ ; V_{hy} and V_y are much lower than in Table for $\sigma = .28$.

What changes across the columns are the properties of the market return. The correlation between innovations in the market return and innovations in the human wealth returns is 0.9 in the case of $\sigma = .5$ (column 1, row 12), whereas the correlation with innovations in financial asset returns is -.7 (column1, row 11). The implied market returns are strongly mean-reverting, as shown by the correlation between m and h^m of -.95 (row 13). When

$\sigma = 1$, the consumption innovation equation (15) specializes to:

$$(c)_{t+1} = (1 - \nu_t)(a)_{t+1} + \nu_t(d^y)_{t+1} - \nu_t(h^y)_{t+1} = (1 - \nu_t)(a)_{t+1} + \nu_t(y)_{t+1} = (m)_t.$$

Indeed, we find that $V_c = V_a$ and $V_{c,a} = V_{m,a}$. When the agent is myopic, her consumption responds one-for-one to innovations in the market return.

In the more-than-log case ($\sigma = 1.5$ in column 3), the market return must display mean aversion to match the consumption moments ($V_{m,h^m} > 0$). The algorithm accomplishes this by choosing a human wealth return process that implies large enough positive correlations $Corr_{a,h^y}$ and $Corr_{y,h^a}$ to overcome the mean reversion in financial asset returns and human wealth returns ($V_{a,h^a} < 0$ and $V_{y,h^y} < 0$).

Robustness: Different Income Measures Our results are robust to including proprietor's income in the income measure and to excluding government and non-financial employees' wages (recall Table VIII in appendix D for the moments of the data). The left column of table XI shows the moments for (h^y) when proprietor's income is included in labor income. The right panel shows the moments for h^y using pay-outs to employees in the non-government non-financial sector. The financial asset returns are the returns on the total firm value. Rows 8 and 9 show that we exactly match the consumption moments for $\sigma = .28$. We obtain strongly negatively correlated news in financial asset and human wealth returns (both current innovations, and future surprises). As before, the correlation between innovations in the market return and innovations in the human wealth return is large and positive (.98), whereas the correlation with innovations in financial asset returns is negative (-.7), evidence of strong mean reversion in the implied market return (-.99). The main difference with our previous results is that innovations in current human wealth returns need only be about half as volatile as before: $V_y = 22$ and 15 respectively versus $V_y = 61$ in the benchmark model, much less variable than financial asset return innovations: $V_a = 48.3$. The reason is that the average labor income share is much higher than in the benchmark case ($\bar{\nu} = .92$ in the left column and $.84$ in the right column compared to 0.73 in Table). A higher average human wealth share requires less volatility in human wealth returns to offset a given volatility in financial asset returns. Interestingly, a higher labor income share also lines up the long-run responses of consumption and the market return much better.

VI. The Consumption-Consistent CAPM

This section examines the cross-sectional asset pricing implications of our framework. We show that the consumption-consistent CAPM does at least as well, and sometimes better at pricing the cross-section of size and value returns.

We start from the linearized Euler equation for asset i :

$$E_t r_{t+1}^i - r_t^f + \frac{V_{ii}}{2} = \frac{\theta}{\sigma} V_{ic} + (1 - \theta) V_{im} \quad (21)$$

$$= \gamma V_{im} + (\gamma - 1) V_{ih^m} \quad (22)$$

In an Epstein-Zin asset pricing model, the expected excess return (corrected for one-half its variance) is determined by two risk factors: the covariance of return i with aggregate consumption growth V_{ic} and the covariance of return i with the market return V_{im} (equation 22). Campbell (1993) substitutes out consumption, replacing V_{ic} by $V_{im} + (1 - \sigma)V_{ih^m}$, which leads to asset pricing equation (22). We have argued that the consumption processes in the three canonical models are very different from the observed consumption process. This will lead to a market return process, different from the one in our consumption-consistent model. Therefore, we stay with equation (21), and evaluate the performance of the three canonical models and our model in pricing the cross-section of stock returns.

Taking expectations of (21) delivers an unconditional asset pricing equation. Following Campbell, we define the excess returns on I assets $er_{t+1}^i = r_{t+1}^i - r_t^f$ with unconditional means μ_i . Both vectors have dimension $I \times 1$. We define $\eta_{t+1}^i \equiv er_{t+1}^i - \mu^i$. Rather than estimating the mean returns, we take them from the data and use sample means.⁹ We estimate the market prices of risk, p_k off the ex-post version of equation (21):

$$\frac{1}{T} \sum_{t=1}^T \left[er_{t+1}^i + \frac{1}{2}(\eta_{t+1}^i)^2 - p_c \eta_{t+1}^i \Delta c_{t+1}^{pred} - p_m \eta_{t+1}^i r_{t+1}^{m,pred} \right] = 0, \quad \forall i \in \{1, 2, \dots, I\} \quad (23)$$

The factor risk prices p_c and p_m depend on the coefficient of relative risk aversion γ and the intertemporal elasticity of substitution σ . We follow the Fama-McBeth procedure, where in a first stage we form the factor loadings V_{ic} and V_{im} for each of the 25 size and value portfolios from a time-series regression of the log excess returns on model-implied consumption growth and market return. In the second stage, we estimate the market prices of risk from a cross-sectional regression of variance-adjusted mean log excess returns on the factor betas from the first stage.¹⁰ We have in mind a researcher who takes each of the different models' implied realized consumption growth and total market return as given, and estimates the Epstein-Zin model via Fama-MacBeth.

The first two columns of Table V show the expected return and the expected return with a variance correction for the 25 size and book-to-market decile portfolios (quarterly data for 1947.II-2004.III from Kenneth French). They show the well documented fact that low book-to-market (growth) firms have lower average returns than high book-to-market (value) firms and small firms have higher average returns than large firms. The next two columns report our model's predicted adjusted return and the pricing error; the part of the return that is not explained by sample covariances with the factors and the sample estimates of the risk prices. The last three columns give the risk contribution to the expected excess return of each asset; the first one of which is the market price of risk on a constant (p_0 , $p_c \times V_{ic}$ and $p_m \times V_{im}$). We use the consumption measure and the market return measure of our model with time-varying human wealth share and the optimal vector C , i.e. the one that is consistent with aggregate consumption moments.

⁹Our results are unchanged if we estimate the mean returns.

¹⁰Alternatively, we can estimate the factor risk prices by GMM. Equations (23) define I moments to identify 2 parameters.

Table V
Risk Contributions From c and m - 25 Size and Value Portfolios

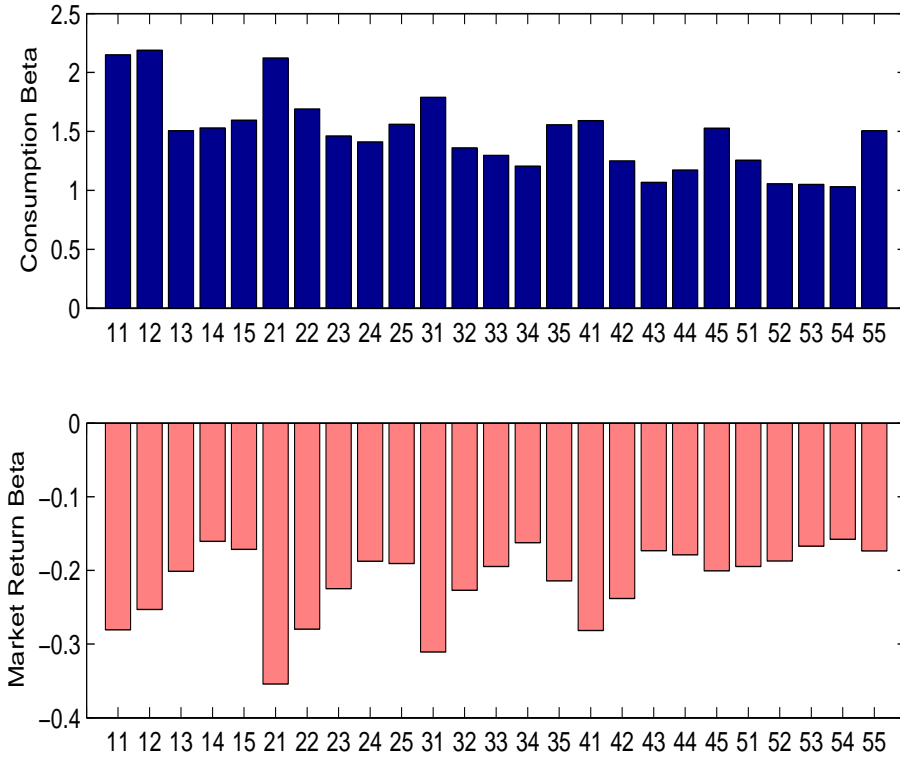
The first column gives the average log excess return per quarter, in excess of a 3-month T-bill return (er^{data}). The second column adjusts for the Jensen effect by adding 1/2 times the variance of the log excess return (er_{adj}^{data}). Columns 3-4 give the model's predicted adjusted return (er_{adj}^{pred}) and the pricing error ($error$). The last three columns give the risk contribution (price of risk times quantity of risk) to the expected excess return of each asset; the first one of which is the market price of risk on a constant (p_0). The assets are the 25 size and book-to-market decile portfolios from Kenneth French. The return measure r^a in the VAR is the firm value return. All numbers are multiplied by 100. Our model is computed for $\sigma = .28$ and time-varying human wealth share.

| Portfolio | er^{data} | er_{adj}^{data} | er_{adj}^{pred} | $error$ | p_0 | $p_c V_{ic}$ | $p_m V_{im}$ |
|-----------|-------------|-------------------|-------------------|---------|-------|--------------|--------------|
| S1B1 | 0.073 | 1.296 | 1.547 | -0.251 | 3.775 | 1.138 | -3.366 |
| S1B2 | 1.841 | 2.704 | 1.900 | 0.805 | 3.775 | 1.158 | -3.034 |
| S1B3 | 2.154 | 2.800 | 2.160 | 0.640 | 3.775 | 0.797 | -2.412 |
| S1B4 | 2.792 | 3.381 | 2.661 | 0.720 | 3.775 | 0.810 | -1.924 |
| S1B5 | 3.137 | 3.826 | 2.566 | 1.261 | 3.775 | 0.845 | -2.054 |
| S2B1 | 0.642 | 1.602 | 0.651 | 0.951 | 3.775 | 1.123 | -4.247 |
| S2B2 | 1.813 | 2.470 | 1.315 | 1.156 | 3.775 | 0.894 | -3.355 |
| S2B3 | 2.432 | 2.947 | 1.854 | 1.093 | 3.775 | 0.773 | -2.694 |
| S2B4 | 2.605 | 3.103 | 2.272 | 0.832 | 3.775 | 0.747 | -2.250 |
| S2B5 | 2.975 | 3.572 | 2.316 | 1.256 | 3.775 | 0.826 | -2.285 |
| S3B1 | 1.123 | 1.903 | 0.995 | 0.908 | 3.775 | 0.947 | -3.727 |
| S3B2 | 1.998 | 2.505 | 1.774 | 0.731 | 3.775 | 0.720 | -2.721 |
| S3B3 | 2.105 | 2.545 | 2.127 | 0.418 | 3.775 | 0.686 | -2.334 |
| S3B4 | 2.519 | 2.953 | 2.465 | 0.488 | 3.775 | 0.638 | -1.948 |
| S3B5 | 2.724 | 3.261 | 2.031 | 1.230 | 3.775 | 0.824 | -2.568 |
| S4B1 | 1.425 | 2.049 | 1.243 | 0.806 | 3.775 | 0.843 | -3.375 |
| S4B2 | 1.580 | 2.035 | 1.581 | 0.453 | 3.775 | 0.662 | -2.856 |
| S4B3 | 2.366 | 2.758 | 2.262 | 0.496 | 3.775 | 0.565 | -2.078 |
| S4B4 | 2.331 | 2.721 | 2.251 | 0.470 | 3.775 | 0.621 | -2.144 |
| S4B5 | 2.524 | 3.062 | 2.178 | 0.884 | 3.775 | 0.808 | -2.405 |
| S5B1 | 1.415 | 1.824 | 2.105 | -0.280 | 3.775 | 0.665 | -2.335 |
| S5B2 | 1.538 | 1.861 | 2.088 | -0.227 | 3.775 | 0.560 | -2.246 |
| S5B3 | 1.925 | 2.195 | 2.326 | -0.131 | 3.775 | 0.556 | -2.005 |
| S5B4 | 1.854 | 2.149 | 2.429 | -0.280 | 3.775 | 0.546 | -1.892 |
| S5B5 | 1.911 | 2.323 | 2.490 | -0.167 | 3.775 | 0.797 | -2.082 |

Our model does a reasonable job accounting for the value spread. In each size quintile, growth firms (B1) are predicted to give a lower return than value firms (B5), and just as in the data the value premium is stronger for small firms. Using book-to-market decile returns, our model predicts a value spread of 1.1% per quarter, whereas in the data the spread is 1.4%. There is an interesting cross-sectional pattern in the covariances of the book-to-market decile returns with V_{im} and V_{ih} . The top panel of figure 8 shows that growth firms are more exposed to consumption risk than value firms (the second number in the horizontal axis index denotes the book-to-market quintile, 11 is small growth, 15 is small value). The bottom panel shows that growth firms form a better hedge against future market risk than value firms. This is confirmed in the last two columns of Table V, which show that the risk contribution of the market factor is much lower for growth firms than for value firms.

Table VI compares the estimates for the market prices of risk and their standard errors, the root mean-squared pricing error and the cross-section R^2 from the second stage of the Fama-MacBeth procedure across models. Each of the 9 columns denotes a different model,

Figure 8. Value Portfolios: Risk Contributions of c and m



each with a different implied consumption growth and market return process. The first column is *Model 1*, the model with financial wealth only $\nu_t = 0$. The market return is simply the financial asset return. The second and third columns are *Model 2 without* and *with* time-varying human wealth share. Columns four and five report *Model 3 without* and *with* time-varying human wealth share. Likewise, columns six and seven are for *Model 4* model, and the last two columns are for our model. In our model with constant human wealth shares (column 8), we use actual consumption data to back out a process for h^y . Thus, consumption growth in column 7 is identical to observed consumption growth, and the market return process, is the one consistent with it.¹¹ Our model with time-varying wealth shares in column 9 finds the optimal vector C to match the variance of consumption innovations, the correlation of

¹¹In this procedure, we back out h^y from consumption data (equation 20). We form innovations in current human wealth returns from $y = d^y - h^y$. To form realized market returns $r^m = (1 - \nu)r^a + \nu r^y$, we need realized human wealth returns r^y . Realized human wealth returns are the sum of innovations in current human wealth returns y and expected human wealth returns. Since this procedure does not identify expected human wealth returns, we assume that they are the same as in *Model 4*, the model the closest to ours. This choice does not affect the RMSE in column 7.

Table VI
Model Comparison

The table shows the market prices of risk obtained from the cross-sectional regression $\bar{e}r^i = \lambda_0 + \lambda_c V_{ic} + \lambda_m V_{im} + \epsilon^i$. The risk exposures (V_{ic}, V_{im}) are obtained from a first step time series regression. Standard errors are Shanken-corrected. The last two lines report the root mean squared pricing error across all portfolios, and the R^2 from the second step regression. The test asset returns are the log real excess returns on the 25 Fama-French size and value portfolios. The estimation uses the firm value return for r^a and $\sigma = .28$. All numbers are multiplied by 100.

| Portfolio | <i>Model 1</i> | <i>Model 2</i> | <i>Model 2_{TV}</i> | <i>Model 3</i> | <i>Model 3_{TV}</i> | <i>Model 4</i> | <i>Model 4_{TV}</i> | <i>Reverse</i> | <i>Model 5</i> |
|----------------------|----------------|----------------|-----------------------------|----------------|-----------------------------|----------------|-----------------------------|----------------|----------------|
| λ_0 | 4.73 | 4.02 | 3.36 | 2.95 | 3.22 | 2.80 | 3.20 | 4.25 | 3.78 |
| σ_{λ_0} | 0.83 | 0.82 | 0.75 | 1.04 | 0.90 | 1.28 | 1.10 | 1.21 | 0.92 |
| λ_c | -3.24 | -0.63 | -0.51 | 0.50 | 0.32 | 0.53 | 0.58 | 0.63 | 0.53 |
| σ_{λ_c} | 1.51 | 0.40 | 0.40 | 0.73 | 0.68 | 0.76 | 0.78 | 0.33 | 0.88 |
| λ_m | -2.25 | 2.03 | -3.11 | -0.67 | -0.66 | -0.92 | -0.73 | 4.12 | 11.99 |
| σ_{λ_m} | 1.03 | 2.14 | 1.73 | 0.44 | 0.42 | 0.46 | 0.43 | 1.57 | 4.75 |
| RMSE | 0.82 | 0.82 | 0.84 | 0.82 | 0.83 | 0.78 | 0.80 | 0.71 | 0.76 |
| adj. R^2 | 36.91 | 36.37 | 31.13 | 37.12 | 35.06 | 50.11 | 45.87 | 65.03 | 47.33 |

consumption innovations with financial asset return innovations to the ones in the data.¹² In all models, the financial asset return is the firm value return, and consumption series are computed for $\sigma = .28$.

The main finding of table VI is that the market price of risk on the market return has the opposite in our model compared to the model without human wealth and the three benchmark models with human wealth: 12 in column 9 versus -2.2, -3.1, -.7, and -.7 in columns 1, 3, 5, and 7 respectively. This is now unsurprising, given the negative correlation between our implied market return and the return on financial assets. Our model is the only one where the market prices of risk on both risk factors are positive. One of the implications is that all other models imply that growth firms are exposed to more market risk than value firms, whereas the opposite is true when the market return is consistent with consumption data. Among the models with constant wealth shares, our model (column 8) has the lowest root mean-squared pricing error (RMSE is 0.7% per quarter) and the highest cross-sectional R^2 (65%). Among the models with time-varying wealth shares, our model also delivers the lowest RMSE. *Model 4*, whose market return process shares many of the features of our market return process, also prices the 25 Fama-French portfolios reasonably well ($R^2 = 45\%$). One failure of all models, is that the intercept λ_0 remains statistically different from zero.

We conclude that the omission of human wealth returns in the calculation of the market return is significant for the CAPM's ability to explain the cross-section of stock returns. When human wealth returns are made consistent with observed consumption, an interesting pattern arises in firm's exposures to market returns: growth firms have lower risk premia because they provide a better hedge against market risk. The opposite conclusion would be reached from a model without human wealth, or a model where human wealth returns were

¹²For the asset pricing results, we additionally include the correlation between consumption innovations in the model and in the data as a third moment to match. The matching exercise is successful in that it yields a model-implied consumption growth process that has a correlation of 0.87 with consumption growth in the data. The downside is that consumption is now 3 times too volatile.

determined in a manner inconsistent with consumption data.

VII. Other Explanations

The previous analysis attributed to human wealth returns the part of consumption innovations that could not be explained by financial wealth return innovations. In this section, we consider three other potential explanations for the lack of correlation and the volatility puzzle. All three amount to richer versions of Model 1 with financial wealth only. We find that we can rule them out, keeping alive the explanation of human wealth returns. First, we consider heteroscedastic returns on financial assets, and we develop a way of testing whether this effect drives our results. We find it does not. Second, we consider the effect of habit-style preferences. We rule out habits because, when reasonably specified, they cannot lower the correlation between consumption innovations and returns enough. Third, we consider heterogeneity across households. We argue this would only make the puzzle worse. Finally, we consider another criticism, that the human wealth return residual may proxy for housing wealth. We add housing wealth to the model, and find that the residual has very much the same properties as in the model without it.

A. Heteroscedastic Market Returns

Sofar we have abstracted from time-variation in the joint distribution of consumption growth and returns. In particular, we worry about time-varying variances in consumption growth and the market return. Denote the conditional variance term by μ_t^m , which was previously assumed to be constant. In this case, a third source of consumption innovations arises (equation 38 in Campbell (1993)), which reflects the influence of changing risk on saving:

$$c_{t+1} - E_t c_{t+1} = r_{t+1}^m - E_t r_{t+1}^m + (1 - \sigma)(E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{t+1+j}^m - (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j \mu_{t+1+j}^m,$$

where $\mu_t^m = \sigma \log \beta + .5 \left(\frac{\theta}{\sigma}\right) \text{Var}_t[\Delta c_{t+1} - \sigma r_{t+1}^m]$. Campbell shows this last term drops out if either γ or σ are one. We call the last term news about future variances h^μ .

Assume we are in the plausible parameter range: $\gamma > 1$ and $\sigma < 1$. In this case, the last term can only resolve the *correlation puzzle* if V_{m,h^μ} is strongly positive -good news in the stock market today increases the conditional volatility of future market returns persistently well into the future. If true, our consumption growth accounting residual should *predict* the future variance of stock market returns. To rule out this explanation, we ask whether the residual $(h^y)_t$ that comes out of our model with time-varying human wealth shares predicts the future variance of stock returns. We find that it does not. From the VAR innovations we construct the conditional variance of financial asset returns:

$$V_t^a \equiv V_t[r_{t+1}^a] = e_1' A z_t z_t' A' e_1 + e_1' \Sigma e_1. \quad (24)$$

We then regress $\sum_{h=1}^H \rho^h V_{t+h}^a$ on $((h^y)_t)$. We vary h from 1 to 20. Using firm value returns, the regression coefficient is never statistically significant (we use Newey-West standard errors), and the R^2 of the regression never exceeds 1%. We only find marginal statistical significance for $\sigma = .28$ when financial asset returns are stock returns and for horizons beyond 12 quarters. However, the R^2 never exceeds 2.7%. We conclude that there is very weak evidence that our residual proxies for conditional return volatility.

B. Habits

Second, we consider the possibility that habits are responsible for the discrepancy between consumption innovation moments in the model and the data. If the log surplus consumption ratio follows an AR (1) with coefficient $0 < \phi < 1$ and a sensitivity parameter $\lambda > 0$ that multiplies the consumption growth innovations, then news about consumption is given by:

$$c_{t+1} - E_t c_{t+1} = \frac{1 - \phi\rho}{1 - \phi\rho + \lambda\rho(\phi - 1)} \left\{ (r_{m,t+1} - E_t r_{m,t+1}) + (1 - \sigma)(E_{t+1} - E_t) \sum_{j=1} \rho^j r_{m,t+j+1} \right\}$$

See appendix section B.6 for the derivation. The implied covariance between consumption innovations and return innovations is:

$$V_{c,m} = \frac{1 - \phi\rho}{1 - \phi\rho + \lambda\rho(\phi - 1)} (V_{m,m} + (1 - \sigma)V_{m,h^m}).$$

Clearly, the habit cannot fix the correlation puzzle because $\phi < 1$, which makes the first term larger than 1. The puzzle in a model with habits is even larger.

C. Heterogeneity

Finally, we argue that allowing for heterogeneity across agents will only make the puzzles worse. If each household's Euler equation is satisfied, aggregation across heterogeneous households is straightforward as long as all of the households share the same *EIS*. Because of the linearity, aggregation reproduces exactly equation (4) for aggregate consumption innovations. The previous results go through trivially. However, if household wealth and the *EIS* are positively correlated, then the aggregate *EIS* that shows up in the aggregate consumption innovation expression exceeds the average *EIS* across households. Vissing-Jorgensen (2002) indeed finds higher *EIS* for wealthier stock- and bond-holders. A higher aggregate *EIS* worsens the consumption volatility and correlation puzzles. Alternatively, think of the consumption process we backed out of Model 1 as that of a stock- or bond-holder rather than the aggregate consumption process. Because these investors are found to have higher *EIS*, this worsens the puzzle.

As it stands, Model 1 simply cannot replicate the consumption moments. The next section brings human wealth into the model. In a first step, we keep the human wealth share constant (section V); in a second step, we allow it to vary over time (section B).

D. Housing Wealth

As a last robustness check, we augment the model for a third source of wealth besides financial wealth and human wealth: housing wealth. Consumption c is now non-durable and services consumption *excluding* housing services. We solve the model with constant and time-varying human wealth share. Appendix C describes the derivation and data in more detail. We find that the human wealth ‘residual’ does not proxy for housing wealth. Rather, the properties of consumption-consistent human wealth returns look very similar in the models with and without housing wealth. Our main conclusions go through: To match consumption moments, human wealth returns must be negatively correlated with financial wealth returns (see Table in appendix D). Since human wealth is such a large share of total wealth, the implied market return remains negatively correlated with financial asset returns. In addition, human wealth returns and the market return are also negatively correlated with housing returns.

VIII. Discussion

From the perspective of a standard growth model, the volatility of consumption innovations relative to that of return innovations and their correlation with return innovations are much too small, even if the single agent is very reluctant to substitute consumption over time. We propose that the resolution of these puzzles lies in the behavior of human wealth returns.

In a standard single agent model with financial wealth and human wealth, returns on human wealth need to be negatively correlated with returns on financial assets in order to generate a consumption process that is consistent with the data. A key question remains: what drives this negative correlation?

The data suggest a *cash-flow channel*. Our firm value data in the last two rows of panel A in Table I show a negative correlation between both current and expected future growth rates of pay-outs to employees and to securities holders. Similarly, dividend growth on stocks only has a very small positive correlation with labor income growth (Table I).

Where does this low or even negative correlation between pay-outs to employees and securities’ holders come from? The rate of job creation plays a key role. We include the National Association of Purchasing Managers’ employment diffusion index in our VAR, following Malloy, Moskowitz, & Vissing-Jorgensen (2005). They show this measure predicts labor income growth. Indeed, table XII in appendix D shows that the R^2 on the Δy equation increases from 25% to 44%. We compute the innovations to the diffusion index and find that they have a correlation of 0.6 with news about future labor income growth (.53 with stock returns instead of firm value returns). In contrast, the correlation coefficient between the diffusion index and news about future dividend growth is around -.3 (.01 for stock returns). Clearly, an increase in the rate of job creation increases future labor income growth, but has a negative effect on future dividend growth. This stylized fact represents a challenge for standard business cycle models. Lustig, VanNieuwerburgh, & Syverson (2005) develop a model that can deliver these stylized facts. The model is motivated by a closely related

piece of empirical evidence, that the labor revenue share increases and the capital revenue share decreases when the total factor productivity dispersion increases within an industry. In our model, such an increase in dispersion leads to labor reallocation.

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A. Appendix

A. Data Appendix: Returns on Firm Value

This computation is based on Hall (2001). The data to construct our measure of returns on firm value were obtained from the Federal Flow of Funds (Federal Reserve Board of Governors, downloadable at www.federalreserve.gov/releases/z1/current/data.htm). The data are for non-farm, non-financial business. We extracted the stock data from `ltabs.zip`. The Coded Tables provide more information about the codes used in the Flow of Funds accounts. A complete description is available in the Guide to the Flow of Funds Accounts. We calculated the value of all securities as the sum of financial liabilities (144190005), the market value of equity (1031640030) less financial assets (144090005), adjusted for the difference between market and book for bonds. The subcategories unidentified miscellaneous assets (113193005) and liabilities (103193005) were omitted from all of the calculations. These are residual values that do not correspond to any financial assets or liabilities. We correct for changes in the market value of outstanding bonds by applying the index of corporate bonds to the level of outstanding corporate bonds at the end of the previous year. The Dow Jones Corporate Bond Index is available from Global Financial Data. We measured the flow of pay-outs as the flow of dividends (10612005) plus the interest paid on debt (net interest series from NIPA, see Gross Product of non-financial, corporate business.) less the increase in the volume of financial liabilities (10419005), which includes issues of equity (103164003).

B. Notation and Model Details

$$\begin{aligned}
 V_a &= V[r_{t+1}^a - E_t[r_{t+1}^a]] \\
 V_{dy} &= V[(E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta y_{t+1+j}] \\
 V_h^a &= V[(E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{t+1+j}^a] \\
 Corr_{a,h^a} &= Corr[r_{t+1}^a - E_t[r_{t+1}^a], (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{t+1+j}^a] \\
 Corr_{a,dy} &= Corr[r_{t+1}^a - E_t[r_{t+1}^a], (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta y_{t+1+j}] \\
 Corr_{h^a,dy} &= Corr[(E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta y_{t+1+j}, (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{t+1+j}^a]
 \end{aligned}$$

News to future expected returns on human wealth, $(h^y)_t$, is an unobservable to the econometrician. The

following moments of $(h^y)_t$ will play a crucial role in the exercise:

$$\begin{aligned}
V_{h^y} &= V[(E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{t+1+j}^y] \\
Corr_{a,h^y} &= Corr[r_{t+1}^a - E_t[r_{t+1}^a], (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{t+1+j}^y] \\
Corr_{d^y,h^y} &= Corr[(E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta y_{t+1+j}, (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{t+1+j}^y] \\
Corr_{h^a,h^y} &= Corr[(E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{t+1+j}^a, (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{t+1+j}^y]
\end{aligned}$$

B.1. Moments of Consumption Innovations with Constant Wealth Shares

We denote the innovations to current consumption growth using $(c)_t$. Using the symbols defined in the text, we get:

$$(c)_t = (1 - \bar{\nu})(a)_t + \bar{\nu}(d^y)_t + (1 - \sigma)(1 - \bar{\nu})(h^a)_t - \sigma\bar{\nu}(h^y)_t. \quad (25)$$

The variance of consumption innovations is readily found as:

$$\begin{aligned}
V_c &= (1 - \bar{\nu})^2 V_a + \bar{\nu}^2 V_{d^y} \\
&\quad + (1 - \sigma)^2 (1 - \bar{\nu})^2 V_{h^a} \\
&\quad + \sigma^2 \bar{\nu}^2 V_{h^y} + 2(1 - \bar{\nu})\bar{\nu} Cor_{a,d^y} \sqrt{V_a} \sqrt{V_{d^y}} \\
&\quad + 2(1 - \sigma)(1 - \bar{\nu})^2 Cor_{a,h^a} \sqrt{V_a} \sqrt{V_{h^a}} \\
&\quad - 2\sigma(1 - \bar{\nu})\bar{\nu} Cor_{a,h^y} \sqrt{V_a} \sqrt{V_{h^y}} + 2(1 - \sigma)(1 - \bar{\nu})\bar{\nu} Cor_{h^a,d^y} \sqrt{V_{d^y}} \sqrt{V_{h^a}} \\
&\quad - 2\sigma\bar{\nu}^2 Cor_{h^y,d^y} \sqrt{V_{d^y}} \sqrt{V_{h^y}} - 2\sigma(1 - \sigma)(1 - \bar{\nu})\bar{\nu} Cor_{h^a,h^y} \sqrt{V_{h^a}} \sqrt{V_{h^y}}.
\end{aligned} \quad (26)$$

Similarly, we derive an expression for $V_{c,a}$, the covariance of consumption with asset return innovations:

$$\begin{aligned}
V_{c,a} &= (1 - \bar{\nu})V_a + \bar{\nu} Cor_{a,d^y} \sqrt{V_a} \sqrt{V_{d^y}} \\
&\quad + (1 - \sigma)(1 - \bar{\nu}) Cor_{a,h^a} \sqrt{V_a} \sqrt{V_{h^a}} - \sigma\bar{\nu} Cor_{a,h^y} \sqrt{V_a} \sqrt{V_{h^y}}.
\end{aligned} \quad (27)$$

Note that $Cor_{a,h^y} > 0$, $Cor_{d^y,h^y} > 0$, and $Cor_{h^a,h^y} > 0$ keep the variance of consumption innovations and the covariance of consumption innovations with financial asset return innovations low. Likewise, a low variance of news in future human capital returns (V_{h^y}) keeps consumption volatility low.

Log Utility The variance of consumption innovations reduces to:

$$\begin{aligned}
V_c &= (1 - \bar{\nu})^2 V_a + \bar{\nu}^2 V_{d^y} + \bar{\nu}^2 V_{h^y} + 2(1 - \bar{\nu})\bar{\nu} \\
&\quad \left(Cor_{a,d^y} \sqrt{V_a} \sqrt{V_{d^y}} - Cor_{a,h^y} \sqrt{V_a} \sqrt{V_{h^y}} \right) - 2\bar{\nu}^2 Cor_{h^y,d^y} \sqrt{V_{d^y}} \sqrt{V_{h^y}},
\end{aligned} \quad (28)$$

while the covariance is given by:

$$V_{c,a} = (1 - \bar{\nu})V_a + \bar{\nu} \left(Cor_{a,d^y} \sqrt{V_a} \sqrt{V_{d^y}} - Cor_{a,h^y} \sqrt{V_a} \sqrt{V_{h^y}} \right). \quad (29)$$

More moments Another moment of interest is the correlation between the innovations in human wealth returns (y) and either innovations in financial asset returns (a) or news in future financial asset returns (h^a). Now go back to equation (9) and take the covariance with current financial asset return innovations:

$$V_{a,y} = Corr_{a,d^y} \sqrt{V_a} \sqrt{V_{d^y}} - Corr_{a,h^y} \sqrt{V_a} \sqrt{V_{h^y}}$$

Likewise, take the covariance with news to future stock market returns:

$$V_{h^a,y} = Corr_{d^y,h^a} \sqrt{V_{d^y}} \sqrt{V_{h^a}} - Corr_{h^a,h^y} \sqrt{V_{h^a}} \sqrt{V_{h^y}}$$

Finally, note that the variance of human capital return innovations is

$$V_y = V_{d^y} + V_{h^y} - 2V_{d^y,h^y}$$

B.2. Time-Varying Wealth Share

Because dp_t^y is a function of the entire state space, so is ν_t . ν_{t+1} is not a linear, but a logistic function of the state. We use a linear specification:

$$\tilde{\nu}_t \equiv \nu_t - \bar{\nu} = D' z_t$$

and we pin down D ($N \times 1$) using a first order Taylor approximation. Let s_t be the labor income share with mean \bar{s} and $w_t = dp_t^y - dp_t$ with mean zero. (The mean of w_t must be zero to be able to use the same linearization constant ρ for human wealth and financial wealth.) We can linearize the logistic function for the human wealth share ν_t from equation (13) using a first order Taylor approximation around ($s_t = \bar{s}, w_t = 0$). We obtain:

$$\begin{aligned} \nu_t(s_t, w_t) &\approx \nu_t(\bar{s}, 0) + \frac{\partial \nu_t}{\partial s_t} \Big|_{s_t=\bar{s}, w_t=0} (s_t - \bar{s}) + \frac{\partial \nu_t}{\partial w_t} \Big|_{s_t=\bar{s}, w_t=0} (w_t), \\ &\approx \bar{s} + (s_t - \bar{s}) - (\bar{s}(1 - \bar{s}))w_t, \\ &\approx s_t - \bar{s}(1 - \bar{s})dp_t^y + \bar{s}(1 - \bar{s})dp_t \end{aligned} \quad (30)$$

The average human wealth share is the average labor income share: $\bar{\nu} = \bar{s}$. If dp_t is the third element of the VAR, $dp_t = e_3' z_t$, and $s_t - \bar{s}$ the sixth, and if $dp_t^y = B' z_t$, then we can solve for D from equation (30) and $\tilde{\nu}_t = D' z_t$:

$$D = e_6 - \bar{s}(1 - \bar{s})B + \bar{s}(1 - \bar{s})e_3. \quad (31)$$

B.3. Sylvester Equations

With the portfolio weights ν_t we can construct consumption innovations according to equation (16). The difficulty is to calculate the terms W_1 and W_2 . We use value function iteration to pin down W_1 and W_2 . Let

$$\begin{aligned} \widetilde{W}_1(z_{t+1}) &= E_{t+1} \sum_{j=1}^{\infty} \rho^j \tilde{\nu}_{t+j} r_{t+1+j}^a \\ \widetilde{W}_1(z_{t+1}) &= \tilde{\nu}_{t+1} E_{t+1} \rho r_{t+2}^a + E_{t+1} \sum_{j=2}^{\infty} \tilde{\nu}_{t+j} \rho^j E_{t+j} r_{t+1+j}^a \\ \widetilde{W}_1(z_{t+1}) &= \tilde{\nu}'_{t+1} \rho e_1' A z_{t+1} + \rho E_{t+1} \sum_{j=2}^{\infty} \tilde{\nu}_{t+j} \rho^{j-1} E_{t+j} r_{t+1+j}^a \\ &= z'_{t+1} D \rho e_1' A z_{t+1} + \rho E_{t+1} \widetilde{W}_1(z_{t+2}) \end{aligned} \quad (32)$$

We can compute a solution to this recursive equation by iterating on it. We posit a quadratic objective function:

$$\widetilde{W}_1(z_{t+1}) = z'_{t+1} P z_{t+1} + d$$

where P solves a matrix Sylvester equation, whose fixed point is found by iterating on:

$$P_{j+1} = R + \rho A' P_j A, \quad (33)$$

starting from $P_0 = 0$, and $R = \rho D e_1' A$. The constant d in the value function equals

$$d = \frac{\rho}{1 - \rho} \text{tr}(P \Sigma)$$

We are interested in:

$$\begin{aligned} W_1(z_{t+1}) &= (E_{t+1} - E_t) \widetilde{W}_1(z_{t+1}) = (E_{t+1} - E_t) [z_{t+1}' P z_{t+1} + d] \\ &= \varepsilon'_{t+1} P \varepsilon_{t+1} - E_t [\varepsilon'_{t+1} P \varepsilon_{t+1}] \\ &= \varepsilon'_{t+1} P \varepsilon_{t+1} - \sum_{i=1}^N \sum_{j=1}^N \Sigma_{ij} P_{ij} \end{aligned}$$

which turns out to be a simple quadratic function of the VAR shocks and the matrix P .

In the same manner we calculate W_2 , replacing R in equation (33) by $S = \rho D C'$. C takes on different values for the three canonical models.

B.4. Market Return

We can now compute innovations to the total market return (m):

$$\begin{aligned} (m)_{t+1} &\equiv r_{t+1}^m - E_t[r_{t+1}^m] \\ &= (\tilde{\nu}_t + \bar{\nu})(r_{t+1}^y - E_t[r_{t+1}^y]) + (1 - \tilde{\nu}_t - \bar{\nu})(r_{t+1}^a - E_t[r_{t+1}^a]) \\ &= (\tilde{\nu}_t + \bar{\nu}) ICY R_{t+1} + (1 - \tilde{\nu}_t - \bar{\nu}) ICAR_{t+1} \\ &= [(\tilde{\nu}_t + \bar{\nu})(e_2' - \rho C')(I - \rho A)^{-1} + (1 - \tilde{\nu}_t - \bar{\nu})e_1'] \varepsilon_{t+1} \end{aligned}$$

and also news in future market returns (h^m):

$$\begin{aligned} (h^m)_{t+1} &\equiv (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{t+1+j}^m \\ &= (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j [(\tilde{\nu}_{t+j} + \bar{\nu}) r_{t+1+j}^y + (1 - \tilde{\nu}_{t+j} - \bar{\nu}) r_{t+1+j}^a] \\ &= \bar{\nu} N F Y R_{t+1} + W_{2,t+1} + (1 - \bar{\nu}) N F A R_{t+1} - W_{1,t+1} \\ &= \rho [\bar{\nu} C' + (1 - \bar{\nu}) e_1' A] (I - \rho A)^{-1} \varepsilon_{t+1} - (\varepsilon'_{t+1} (P - Q) \varepsilon_{t+1}) - q \end{aligned}$$

where the constant $q = \sum_{i=1}^N \sum_{j=1}^N \Sigma_{ij} (P_{ij} - Q_{ij})$.

From the innovations, we back out *realized* human wealth returns and market returns:

$$\begin{aligned} r_{t+1}^y &= (y)_{t+1} + C' z_t \\ r_{t+1}^m &= (m)_{t+1} + (\tilde{\nu}_t + \bar{\nu}) C' z_t + (1 - \tilde{\nu}_t - \bar{\nu}) e_1' A z_t \end{aligned}$$

B.5. Asset Pricing

Using the definition of $(m)_t$ in equation (34),

$$V_{im} = \sum_{k=1}^N [(\tilde{\nu}_t + \bar{\nu})(e_2' - \rho C')(I - \rho A)^{-1} + (1 - \tilde{\nu}_t - \bar{\nu})e_1']_k V_{ik} \quad (34)$$

Likewise, we can define V_{ih} as a linear combination of V_{ik} terms. Recalling the definition of $(h^m)_t$ in equation (34), we note that it contains both linear and quadratic terms in ε . The covariance of return innovations in asset i with the quadratic terms involves third moments of normally distributed variables. They are all zero. The expression for V_{ih} becomes:

$$V_{ih} = \sum_{k=1}^N [\rho [\bar{\nu}C' + (1 - \bar{\nu})e_1' A] (I - \rho A)^{-1}]_k V_{ik} \quad (35)$$

B.6. Habits

Denote the log surplus consumption ratio by sp_t , and assume it follows an AR(1) as in Campbell & Cochrane (1999):

$$sp_{t+1} = \phi sp_t + \lambda(sp_t)(c_{t+1} - E_t c_{t+1}),$$

where $\lambda, \phi > 0$ and $\phi < 1$. Lowercase letters denote logs. The consumption Euler equation is standard for $\theta = 1$:

$$1 = E_t \left[\beta \left\{ \left(\frac{C_{t+1} S p_{t+1}}{C_t S p_t} \right)^{-1/\sigma} R_{m,t+1} \right\}^\theta \right]$$

where $S p_{t+1}$ is the surplus consumption ratio in levels. We do not allow for non-separability of utility in current and future consumption goods.

Taking logs and assuming log-normality produces the following equation:

$$0 = \frac{\theta}{\sigma} \mu_{m,t} - \frac{\theta}{\sigma} (E_t \Delta c_{t+1} + E_t \Delta sp_{t+1}) + \theta E_t r_{m,t+1}$$

where the intercept is time-varying because of sp_t :

$$\begin{aligned} \mu_{m,t} &= \sigma \log \beta + \frac{1}{2} \frac{\theta}{\sigma} \text{var}_t [\Delta c_{t+1} + \Delta sp_{t+1} - \sigma r_{m,t+1}] \\ &= \sigma \log \beta + \frac{1}{2} \frac{\theta}{\sigma} \text{var}_t [\Delta c_{t+1} + (\phi - 1) sp_t + \lambda(sp_t) \Delta c_{t+1} - \sigma r_{m,t+1}] \\ &= \sigma \log \beta + \frac{1}{2} \frac{\theta}{\sigma} \left\{ \begin{array}{l} (1 + \lambda(sp_t))^2 \text{var}_t [\Delta c_{t+1}] \\ -\sigma (1 + \lambda(sp_t)) \text{cov}_t (\Delta c_{t+1}, r_{m,t+1}) \\ + \sigma^2 \text{var}_t r_{m,t+1} \end{array} \right\} \end{aligned}$$

This implies expected consumption growth can be restated as:

$$E_t \Delta c_{t+1} = \mu_{m,t} + \sigma E_t r_{m,t+1} - E_t \Delta sp_{t+1}$$

Since we have already discussed heteroscedasticity in the previous section, we assume that $\lambda(sp_t) = \lambda$ is constant. In that case the the intercept is constant:

$$\mu_m = \sigma \log \beta + \frac{1}{2} \frac{\theta}{\sigma} \left\{ (1 + \lambda)^2 V_c - \sigma (1 + \lambda) V_{cm} + \sigma^2 V_m \right\}$$

This can be substituted back into the consumption innovation equation to produce the following expression:

$$\begin{aligned} c_{t+1} - E_t c_{t+1} &= r_{m,t+1} - E_t r_{m,t+1} + (1 - \sigma) (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{m,t+j+1} \\ &\quad - (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j \Delta sp_{t+1+j} \end{aligned}$$

First, note that $(E_{t+1} - E_t) \Delta sp_{t+1+j} = (\phi - 1) (E_{t+1} - E_t) sp_{t+j}$. Second, note that

$$(E_{t+1} - E_t) sp_{t+1+j} = \lambda \phi^{j-1} (c_{t+1} - E_t c_{t+1}).$$

All of this implies in turn that:

$$\begin{aligned} c_{t+1} - E_t c_{t+1} &= r_{m,t+1} - E_t r_{m,t+1} + (1 - \sigma) (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{m,t+j+1} \\ &\quad - (\phi - 1) (E_{t+1} - E_t) \sum_{j=1}^{\infty} \phi^{j-1} \rho^j \lambda (c_{t+1} - E_t c_{t+1}), \end{aligned}$$

which can be simplified further into:

$$\begin{aligned} c_{t+1} - E_t c_{t+1} &= r_{m,t+1} - E_t r_{m,t+1} + (1 - \sigma) (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{m,t+j+1} \\ &\quad - \frac{(\phi - 1)\lambda\rho}{1 - \phi\rho} (c_{t+1} - E_t c_{t+1}). \end{aligned}$$

Finally, note that

$$1 + \frac{(\phi - 1)\lambda\rho}{1 - \phi\rho} = \frac{1 - \phi\rho + (\phi - 1)\lambda\rho}{1 - \phi\rho},$$

so that

$$c_{t+1} - E_t c_{t+1} = \frac{1 - \phi\rho}{1 - \phi\rho + \lambda\rho(\phi - 1)} \left\{ (r_{m,t+1} - E_t r_{m,t+1}) + (1 - \sigma) (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{m,t+j+1} \right\}$$

The implied covariance between consumption innovations and return innovation follows immediately from this expression.

C. Model with Housing Wealth

This appendix augments the model to include housing wealth. We re-derive the consumption innovation equations in the case of constant and time-varying wealth shares. The moments of the data are somewhat changed when the returns on housing are included into the VAR. However, our main results continue to hold. We conclude that the residual does not capture housing wealth, rather it captures human wealth.

Budget Constraint The representative agent's budget constraint is:

$$W_{t+1} = R_{t+1}^m (W_t - C_t - P_t^h H_t) = R_{t+1}^m \left(W_t - \frac{C_t}{A_t} \right). \quad (36)$$

where P_t^h is the relative price of housing services, C is non-housing consumption, and $A_t = \frac{C_t}{C_t + P_t^h H_t}$ is the non-housing expenditure share. This can be rewritten in logs, denoted by lowercase variables:

$$\Delta w_{t+1} = r_{t+1}^m + \log(1 - \exp(c_t - a_t - w_t)).$$

We follow Campbell (1993) and linearize the budget constraint:

$$\Delta w_{t+1} = k + r_{t+1}^m + \left(1 - \frac{1}{\rho}\right) (c_t - a_t - w_t),$$

where $\rho = 1 - \exp(\overline{c - a - w})$ and k is a linearization constant. A second way of writing the growth rate of wealth is by using the identity:

$$\Delta w_{t+1} = \Delta c_{t+1} - \Delta a_{t+1} + (c_t - a_t - w_t) - (c_{t+1} - a_{t+1} - w_{t+1}).$$

Combining these two expressions, iterating forward, and taking expectations, we obtain the linearized budget constraint (Campbell, 1991):

$$c_{t+1} - E_t c_{t+1} = (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j r_{t+1+j}^m + (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta a_{t+1+j} - (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j \Delta c_{t+1+j} \quad (37)$$

Preferences The representative household has non-separable preferences over housing and non-housing consumption. We model the period utility kernel as CES with intratemporal substitution parameter ε :

$$u(C_t, H_t) = \left[(1 - \alpha)C_t^{\frac{\varepsilon-1}{\varepsilon}} + \alpha H_t^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon-1}}$$

Intertemporal preferences are still of the Epstein-Zin type:

$$U_t = \left((1 - \beta)u(C_t, H_t)^{(1-\gamma)/\theta} + \beta \left(E_t U_{t+1}^{1-\gamma} \right)^{1/\theta} \right)^{\theta/(1-\gamma)},$$

where γ is the coefficient of relative risk aversion and σ is the intertemporal elasticity of substitution, henceforth *IES*. Finally, θ is defined as $\theta = \frac{1-\gamma}{1-(1/\sigma)}$. Special cases obtain when $\varepsilon = 1$ (Cobb-Douglas) and $\varepsilon = \sigma$.

The Euler equation with respect to the market return takes on the form

$$1 = E_t[\exp(sdf_{t+1} + r_{t+1}^m)],$$

where the log stochastic discount factor is:

$$sdf_{t+1} = \theta \log \beta - \frac{\theta}{\sigma} \Delta c_{t+1} - \frac{\theta}{\sigma} \left(\frac{\sigma - \varepsilon}{\varepsilon - 1} \right) \Delta a_{t+1} + (\theta - 1)r_{t+1}^m$$

We then assume that non-housing consumption growth, non-housing expenditure share growth and the market return are conditionally homoscedastic and jointly log-normal. This leads to the consumption Euler equation:

$$E_t \Delta c_{t+1} = \mu_m + \sigma E_t r_{t+1}^m - \left(\frac{\sigma - \varepsilon}{\varepsilon - 1} \right) E_t \Delta a_{t+1}, \quad (38)$$

where μ_m is a constant that includes the variance and covariance terms for non-housing consumption, non-housing expenditure share, and market innovations, as well as the time preference parameter.

Substituting out Consumption Growth We can now substitute equation (38) back into the consumption innovation equation in (37), to obtain an expression with only returns on the right hand side:

$$\begin{aligned} c_{t+1} - E_t c_{t+1} &= r_{t+1}^m - E_t r_{t+1}^m + (1 - \sigma)(E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{t+1+j}^m + \\ &\quad \left(\frac{\sigma - 1}{\varepsilon - 1} \right) (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta a_{t+1+j}, \end{aligned} \quad (39)$$

Innovations to the representative agent's non-housing consumption are determined by (1) the unexpected part of this period's market return (2) the innovation to expected future market returns, and (3) innovations to current and future expenditure share changes. In the realistic parameter region $\sigma < 1$, $\varepsilon < 1$, the last term is more important the more $\sigma < \varepsilon$.

Housing Return Data We 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, series FL155035015). The dividend on aggregate housing is measured as housing services consumption (quarterly flow, from NIPA Table 2.3.5). We construct a log price index p^h by fixing the 1947.I 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.) We construct housing returns from the Campbell-Shiller decomposition:

$$r_{t+1}^h = k + \Delta d_{t+1}^h + (d_t^h - p_t^h) - \rho(d_{t+1}^h - p_{t+1}^h)$$

where ρ 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). We use stock market data to pin down ρ and k : $\rho = \frac{1}{1 + \bar{d}^a - \bar{p}^a} = .9901$ and $k = -\log(\rho) - (1 - \rho)\log(\rho^{-1} - 1) = .0556$. 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. The procedure results in an average quarterly housing return of 2.22% with a standard deviation of 1.30%. For comparison, the log real value weighted CRSP stock market return is 1.92% on average with a standard deviation of 8.26%. the correlation between the two return series is .076.¹³

VAR Additions To keep the state space as small as possible, we define a new variable, $\tilde{r}^a = \varphi r^a + (1 - \varphi)r^h$, which denotes the return on a portfolio of financial assets and housing. The portfolio weight φ is the ratio of financial income (dividends, interest and proprietor's income) to financial income plus housing income (measured by housing services). This weight varies over time and is 0.67 on average. Likewise, we define the log dividend-price ratio $\tilde{d}p^a = \varphi dp^a + (1 - \varphi)dp^h$. The variables \tilde{r}^a and $\tilde{d}p^a$ take the place of r^a and dp^a in the VAR. The labor income share s is defined as the ratio of labor income to total income, where total income consists of labor income, financial income and housing income. To the 7 elements in the VAR without housing we add the log growth rate in the non-housing expenditure share (Δa , element 8). Once the VAR has been estimated, we can construct the new series for news about current and future growth rates on the non-housing expenditure share $\{(d^a)_t\}$:

$$(d^a)_{t+1} = (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta a_{t+1+j} = e'_8 (I - \rho A)^{-1} \varepsilon_{t+1}.$$

The procedure with time-varying wealth shares goes through as in the main text. The expression for consumption innovations with time-varying human wealth share is identical to equation (16), except for the additional term $\frac{\sigma-1}{\varepsilon-1} (d^a)_{t+1}$.

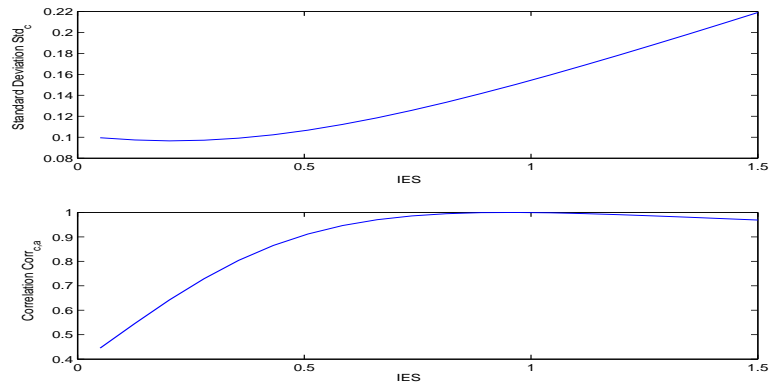
Moments of the Data Table XIII summarizes the moments from the data using the firm value returns and stock returns. The main change with the model without housing is that the combined financial asset - housing return innovations \tilde{r}^a are 33% less volatile than financial assets alone. News about changes in the non-housing expenditure share d^a has a very low variance ($V_{d^a} = 0.08$ compared to $V_c = .34$). This term will play a negligible role in the analysis.

Consumption Growth Accounting The results with time-varying wealth shares are close to the results without housing. Matching the moments of consumption requires financial-housing wealth returns and human wealth returns to be negatively correlated. The resulting market return is negatively correlated with returns on financial-housing wealth, and strongly positively correlated with returns on human wealth. This is true for both measures of financial assets (both panels).

¹³Those numbers are broadly consistent with the small literature on housing returns. Case and Shiller (1989) find that the volatility of house price changes is mostly idiosyncratic. The regional component of housing prices only explains between 7 and 27 percent of individual house price variation for the four cities in their study. They also report a zero correlation between housing returns and stock returns. Regional repeat sales price indices from Freddie Mac for 50 US states between 1976 and 2002 show a low volatility. The median region has a real annual house price appreciation (ex-dividend return) with a standard deviation of 5.1%. Across regions, the volatility varies between 2.4% and 12.8% per year (own calculations). For nation-wide data, the annual volatility of the ex-dividend return is 3.3%.

Figure 9. Matching Moments of Consumption Innovations: Annual Stock Returns

The first panel plots the annual model-implied standard deviation of consumption innovations against the EIS σ , while the second panel plots the model-implied correlation of consumption innovations. The sample is 1947-2004, at annual frequencies. We use the returns on stocks.



The failure of the benchmark models to match the consumption moments derives from a failure to generate $Corr_{a,y} < 0$. Consumption is still much too highly correlated with financial asset returns, but the failure in the consumption variance is less pronounced than before. In sum, the properties of the human wealth process in the model with housing are virtually unaffected, relative to the model without housing.

D. Additional Figures and Tables

Figure 10. The EIS and Consumption Innovation Volatility and Correlation - Using Returns on Firm Value, Quarterly Data 1947-2003

The labor share ν is .70.

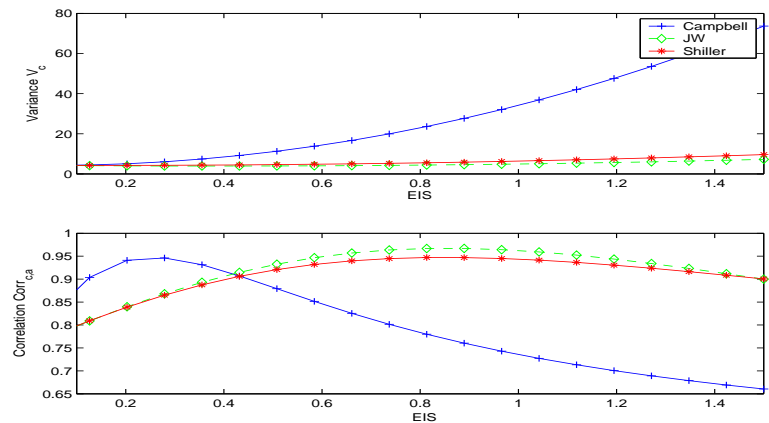


Table VII
VAR Estimation - Using Returns on Value-weighted Stock Market Index

This table reports the results from the VAR estimation for the sample 1947.II-2004.III. The asset return is the return on firm value in panel A and the return on the CRSP value-weighted stock market index in panel B. The rows describe the time t variables and the columns the time $t - 1$ variables). Newey-West HAC standard errors are in parentheses. The VAR contains 7 elements.

| <i>Firm Value Returns</i> | | | | | | | | |
|---------------------------|-------------|------------------|--------------|-------------|-------------|-----------|------------------|-------|
| Variable | r_{t-1}^a | Δy_{t-1} | dp_{t-1}^a | rtb_{t-1} | ysp_{t-1} | s_{t-1} | Δc_{t-1} | R^2 |
| r_t^a | 0.0586 | -0.2325 | 0.0290 | -0.9373 | -0.1186 | -0.1222 | -1.1222 | 6.06 |
| <i>se</i> | (0.0729) | (0.4656) | (0.0216) | (0.5541) | (0.6325) | (0.3086) | (0.8427) | |
| Δy_t | 0.0225 | 0.2690 | -0.0051 | 0.0752 | 0.0871 | -0.0342 | 0.3565 | 27.08 |
| <i>se</i> | (0.0070) | (0.1372) | (0.0034) | (0.0748) | (0.0728) | (0.0462) | (0.1224) | |
| dp_t^a | 0.1024 | -1.4521 | 0.9061 | 2.2013 | 0.5850 | -0.2164 | 1.0603 | 83.01 |
| <i>se</i> | (0.1195) | (0.8278) | (0.0315) | (1.0297) | (0.8820) | (0.4355) | (1.4612) | |
| rtb_t | 0.0125 | 0.1120 | -0.0047 | 0.5667 | 0.1514 | 0.0799 | 0.0775 | 33.91 |
| <i>se</i> | (0.0081) | (0.0648) | (0.0029) | (0.1718) | (0.0675) | (0.0494) | (0.0727) | |
| ysp_t | -0.0045 | -0.1037 | 0.0057 | 0.0708 | 0.8058 | -0.0522 | -0.0190 | 73.09 |
| <i>se</i> | (0.0084) | (0.0506) | (0.0022) | (0.1488) | (0.0504) | (0.0430) | (0.0694) | |
| s_t | -0.0010 | 0.0447 | -0.0012 | -0.0436 | -0.0114 | 0.9731 | 0.0153 | 97.10 |
| <i>se</i> | (0.0027) | (0.0278) | (0.0010) | (0.0319) | (0.0224) | (0.0150) | (0.0313) | |
| Δc_t | 0.0161 | 0.1972 | -0.0023 | -0.0581 | 0.1074 | 0.0714 | -0.0251 | 20.49 |
| <i>se</i> | (0.0054) | (0.0541) | (0.0024) | (0.0468) | (0.0373) | (0.0323) | (0.1239) | |
| <i>Stock Returns</i> | | | | | | | | |
| Variable | r_{t-1}^a | Δy_{t-1} | dp_{t-1}^a | rtb_{t-1} | ysp_{t-1} | s_{t-1} | Δc_{t-1} | R^2 |
| r_t^a | 0.0336 | -0.0317 | 0.0479 | -0.8253 | 0.4970 | -0.1364 | -0.6616 | 7.31 |
| <i>se</i> | (0.0665) | (0.5057) | (0.0209) | (0.7921) | (0.6978) | (0.3721) | (0.8083) | |
| Δy_t | 0.0206 | 0.2844 | -0.0018 | 0.0598 | 0.0450 | -0.0246 | 0.3577 | 25.97 |
| <i>se</i> | (0.0067) | (0.1330) | (0.0025) | (0.0771) | (0.0640) | (0.0464) | (0.1255) | |
| dp_t^a | 0.0532 | 0.5213 | 0.9728 | 1.3571 | -0.0181 | 0.0971 | 0.5055 | 93.17 |
| <i>se</i> | (0.0635) | (0.5221) | (0.0170) | (0.8219) | (0.6439) | (0.3537) | (0.8258) | |
| rtb_t | 0.0153 | 0.1316 | 0.0008 | 0.5591 | 0.1232 | 0.1013 | 0.0956 | 33.38 |
| <i>se</i> | (0.0082) | (0.0659) | (0.0024) | (0.1686) | (0.0549) | (0.0494) | (0.0710) | |
| ysp_t | -0.0074 | -0.1295 | -0.0014 | 0.0854 | 0.8384 | -0.0776 | -0.0495 | 72.47 |
| <i>se</i> | (0.0076) | (0.0541) | (0.0020) | (0.1486) | (0.0445) | (0.0443) | (0.0679) | |
| s_t | 0.0001 | 0.0484 | -0.0011 | -0.0481 | -0.0238 | 0.9722 | 0.0082 | 97.11 |
| <i>se</i> | (0.0022) | (0.0272) | (0.0008) | (0.0317) | (0.0215) | (0.0149) | (0.0321) | |
| Δc_t | 0.0140 | 0.1996 | -0.0033 | -0.0669 | 0.0782 | 0.0652 | -0.0473 | 21.68 |
| <i>se</i> | (0.0046) | (0.0545) | (0.0017) | (0.0478) | (0.0372) | (0.0276) | (0.1260) | |

Table VIII
Moments from Data: Different Income Measures

The left column uses pay-outs to employees of non-farm, non-financial corporate firms as the measure of labor income. The labor income share is defined as the ratio of pay-outs to employees to the sum of pay-outs to employees and pay-outs to securities holders. The mean in the sample 1947.II-2004.III is 0.92 (compared to 0.73 in the benchmark model). The second column uses labor income plus proprietors' income to all employees (BEA). When we include proprietor's income to y , the average labor income share is 0.84 (compared to 0.73 without proprietor's income). The asset return is the return on firm value. The moments for quarterly data are from own calculations for the 1947.II-2004.III. All other symbols are as in Table I.

| <i>Moments</i> | <i>Non-Fin. Business</i> | <i>With Proprietor's Income</i> |
|-----------------|--------------------------|---------------------------------|
| V_a | 47.22 | 48.33 |
| V_{dy} | 4.18 | 2.02 |
| V_{h^a} | 27.82 | 22.71 |
| $Corr_{a,h^a}$ | -.622 | -.532 |
| $Corr_{a,dy}$ | .334 | .280 |
| $Corr_{dy,h^a}$ | -.625 | -.467 |
| $Corr_{dy,d^d}$ | -.184 | -.047 |
| $Corr_{fy,fd}$ | -.016 | -.058 |
| V_c | .346 | .340 |
| $Corr_{c,a}$ | .196 | .157 |

Table IX
Moments for Consumption Growth and Human Capital Returns - Constant Wealth Shares - Annual Data

Same as table II, but the computations are done for *annual data* over the same period 1947-2004. The parameters are $\bar{\nu} = .7000$ and $\sigma = .2789$.

| <i>Moments</i> | <i>Campbell</i> | <i>Shiller</i> | <i>JW</i> | <i>Reverse</i> | <i>Campbell</i> | <i>Shiller</i> | <i>JW</i> | <i>Reverse</i> |
|------------------|------------------------------------|----------------|-----------|----------------|-------------------------------|----------------|-----------|----------------|
| | <i>Panel A: Firm Value Returns</i> | | | | <i>Panel B: Stock Returns</i> | | | |
| V_{h^y} | 47.44 | 0 | 2.83 | 513.56 | 231.85 | 0 | 1.94 | 375.48 |
| $Corr_{a,h^y}$ | -.487 | 0 | .861 | .956 | -.760 | 0 | .693 | .690 |
| $Corr_{dy,h^y}$ | -.818 | 0 | .676 | .529 | -.196 | 0 | .767 | .579 |
| $Corr_{h^a,h^y}$ | 1.000 | 0 | -.501 | -.307 | 1.000 | 0 | -.285 | -.114 |
| V_y | 83.20 | 6.67 | 3.62 | 458.28 | 254.55 | 6.95 | 3.25 | 323.25 |
| $Corr_{y,a}$ | .526 | .559 | -.003 | -.945 | .780 | .329 | -.055 | -.696 |
| $Corr_{y,h^a}$ | -.987 | -.818 | -.666 | .226 | -.987 | -.196 | -.066 | .095 |
| V_c | 27.19 | 20.07 | 17.55 | .68 | 28.54 | 15.99 | 14.04 | .64 |
| $Corr_{c,a}$ | .963 | .975 | .975 | .163 | .943 | .695 | .691 | .208 |
| V_m | 83.50 | 24.63 | 15.25 | 125.62 | 229.92 | 26.54 | 18.65 | 98.37 |
| $Corr_{m,a}$ | .784 | .949 | .934 | -.899 | .876 | .935 | .952 | -.411 |
| $Corr_{m,y}$ | .940 | .792 | .354 | .993 | .985 | .641 | .252 | .941 |
| $Corr_{m,h^m}$ | -.915 | -.670 | -.169 | -.997 | -.969 | -.691 | -.587 | -.997 |

Table X
Moments for Consumption Growth and Human Capital Returns - Model 5 -
Sensitivity to *EIS*.

The table reports the same moments as Table II. All results are for Model 5 with time-varying human wealth share. The first column is for $\sigma = .5$, the second column is for $\sigma = 1$, and the last column is for $\sigma = 1.5$. The sample is 1947.II-2004.III. Financial asset returns are firm value returns in panel A and stock returns in panel B.

| <i>Moments</i> | $\sigma = .5$ | $\sigma = 1$ | $\sigma = 1.5$ | $\sigma = .5$ | $\sigma = 1$ | $\sigma = 1.5$ |
|-----------------|------------------------------------|--------------|----------------|-------------------------------|--------------|----------------|
| | <i>Panel A: Firm Value Returns</i> | | | <i>Panel B: Stock Returns</i> | | |
| V_{hy} | 24.36 | 8.59 | 5.91 | 18.10 | 12.58 | 11.81 |
| $Corr_{a,hy}$ | .941 | .967 | .914 | .791 | .956 | .978 |
| $Corr_{dy,hy}$ | .466 | .561 | .604 | .751 | .704 | .643 |
| $Corr_{h^a,hy}$ | -.280 | -.588 | -.757 | -.512 | -.809 | -.905 |
| V_y | 20.14 | 6.02 | 3.79 | 11.55 | 7.82 | 7.79 |
| $Corr_{y,a}$ | -.940 | -.980 | -.922 | -.805 | -.987 | -.978 |
| $Corr_{y,h^a}$ | .159 | .430 | .603 | .515 | .872 | .960 |
| V_c | .33 | .33 | .333 | .33 | .33 | .41 |
| $Corr_{c,a}$ | .168 | .168 | .168 | .185 | .185 | .185 |
| V_m | 3.12 | .33 | .82 | 2.21 | .33 | .66 |
| $Corr_{m,a}$ | -.719 | .168 | .614 | .032 | .185 | .188 |
| $Corr_{m,y}$ | .895 | -.036 | -.318 | .546 | -.116 | -.056 |
| $Corr_{m,h^m}$ | -.947 | .199 | .779 | -.925 | -.052 | .625 |

Table XI
Moments for Consumption Growth and Human Capital Returns - Model 5 -
Sensitivity to Income Measures

The left column includes proprietor's income. The right column uses pay-outs to employees of non-financial corporate business. All results are for the full sample 1947.II-2004.III. Computations are done for time-varying wealth share and $\sigma = .2789$. Financial asset returns are returns on total firm value.

| <i>Moments</i> | <i>model</i> | <i>data</i> | <i>model</i> | <i>data</i> |
|-----------------|---------------------|-------------|-------------------|-------------|
| | Proprietor's Income | | Non-Fin. Business | |
| V_{hy} | 30.58 | | 33.44 | × |
| $Corr_{a,hy}$ | .828 | | .628 | × |
| $Corr_{dy,hy}$ | .643 | | .937 | × |
| $Corr_{h^a,hy}$ | -.346 | | -.720 | × |
| $Corr_{y,a}$ | -.882 | | -.751 | × |
| $Corr_{y,h^a}$ | .264 | | .733 | × |
| V_y | 22.49 | | 15.46 | × |
| V_c | .340 | .340 | .346 | .346 |
| $Corr_{c,a}$ | .157 | .157 | .196 | .196 |
| V_m | 9.49 | | 10.29 | × |
| $Corr_{m,a}$ | -.783 | | -.654 | × |
| $Corr_{m,y}$ | .981 | | .988 | × |
| $Corr_{m,h^m}$ | -.984 | | -.992 | × |

Table XII
VAR Estimation

This table reports the results from the VAR estimation for the sample 1947.II-2004.III. The asset return is the return on firm value in panel A and the return on the CRSP value-weighted stock market index in panel B. The rows describe the time t variables and the columns the time $t - 1$ variables. Newey-West HAC standard errors are in parentheses. The VAR contains 7 elements. The 7th element is the employment NAPM diffusion index ($Diff_t^{NAPM}$).

| | | <i>Firm Value Returns</i> | | | | | | | |
|-----------------|-------------------|---------------------------|-------------------|-------------------|-------------------|-------------------|---------------------|-------|--|
| Variable | r_{t-1}^a | Δy_{t-1} | dp_{t-1}^a | rtb_{t-1} | $yspt_{t-1}$ | s_{t-1} | $Diff_{t-1}^{NAPM}$ | R^2 | |
| r_t^a | 0.042 [0.071] | -0.276 [0.605] | 0.027 [0.024] | -0.735 [0.579] | -0.144 [0.643] | -0.206 [0.315] | -0.076 [0.103] | 5.70 | |
| Δy_t | 0.026 [0.008] | 0.029 [0.129] | -0.003 [0.003] | -0.182 [0.072] | 0.036 [0.063] | -0.057 [0.039] | 0.087 [0.016] | 43.29 | |
| dp_t^a | 0.124 [0.119] | -0.028 [0.914] | 0.899 [0.033] | 3.074 [1.115] | 0.922 [0.864] | 0.078 [0.404] | -0.271 [0.136] | 83.41 | |
| rtb_t | 0.014 [0.008] | -0.030 [0.061] | -0.003 [0.003] | 0.415 [0.193] | 0.112 [0.074] | 0.077 [0.049] | 0.046 [0.018] | 39.15 | |
| $yspt_t$ | -0.005 [0.008] | 0.015 [0.055] | 0.004 [0.002] | 0.188 [0.177] | 0.839 [0.055] | -0.047 [0.042] | -0.035 [0.015] | 74.87 | |
| s_t | -0.001 [0.003] | 0.014 [0.034] | -0.001 [0.001] | -0.072 [0.044] | -0.022 [0.022] | 0.960 [0.016] | 0.009 [0.006] | 97.33 | |
| $Diff_t^{NAPM}$ | 0.195 [0.053] | 0.447 [0.499] | -0.013 [0.020] | -0.250 [0.546] | 0.897 [0.404] | 0.423 [0.252] | 0.759 [0.072] | 64.81 | |
| | | <i>Stock Returns</i> | | | | | | | |
| Variable | r_{t-1}^a | Δy_{t-1} | dp_{t-1}^a | rtb_{t-1} | $yspt_{t-1}$ | s_{t-1} | $Diff_{t-1}^{NAPM}$ | R^2 | |
| r_t^a | 0.031 [0.066] | 0.177 [0.665] | 0.049 [0.022] | -0.484 [0.837] | 0.536 [0.702] | -0.138 [0.379] | -0.110 [0.110] | 7.65 | |
| Δy_t | 0.020 [0.007] | 0.037 [0.130] | -0.002 [0.002] | -0.195 [0.070] | 0.008 [0.063] | -0.054 [0.040] | 0.086 [0.015] | 41.98 | |
| dp_t^a | 0.052 [0.063] | 0.102 [0.649] | 0.973 [0.018] | 0.799 [0.834] | -0.103 [0.630] | 0.101 [0.357] | 0.166 [0.104] | 93.18 | |
| rtb_t | 0.015 [0.008] | -0.018 [0.061] | 0.001 [0.002] | 0.409 [0.185] | 0.098 [0.060] | 0.093 [0.049] | 0.047 [0.018] | 38.99 | |
| $yspt_t$ | -0.007 [0.007] | -0.002 [0.055] | -0.002 [0.002] | 0.207 [0.174] | 0.860 [0.048] | -0.069 [0.044] | -0.038 [0.016] | 74.57 | |
| s_t | -0.001 [0.002] | 0.016 [0.034] | -0.001 [0.001] | -0.078 [0.044] | -0.032 [0.022] | 0.960 [0.016] | 0.010 [0.006] | 97.33 | |
| $Diff_t^{NAPM}$ | 0.189 [0.037] | 0.486 [0.476] | -0.006 [0.014] | -0.204 [0.506] | 0.791 [0.296] | 0.477 [0.250] | 0.751 [0.066] | 65.23 | |

Table XIII
Moments from Data - Model With Housing

This Table has the same structure as Table I, except that a and h^a pertain to the return on a portfolio of financial asset returns and housing returns. In the left panel, the financial asset returns in the portfolio are firm value returns; in the right column they are stock returns.

| <i>Moments</i> | <i>Firm Value Returns</i> | <i>Stock Returns</i> |
|------------------|---------------------------|----------------------|
| V_a | 21.69 | 28.81 |
| V_{d^y} | 1.82 | 1.79 |
| V_{h^a} | 12.99 | 49.31 |
| $Corr_{a,h^a}$ | -.511 | -.910 |
| $Corr_{a,d^y}$ | .280 | .411 |
| $Corr_{d^y,h^a}$ | -.463 | -.210 |
| V_c | 0.343 | 0.337 |
| $Corr_{c,a}$ | 0.175 | 0.186 |
| $Corr_{d^d,d^y}$ | -.087 | .236 |
| $Corr_{f^d,f^y}$ | -.076 | .184 |

Table XIV
Moments for Consumption Growth, Human Capital Returns, and the Market Return - Model With Housing.

This Table has the same structure as Table D, except that a and h^a pertain to the return on a portfolio of financial asset returns and housing returns. Computations are done for the model with time-varying human wealth share. The *EIS* is $\sigma = .2789$ and the intratemporal elasticity of substitution between housing and non-housing consumption is $\varepsilon = 0.5$.

| <i>Moments</i> | <i>Panel A: Firm Value Returns</i> | | | | <i>Panel B: Stock Returns</i> | | | |
|------------------|------------------------------------|----------------|----------------|----------------|-------------------------------|----------------|----------------|----------------|
| | <i>Model 2</i> | <i>Model 3</i> | <i>Model 4</i> | <i>Model 5</i> | <i>Model 2</i> | <i>Model 3</i> | <i>Model 4</i> | <i>Model 5</i> |
| V_{h^y} | 12.99 | 0 | .53 | 59.28 | 49.31 | 0 | .64 | 35.58 |
| $Corr_{a,h^y}$ | -.511 | 0 | .400 | .888 | -.910 | 0 | .598 | .640 |
| $Corr_{d^y,h^y}$ | .463 | 0 | .817 | .446 | -.210 | 0 | .782 | .869 |
| $Corr_{h^a,h^y}$ | 1.000 | 0 | -.296 | -.215 | 1.000 | 0 | -.368 | -.328 |
| V_y | 19.32 | 1.82 | .75 | 51.82 | 55.05 | 1.79 | .75 | 23.51 |
| $Corr_{y,a}$ | .505 | .280 | .101 | -.897 | .936 | .411 | .081 | -.673 |
| $Corr_{y,h^a}$ | -.962 | -.463 | -.474 | .143 | -.984 | -.210 | .016 | .345 |
| V_c | 3.73 | 2.73 | 2.44 | .343 | 4.78 | 2.16 | 1.81 | .337 |
| $Corr_{c,a}$ | .908 | .856 | .869 | .175 | .930 | .597 | .583 | .186 |
| V_m | 15.67 | 4.04 | 2.94 | 12.93 | 44.12 | 5.40 | 3.80 | 6.12 |
| $Corr_{m,a}$ | .765 | 0.896 | .935 | -.799 | .966 | .928 | .940 | -.213 |
| $Corr_{m,y}$ | .941 | 0.671 | .435 | .980 | .995 | .709 | .387 | .857 |
| $Corr_{m,h^m}$ | -.916 | -.603 | -.432 | -.991 | -.976 | -.774 | -.718 | -.984 |

Figure 11. The Labor Share and Consumption Innovation Volatility and Correlation - Using Returns on Firm Value, Quarterly Data 1947-2003
 The *EIS* σ is .28.

