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. 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)).

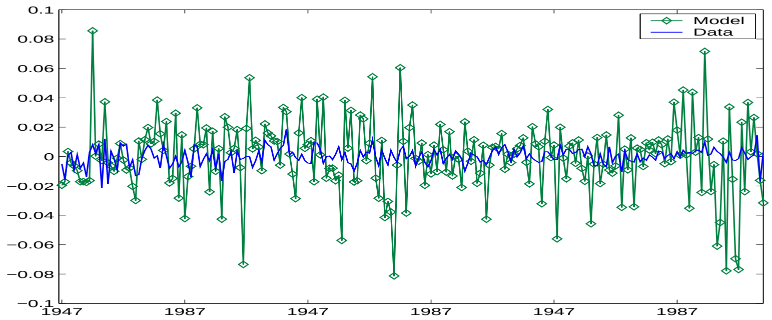
If her portfolio only includes financial wealth, the model-implied consumption innovations are radically different from those in the data. The agent's consumption innovations are at least eight times too volatile relative to US aggregate consumption innovations and the implied correlation of her consumption 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, but 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 (PDV) 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 PDV 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. Following

Figure 1. *Campbell* Model-Implied and Actual Consumption Innovations
The labor income share is .7 and the EIS is .27. The sample is 1947.I-2004.IV.



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)), but we do not observe the returns on human wealth. 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 (Jagannathan & Wang (1996) and Shiller (1993)) do better, but still over-predict the volatility of consumption innovations and their correlation with news about financial returns (section V.B).

In a second step, we conduct a basic *consumption growth accounting* exercise (section V.C). 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 *EIS*, and (2) the implied total market return is negatively correlated with the returns on financial wealth, at least 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 tends 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.

The negative correlation between the discount rates on these two assets is not surprising (see Santos & Veronesi (2004)). In a two-tree Lucas endowment economy with i.i.d dividend growth, the expected return on the first tree increases when its dividend share increases, and in the log case, the expected return on the second tree has to decrease, because the market price/dividend ratio is constant(Cochrane, Longstaff, & Santa-Clara (2004)).

In a third step, we generalize the exercise and allow for time-varying wealth shares (section VI). We estimate a linear factor model, i.e. the expected return on human wealth is a linear function of the state, by minimizing the distance between the consumption innovation moments in the model and the data. These estimates corroborate our earlier findings. 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 consider human wealth returns (section VII). Growth stocks provide better insurance against future human capital and they trade at a premium.

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 findings represent 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)). There is also an emerging consensus among macroeconomists that the *EIS* is much lower than one, because aggregate consumption growth hardly responds to large changes in real interest rates (Hall (1988)), and our work provides more evidence.

Other Explanations We attribute the residual of aggregate consumption growth to human wealth returns, but other explanations come to mind. In the paper, we consider three in detail. First, if the agent's preferences display habit formation, the volatility puzzle can be resolved, but the correlation puzzle cannot unless through heteroskedasticity 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. Finally, we argue that heterogeneity makes matters worse, if anything, because stock and bond holders seem to have a higher *EIS*.

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.

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 ought to predict stock returns, and it does. 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[1].

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.

[1]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.

A. Preferences

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

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

where γ is the coefficient of relative risk aversion and σ is the intertemporal elasticity of substitution, henceforth IES. Finally, θ is defined as $\theta = \frac{1-\gamma}{1-(1/\sigma)}$. 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^m_{t+1} is the gross return on wealth invested from t to $t+1$. This representative agent's budget constraint is:

$$W_{t+1} = R^m_{t+1} \left(W_t - C_t \right). \tag{1}$$

Our single agent takes the returns on the market $\{R^m_t\}$ 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 $\{R^m_t\}$ 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 $\lim_{j \to \infty} \rho^j (c_{t+j} - w_{t+j}) = 0$, this approximation implies that:

$$c_{t+1} - E_t c_{t+1} = (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j r^m_{t+1+j} - (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j \Delta c_{t+1+j}, \tag{2}$$

where $r^m = \log(1 + R^m)$ and ρ is defined as $1 - exp(c - w)$. Innovations to consumption today reflect innovations to current and future expected returns, and innovations to future expected consumption growth. Consumption and returns are assumed to be conditionally homoscedastic and jointly lognormal.

Second, Campbell substitutes the consumption Euler equation:

$$E_t \Delta c_{t+1} = \mu_m + \sigma E_t r^m_{t+1}, \tag{3}$$

where μ_m is a constant that includes some 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:

$$c_{t+1} - E_t c_{t+1} = r^m_{t+1} - E_t r^m_{t+1} + (1 - \sigma)(E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r^m_{t+1+j}, \tag{4}$$

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, the case we will focus on, she chooses to increase her consumption.

Campbell (1993) uses the consumption innovation equation in (4) to do asset pricing without aggregate consumption. This is not without loss of generality because equation (4) puts tight restrictions on the joint distribution of aggregate consumption innovations and total wealth return innovations. Our aim is to reintroduce aggregate consumption. 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:

$$(E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j r^m_{t+1+j} = (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta c_{t+1+j}, \tag{5}$$

The force of this restriction is that it does not depend on the preferences at all; we only used the budget constraint to derive it, not the Euler equation. When we back out a process for human wealth returns that matches aggregate consumption innovations, we will check whether the news about the PDV of consumption growth in the data and the news about the discounted value of future market returns 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: $R^a_{t+1} = \frac{P_{t+1}+D_{t+1}}{P_t}$, 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

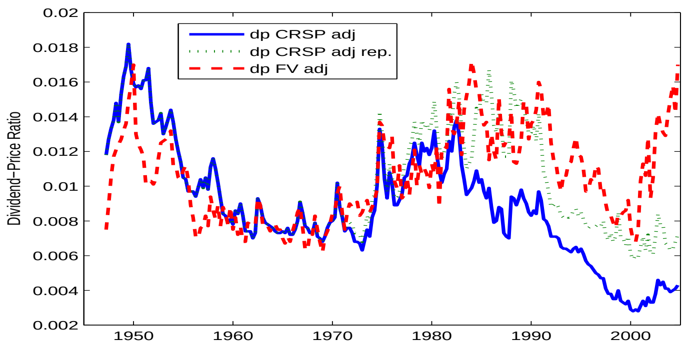
$$dp^a_t = \log\left(\frac{.25D_t + .25D_{t-1} + .25D_{t-2} + .25D_{t-3}}{P_t}\right).$$

The full line in figure 2 shows the dividend-price ratio, $\exp(dp^a_t)$. 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 we 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 (own computations). Over the last two decades, the dividend yield for the firm-value measure has been much higher than the dividend yield on stocks. This

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



is consistent with the findings of Hall (2001). The firm value dividend yield completely 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^a_{t+1}), real per capita labor income growth (Δy_{t+1}), and three return predictors: the log dividend yield on financial assets (dp^a_{t+1}), 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 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 XI 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 $\{(h^y)_t\}$:

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

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), and using the firm value returns as the measure of financial asset 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

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

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%; the same number for consumption is 1.15% (V_a versus V_c). News about future firm value returns is also volatile. In annualized terms, the standard deviation is 11 percent (V_{h^a}).

- Consumption innovations and return innovations are only weakly correlated: $Corr_{c,a} = 0.17$.

- Current return innovations are negatively correlated with news about future expected returns: there is strong (multivariate) mean reversion in returns on firm value ($Corr_{a,h^a}$).

- News about future dividend growth and news about future labor income growth are negatively correlated ($Corr_{d^y,d^d}$). News about current labor income growth and current dividend growth are not correlated or negatively correlated ($Corr_{f^y,f^d}$).

The first four facts are well-documented (at least for stock returns); the last two are not. These facts indicate that good cash flow news for securities holders may not necessarily be good cash flow news for workers. All of these stylized facts are robust. Including additional forecasting variables in the VAR does not affect these moments much.

Different Income Measures 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 and salaries to government employees. We investigate the robustness of the stylized facts to alternative income measures. The left column of II uses a measure of pay-outs to employees of non-financial corporate businesses. This measure is consistent with our measure of pay-outs to securities holders of non-financial corporate business. 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

[3]Our 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. The asset return is the return on firm value. The first column reports results for a 1-lag VAR. The second column reports results for a 2-lag VAR over the full sample. The third column reports the results for annual data (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.

Moments	*1 Lag*	*2 Lags*	*Annual*
V_a	48.32	47.74	185.12
V_{d^y}	1.61	1.90	6.67
V_{h^a}	32.74	32.97	47.44
$Corr_{a,h^a}$	-.478	-.625	-0.487
$Corr_{a,d^y}$	.337	.377	0.599
$Corr_{d^y,h^a}$	-.526	-.656	-0.818
$Corr_{d^y,d^d}$	-.102	-.209	0.166
$Corr_{f^y,f^d}$	-.092	-.081	-0.259
V_c	.333	.325	0.681
$Corr_{c,a}$	.168	.168	0.163

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 of Table II lists the results if we include proprietor's income (from the BEA) into the labor income measure. When we include proprietor's income to y, the average labor income share is 0.84 (compared to 0.73 without proprietor's income). Most moments are virtually unchanged. The correlation between innovations to current financial returns and future labor income growth is lower than before ($Corr_{a,d^y}$), and the correlation between future financial returns and news about future labor income growth is more negative ($Corr_{d^y,h^a}$). Both of these will deepen the puzzle in the standard model.

Stock Market Returns When we use stock market returns instead of the our measure of the return on a claim to US non-financial firms, we obtain very similar results. Table III shows that the innovations to stock market returns are slightly more volatile (around 15 percent at annualized rates), and more mean-reverting: $Corr_{a,h^a}$ is -.92; the same moment is about -.48 for the returns on firm value. News about future stock market returns is much more volatile than news about future firm value returns. In addition,

Table II
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 second column uses labor income plus proprietors' income to all employees (BEA). 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.

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

the correlation between news about dividend and labor income growth (both current and future) is weakly positive for stock market returns, instead of weakly negative.

D. Two Key Consumption Moments

We can back out the model-implied moments of the consumption innovation process from the expression for the consumption innovations in (4). We focus on two moments in particular: the variance of consumption innovations and their correlation with innovations to the current market return.

From equation (4), it follows that the variance of consumption innovations $V_c = var(c_{t+1} - E_t c_{t+1})$ is given by:

$$V_c = V_m + (1-\sigma)^2 V_{h^m} + 2(1-\sigma)V_{m,h^m},$$

while the covariance of consumption with current return innovations $V_{c,m} = cov(c_{t+1} - E_t c_{t+1}, r^m_{t+1} - E_t r^m_{t+1})$ is:

$$V_{c,m} = V_m + (1-\sigma)V_{m,h^m}.$$

Table III
Moments from Data: Stock Returns

The asset return is the return on the CRSP value-weighted stock index. The sample covers 1947.II-2004.III. The second column reports results for a 2-lag VAR over the full sample. The third column reports the results for annual data (1947-2004). All other symbols are as in Table I.

Moments	*1 Lag*	*2 Lags*	*Annual*
V_a	63.54	62.74	242.96
V_{d^y}	1.65	1.92	6.95
V_{h^a}	103.07	98.37	231.85
$Corr_{a,h^a}$	-.918	-.805	-0.76
$Corr_{a,d^y}$	.491	.473	0.329
$Corr_{d^y,h^a}$	-.336	-.208	-0.196
$Corr_{d^y,d^d}$	.118	.286	0.200
$Corr_{f^y,f^d}$	.173	.114	0.139
V_c	.328	.321	0.6422
$Corr_{c,a}$	.185	.175	0.208

Variance In the log case ($\sigma = 1$), consumption responds one-for-one to current return innovations, and the variance of consumption innovations is the variance of news about current market returns. As the *EIS* decreases below 1, consumption absorbs part of the volatility of shocks to future asset returns V_{h^m}, but this effect on the variance of consumption innovations can be mitigated by the mean-reversion in the market return (negative covariance of shocks to current and future expected returns $V_{h^m,m}$). When the *EIS* is zero, the innovation to consumption simply equals the innovation to all expected returns, including the current one, and the variance of consumption innovations equals the total variance of current and future return innovations.

Correlation The correlation between consumption and return innovations is determined by the sum of the variance of returns and the covariance of current with future return innovations. If σ is smaller than one, a negative covariance of current and future return innovations 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. In the less than log case, mean reversion helps to match the variance and volatility of consumption.

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!

There 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 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 *IES* estimates for non-asset holders.

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, simply by feeding the actual innovations to financial asset returns and news about future returns into the linearized policy function of our single agent; our procedure delivers a time series for the model-implied consumption innovations.

A. Fails to Match The Variance and Correlation Moments

In quarterly post-war data, the variance of consumption innovations V_c is only .32, compared to 48 for return innovations, and the correlation with return innovations is around

[4]The 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.

.15 (see Table I). The mean reversion in returns helps to lower the implied volatility and correlation of consumption innovations, but not nearly enough. The top panel of Figure 3 plots the standard deviation of the model-implied consumption innovations and in the bottom panel plots their correlation with current stock market return innovations. In both panels we vary the *EIS* between zero and 1.5.

Even if σ is zero - this value of the *EIS* maximizes the effect of the mean reversion on the volatility of consumption 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: at an annualized rate the model-implied standard deviation of news about current consumption is at least 12 percent, compared to about 1.2 percent in the data. As the *EIS* increases beyond the log case, the variance of consumption explodes. The correlation between consumption and stock market return innovations never falls below 0.7, whereas it is less than 0.2 in the data.

If we use stock returns instead of firm value returns, model 1 can match the correlation moment at low values of σ, because of the large mean-reversion in stock returns (-0.9, see table III). 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 4 shows Model 1's consumption moments for annual data using stock returns.

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:

$$(d^c)_{t+1} = (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta c_{t+1+j} = e_7'(I - \rho A)^{-1} \varepsilon_{t+1}.$$

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.

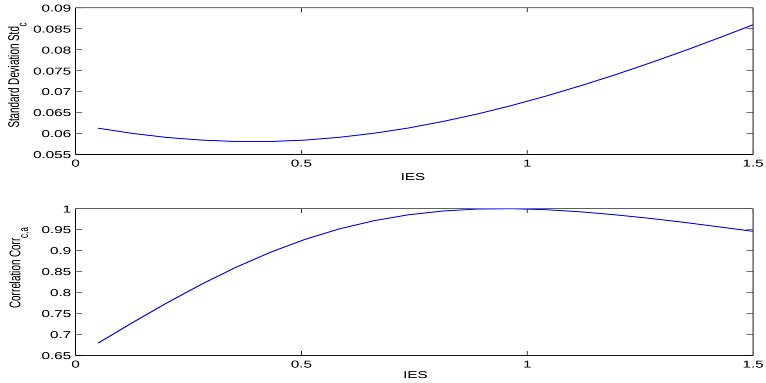
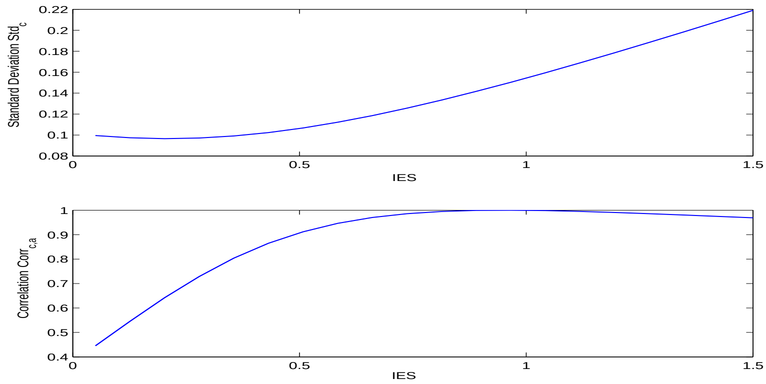


Figure 4. Matching Moments of Consumption Innovations: Annual Stock Returns

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.



Because the market returns only includes financial assets, $(m) + (h^m)$ equals news about current and future dividend growth $(f^d) + (d^d)$. These two objects should be perfectly correlated. 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: .02 for stock returns and .04 for firm value returns. This would amount to a severe violation of the household budget constraint if it 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!

C. Other Explanations

Before we introduce human wealth into the picture, 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 attempt to rule them out because these could interfere with our consumption growth accounting exercise in section (V). 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 reasonably specified 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.

C.1. 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:

$$c_{t+1} - E_t c_{t+1} = r^m_{t+1} - E_t r^m_{t+1} + (1-\sigma)(E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r^m_{t+1+j}$$
$$-(E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j \mu^m_{t+1+j},$$

where $\mu^m_t = \sigma \log \beta + .5 \left(\frac{\theta}{\sigma}\right) Var_t[\Delta c_{t+1} - \sigma r^m_{t+1}]$. 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. This seems implausible, especially at annual frequencies. In section VI.E we test the heteroscedasticity hypothesis directly: if true, our consumption growth accounting residual should *predict* the future variance of stock market returns. We will show it does not.

C.2. 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:

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

See appendix section B.2 for the derivation. The implied covariance between consumption innovations and return innovations is:

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

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.3. 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 *IES* 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 VI).

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:

$$R^m_{t+1} = (1 - \nu_t) R^a_{t+1} + \nu_t R^y_{t+1}, \tag{6}$$

where ν_t is the ratio of human wealth to total wealth. Campbell (1996) assumes that the human wealth share is constant: $\nu_t = \bar{\nu}$. For now we maintain that assumption, but we will relax it later on. The constant human wealth share equals the constant labor income share: $\bar{\nu} = \bar{s}$.

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

$$r^y_{t+1} - E_t[r^y_{t+1}] = (E_{t+1} - E_t)\sum_{j=0}^{\infty}\rho^j \Delta y_{t+1+j} - (E_{t+1} - E_t)\sum_{j=1}^{\infty}\rho^j r^y_{t+1+j}. \tag{7}$$

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

The expression for news about the current returns on human wealth in equation (7) is substituted back into the expression for consumption innovations in (4) is:

$$c_{t+1} - E_t c_{t+1} = (1-\bar{\nu})(r^a_{t+1} - E_t r^a_{t+1}) + \bar{\nu}(E_{t+1} - E_t)\sum_{j=0}^{\infty}\rho^j \Delta y_{t+1+j}$$
$$+(1-\sigma)(1-\bar{\nu})(E_{t+1} - E_t)\sum_{j=1}^{\infty}\rho^j r^a_{t+1+j} - \sigma\bar{\nu}(E_{t+1} - E_t)\sum_{j=1}^{\infty}\rho^j r^y_{t+1+j}.$$

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 before, 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 7).[5]

In the benchmark case of log utility ($\sigma = 1$), our agent is myopic: her consumption-wealth ratio is constant, and her consumption moves one-for-one with the weighted news about current asset returns and human capital returns:

$$c_{t+1} - E_t c_{t+1} = (1-\bar{\nu})(r^a_{t+1} - E_t r^a_{t+1}) + \bar{\nu}(r^y_{t+1} - E_t r^y_{t+1}).$$

[5]There 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 (7), which makes explicit the dividend part.

News about future financial asset returns has no direct effect on consumption. In contrast, news in future human wealth returns has an indirect effect on consumption through the innovations in the current human wealth return. An increase in future risk premia decreases the agent's consumption today, while an increase in expected future labor income growth increases it.

A. Channels to Match Consumption Moments

Using the consumption policy function

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

we can compute the model-implied correlation of consumption innovations with financial return innovations $Corr_{c,a}$ and the implied variance of consumption innovations V_c as a function of observed variance and correlation moments. The expressions for V_c and $Corr_{c,a}$ are long, so we relegate them to the appendix (equations 30 and 31 in section B.1).

Log Utility To build intuition, we consider the simplest case of log utility (see equations 32 and 33 in the appendix). The variance of consumption innovations increases the more volatile news about current asset returns, future labor income growth and future human wealth returns is. A negative correlation between current asset returns and future labor income growth $Corr_{a,d^y}$ or a positive correlation with news about future risk premia on human wealth $Corr_{a,h^y}$, reduces the variance of consumption innovations, while a positive correlation between news about future labor income growth and news about future expected returns on human wealth $Corr_{h^y,d^y}$ also helps. If good news in the stock market coincides with higher future risk premia on human wealth and lower expected future labor income growth, the innovation to the current human wealth returns will be negative, offsetting the effect of good news in the stock market on consumption.

To lower the correlation between current innovations to returns and consumption ($Corr_{c,a}$), we need essentially the same pattern: (1) a negative correlation between current asset returns and future labor income growth $Corr_{a,d^y}$, and (2) a positive correlation between current asset returns and future expected risk premia on human wealth $Corr_{a,h^y}$.

Table IV
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	+	+	+	−

In the data, we observe that news about current asset returns and future labor income growth is weakly *positively* correlated ($Corr_{a,d^y}$ is around .4 in table I). This fact works against a low variance and a low correlation.

Less-than-Log Utility In the case in which the *EIS* is smaller than one, changes in the investment opportunity set, through changes in future risk premia, also affect consumption behavior. Table IV reports the effect of all the variances and covariances on the variance of consumption. $Corr_{a,d^y}$ and $Corr_{h^y,d^y}$ have the same effect as in the case of log utility, but now "hedging" motives matter as well. A positive correlation between current asset and future human wealth return innovations $Corr_{a,h^y}$ pushes V_c down. A negative $Corr_{a,h^a}$ also helps to lower the correlation between consumption and return innovations $Corr_{c,a}$.[6]

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

To the econometrician the returns on human capital are unobserved. We proceed in three stages. First, we entertain three different, reasonable specifications for the returns on human wealth that have been put forward in the literature (Models 2, 3, and 4). Each of

[6] In the more-than-log utility case, the hedging effects switch signs. Since the mean reversion in financial asset returns increases the volatility of consumption for $\sigma > 1$, this effect would have to be offset by imputing enough $Corr_{y,h^y} > 0$ to the returns on human wealth process.

these models specifies expected returns on human wealth as a linear function of the state. Each has different implications for the cross-moments that determine the variance of consumption innovations and their correlation with asset return innovations. In a second step, we impute the unexplained part of consumption growth innovations to news about future risk premia on human wealth (section C). Finally, in a third step, we estimate a process for human wealth by minimizing the distance between model-implied moments and the moments in the data (Model 5 in section VI). Just like Models 2, 3, and 4, Model 5 specifies expected human wealth returns as a linear function of the state, but it is the only one that does so by imposing consistency with consumption moments.

Model 2: Expected Return on Human Wealth is Expected Return on Financial Assets Campbell (1996) assumes that $E_t[r^a_{t+1}] = E_t[r^y_{t+1}], \forall t$ and proceeds with the following expression for innovations in the human capital return:

$$r^y_{t+1} - E_t r^y_{t+1} = (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta y_{t+1+j} - (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r^a_{t+1+j}. \tag{8}$$

The *Campbell model* sets: $V_{h^y} = V_{h^a}$, $Corr_{a,h^y} = Corr_{a,h^a}$, $Corr_{d^y,h^y} = Corr_{d^y,h^a}$, $Corr_{h^a,h^y} = 1$. Aggregate consumption innovations in *Campbell*'s model are more volatile and more correlated with return innovations as a result. The news about future expected returns on human capital is as volatile as the news about financial returns, but it has the wrong effect. $Corr_{a,h^y}$ 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.

Model 3: Constant Expected Return on Human Wealth An alternative assumption is that the discount rate of labor income growth is constant. This implies that the second term in equation (7) is zero.

$$r^y_{t+1} - E_t r^y_{t+1} = (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta y_{t+1+j} \tag{9}$$

This is the specification formulated by Shiller (1993). We expect the *Shiller model* to do better by assuming a constant discount rate for human capital, because this implies that $V_{h^y} = 0 = Corr_{a,h^y} = Corr_{d^y,h^y} = Corr_{a,h^y}$.

Model 4: Constant Expected Return and No Predictability In the final model the innovation to human wealth return equals the innovation to the labor income growth rate. This implies that:

$$r^y_{t+1} - E_t r^y_{t+1} = (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta y_{t+1+j} - (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j \Delta y_{t+1+j} = \Delta y_{t+1} - E_t \Delta y_{t+1}. \tag{10}$$

This is the specification adopted by Jagannathan & Wang (1996), henceforth the *JW model*. *JW* assume that (i) the discount rate is constant, implying that the second term in equation (7) is zero, and they assume (ii) that labor income growth is unpredictable, so that the first term in equation (7) is $\Delta y_{t+1} - E_t \Delta y_{t+1}$. As a result, the moments of news in future human wealth returns in the *JW* model are:

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

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. This means $V_{h^y} \approx V_{d^y}$, much less volatile than in *Campbell*'s model. Also $Corr_{h^y,a} \approx Corr_{d^y,a} > 0$, a good assumption, because we know $Corr_{h^y,a} > 0$ helps to lower the volatility and correlation of consumption innovations, when the IES is smaller than one.

Linear Factor Model These three models differ only in the $N \times 1$ vector C in $E_t[r^y_{t+1}] = C' z_t$. This vector C describes how the innovations to the expected returns on human wealth relate to the innovations to the state vector z. In the *Campbell* model $C' = e_1' A$, in the *Shiller* model $C' = 0$, and in the *Jagannathan-Wang* model, $C' = e_2' A$.

C implies a process for $\{(h^y)_t\}$, the innovations to expected future returns on human wealth:

$$(h^y)_t = C' \rho (I - \rho A)^{-1} \varepsilon_t, \tag{11}$$

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

$$\begin{aligned} (y)_t &= (d^y)_t - (h^y)_t. && (12) \\ &= e_2'(I - \rho A)^{-1} \varepsilon_t - C' \rho (I - \rho A)^{-1} \varepsilon_t && (13) \end{aligned}$$

¿From this equation, it is easy to verify that C' needs to be equal to $e_2' A$ for $(y)_{t+1}$ to be equal to $\Delta y_{t+1} - E_t \Delta y_{t+1} = e_2' \varepsilon_{t+1}$ in the *JW* case.

Having specified three different models for the expected returns on human wealth, we can now back out the moments of the implied aggregate consumption innovations.

Results Table V summarizes the moments of consumption innovations, and human capital return innovations for quarterly data, and for our benchmark calibration with constant labor income share $\bar{\nu} = .7$, and *EIS* of $\sigma = .28$. We start with the firm value results (left panel). All three models display too much variance in consumption innovations (by a factor of 30 for the *Campbell* model and a factor of 10 for the *JW* model), and a correlation with stock returns that is roughly 3 times too high. The implied standard deviation (at annual frequencies) for consumption innovations is 6 percent in *Campbell*'s model, 4 percent for the *JW* model, compared to only 1 percent in the data. The *Campbell* model does worse than the others because the high implied correlation between innovations in financial asset returns and human capital returns imputes too much volatility to consumption. When we use stock returns instead of the returns on firm value (right panel), the predicted correlation of innovations in consumption decreases dramatically for the *Shiller* and *JW* models, 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.

Table V
Moments for Consumption Growth and Human Capital Returns - Models 2, 3, & 4 - 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 (equation 8). The second column represents the constant discounter model (equation 9), and the third column represents the autarkic model (equation 10). The last column gives the corresponding moments in the data, when available. Computations are done for $\bar{\nu} = .7000$ and $\sigma = .2789$.

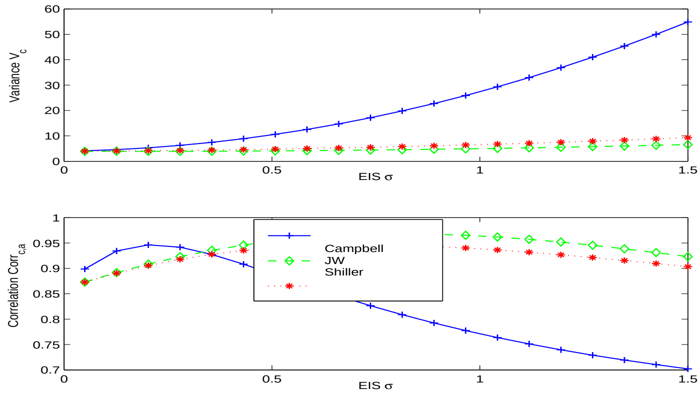
Moments	*Campbell*	*Shiller*	*JW*	*data*	*Campbell*	*Shiller*	*JW*	*data*
	Panel A: Firm Value				*Panel B: Stocks*			
V_{h^y}	32.74	0	.54		103.7	0	.79	
$Corr_{a,h^y}$	-.478	0	.485		-.918	0	.644	
$Corr_{d^y,h^y}$	-.526	0	.752		-.336	0	.735	
$Corr_{h^a,h^y}$	1.000	0	-.306		1.000	0	-.453	
$Corr_{y,a}$	.488	.337	.081		.934	.491	.065	
$Corr_{y,h^a}$	-.986	-.526	-.511		-.994	-.336	-.032	
V_y	42.00	1.61	.75		113.84	1.65	.76	
V_c	6.05	4.29	3.94	.230	7.61	2.49	2.10	.225
$Corr_{c,a}$	.946	.865	.868	.195	.955	.518	.465	.213

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 reversion in stock returns decreases. The lowest standard deviation for consumption news is 3.74 percent (*JW* model), compared to .8 percent in the data. The results are in Table XII in appendix D.

Varying the IES and the Labor Income Share These results are robust to plausible changes in parameter values. Figure 5 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 (6) 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 the *JW* model down to 2.7 times its value in the data; the correlation is still much too high (see Table XIII in appendix D).

Sofar we have been unable to bring the model's moments closer to matching those in

Figure 5. The *EIS* and Consumption Innovation Volatility and Correlation - Using Returns on Firm Value, Quarterly Data 1947-2003
The labor share ν is .70.



the data. In the next section, we 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.

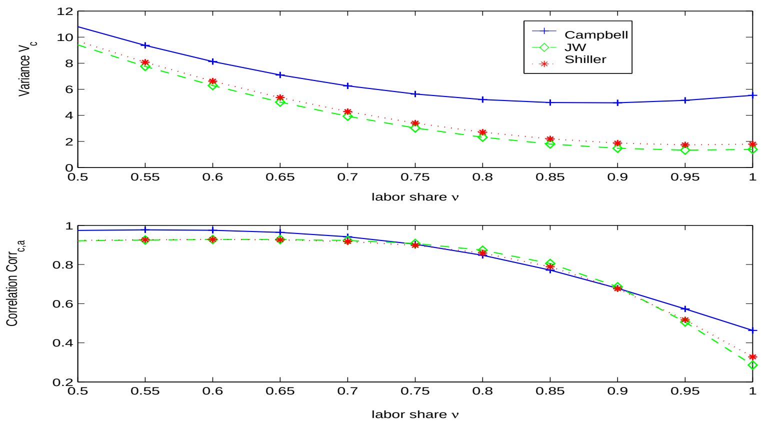
C. Consumption Growth Accounting

This section reverses the logic we followed up until now: we 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 start by fixing a value of the *EIS* σ and then we 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. The human wealth share is still constant. We find that positive news for current financial wealth returns is bad news for current human wealth returns. This finding is robust to changes in the EIS.

Backing out a Human Wealth Return Process Innovations in current consumption growth can be recovered from the VAR residuals as follows:

$$(c)_t \equiv c_{t+1} - E_t[c_{t+1}] = e_7' \varepsilon_{t+1}'. \tag{14}$$

Figure 6. The Labor Share and Consumption Innovation Volatility and Correlation - Using Returns on Firm Value, Quarterly Data 1947-2003
The *EIS* σ is .28.



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

$$(h^y)_{t+1} \equiv \frac{1}{\sigma\bar{\nu}} \left[(1-\bar{\nu})(a)_{t+1} + \bar{\nu}(d^y)_{t+1} + (1-\sigma)(1-\bar{\nu})(h^a)_{t+1} - (c)_{t+1}\right]. \tag{15}$$

Once we have constructed (h^y), we form innovations in current human wealth returns $(y)_{t+1} = (d^y)_{t+1} - (h^y)_{t+1}$ and innovations in the current market return $(m)_{t+1} = (1-\bar{\nu})(a)_{t+1} + \bar{\nu}(y)_{t+1}$.

Current Human Wealth and Market Returns The first panel of table VI reports the implied moments for the current innovations to human wealth (y) and the market return (m), implied by consumption data, firm value returns, and the model. Regardless of the *EIS* and the labor income share, we find that innovations in current financial asset and human wealth returns are consistently negatively correlated: $Corr_{y,a} < 0$.

In the benchmark case, $\bar{\nu} = .700$ and $\sigma = .279$, current human wealth returns V_y are highly volatile, twice as volatile as the innovations to financial asset returns. As the *EIS* increases to $\sigma = .73$, the implied volatility decreases to less than 50 percent of the volatility of news about current financial returns.

For the total market return, things are more complicated. In the less-than-log-case, good news in financial markets is bad news for the market return $Corr_{m,a} < 0$, and the market return is mean reverting. In the more-than-log-case, good news in financial markets is good news for the market as a whole $Corr_{m,a} > 0$, but the market returns display multivariate mean aversion.

The first panel of Table XIV in appendix D confirms these results for stock returns. The main difference is that the implied correlations between innovations to the market return and financial asset returns are much smaller in absolute value, and slightly positive. The correlation between innovations to current human wealth returns and current financial asset returns is still strongly negative.

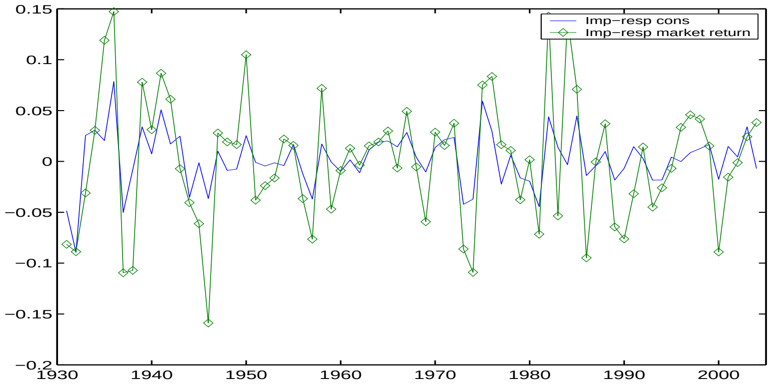
Future Risk Premia on Human Wealth The second panel of Table VI reports the moments for the innovations to expected future returns on human wealth, $(h^y)_t$, that we backed out of the model. Regardless of the *EIS* and the labor income share, news about the implied risk premia on human and financial assets is negatively correlated: $Corr_{h^y,h^a} < 0$.

For our benchmark calibration $\bar{\nu} = .70$ and $\sigma = .28$, 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 $Corr_{h^y,d^y}$ is .32, and its correlation with news in future returns $Corr_{h^a,h^y}$ is $-.04$. This correlation becomes more negative for larger σ. Good news about expected future financial market returns implies bad news about future expected human wealth returns. This is true for all cases we consider.

For all calibrations, human wealth returns are strongly mean reverting, $Corr_{y,h^y} = -.90$ or lower. As long as $\sigma < 1$, the implied market returns is also strongly mean-reverting (last column). As with human wealth returns, the mean reversion in the market return is smaller when the *EIS* is higher. However, in the more-than-log case the market return displays mean-aversion. A high consumption-wealth ratio predicts low market returns in the future, further increasing the consumption-wealth ratio. In that case, the implied consumption wealth ratio is not stationary and this invalidates Campbell's approximation method. This suggests we should rule out the case of $\sigma > 1$.

Looking back at the three benchmark models, only the *JW model* actually gener-

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 1930-2003. 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 0.75.



ates the correct correlation pattern: $Corr_{a,h^y}$ and $Corr_{h^y,d^y}$ are positive and $Corr_{h^a,h^y}$ is negative, but $(h^y)_t$ is not nearly volatile enough (2.8 versus 107).

Long Run Restrictions In quarterly data, the correlation between $(m)_t + (h^m)_t$ and $(d^c)_t$ is .16 for firm value returns and .18 for stock returns, but the market response is about twice as volatile. This correlation increases to .40 (.36) at annual frequencies for firm value returns (stock returns) over the 1947-2004 sample and to .75 for stock returns over the 1930-2004 sample (see figure 7). 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.

VI. Incorporating Time-Varying Wealth Shares

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

The return on the market is a weighted average of the return on financial assets and

Table VI: Consumption Growth Accounting: Using Firm Value Data

The table displays moments for consumption growth, human capital returns and market returns implied by the consumption growth accounting exercise. Panel A displays moments of current human wealth and market returns; Panel B displays moments of expected future human wealth and market returns. We use the full sample 1947.II-2004.III. The symbols are as in Table V. Computations are done for $\bar{\nu} = .70$ and $\sigma \in \{.2789, .7368, 1.50\}$.

Panel A: Current Returns										
EIS	V_y	$Corr_{y,a}$	$Corr_{y,d^y}$	$Corr_{y,h^a}$		V_m	$Corr_{m,a}$	$Corr_{m,d^y}$	$Corr_{m,h^a}$	$Corr_{m,y}$
$\sigma = .28$	100.46	−0.82	−0.21	−0.03		29.45	−0.68	−0.14	−0.22	0.98
$\sigma = .73$	14.49	−0.94	−0.21	0.26		0.97	−0.43	0.14	−0.30	0.71
$\sigma = 1.50$	5.34	−0.93	−0.17	0.60		0.71	0.69	0.50	−0.02	−0.37
Panel B: Future Returns										
EIS	V_{h^y}	$Corr_{h^y,a}$	$Corr_{h^y,d^y}$	$Corr_{h^y,h^a}$	$Corr_{y,h^y}$	V_{h^m}	$Corr_{h^m,a}$	$Corr_{h^m,d^y}$	$Corr_{h^m,h^a}$	$Corr_{m,h^m}$
$\sigma = .28$	107.38	0.84	0.32	−0.04	−0.99	54.65	0.71	0.20	0.20	−0.99
$\sigma = .73$	18.14	0.94	0.49	−0.39	−0.96	7.83	0.71	0.20	0.20	−0.81
$\sigma = 1.50$	7.97	0.91	0.59	−0.73	−0.90	1.89	0.71	0.20	0.20	0.74

the return on human wealth:

$$r^m_{t+1} = (1-\nu_t)r^a_{t+1} + \nu_t r^y_{t+1}.$$

with portfolio weight ν_t, the ratio of human wealth tot total wealth. This human wealth share depends on all the state variables in z: $\nu_t(z_t)$ (part A). We show how to compute consumption innovations in part B. We then revisit the three benchmark sections, and show that accounting for time-varying wealth shares does not help much (part C). In part D, we estimate the vector C, which determines expected returns on human wealth, that most closely matches the moments of consumption. The resulting human wealth returns are negatively correlated with financial asset returns, to the extent that the market return is negatively correlated with financial asset returns.

A. Computing the Human Wealth Share

First, we show that the price-dividend ratios on financial and human wealth are both linear in the state. We start with the human wealth part. The vector C relates the expected return on human wealth to the state vector. In *Campbell*'s model $C' = e_1' A$, in *Shiller*'s model $C' = 0$, and in JW's model, $C' = e_2' A$. These different choices of C imply a different process for $(y)_t$ (as defined by equation 12) and a process for the (demeaned) dividend yield on human wealth:

$$\begin{aligned} dp^y_t - E[dp^y_t] &= E_t \sum_{j=1}^{\infty} \rho^j (r^y_{t+j} - \Delta y_{t+j}) \\ &= \rho(C' - e_2' A)(I - \rho A)^{-1} z_t = B' z_t \end{aligned} \tag{16}$$

In all three of the benchmark models we can write the (demeaned) log dividend yield as a linear function of the state z with loadings B $(N \times 1)$. The demeaned log dividend yield on financial assets is simply the third element in the VAR: $dp_t - E[dp_t] = e_3' z_t$.

Now, 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:

$$\frac{W}{C} C = \frac{P^a}{D} D + \frac{P^y}{Y} Y, \tag{17}$$

where $dp^y = -\log\left(\frac{P^y}{Y}\right)$. The human wealth to total wealth ratio is given by:

$$\nu_t = \frac{\frac{P^y}{Y}Y}{\frac{W}{C}C} = \frac{e^{-dp_t^y}s_t}{e^{-dp_t^y}s_t + e^{-dp_t}(1-s_t)} = \frac{1}{1+e^{x_t}}, \tag{18}$$

which is a logistic function of $x_t = dp_t^y - dp_t + \log\left(\frac{1-s_t}{s_t}\right)$. We recall that s denotes the labor income share $s_t = Y_t/C_t$ with mean $\bar{s}$. When $dp_t = dp_t^y$, the human wealth share equals the labor income share $\nu_t = s_t$, but in general, ν_t is a function of the difference in log dividend price ratios on human wealth and financial market wealth as well. In section B.3 of the appendix, we derive a linear approximation of the demeaned human wealth share $\tilde{\nu}_t \equiv \nu_t - \bar{\nu} = D'z_t$, with loadings D that are given by:

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

The linear expression for the wealth shares produces quadratic expression for news about future market returns.

B. Computing Consumption Innovations

Allowing for time-varying wealth shares makes the algebra more involved, but the economics is very similar. Our agent now considers the effect of (future) changes in the portfolio share of each asset when she responds to news about returns.

The expression for consumption innovations with time-varying human wealth share is:

$$\begin{aligned} (c)_{t+1} &= (1-\nu_t)(a)_{t+1} + \nu_t(d^y)_{t+1} - \nu_t(h^y)_{t+1} \\ &+(1-\sigma)(E_{t+1}-E_t)\sum_{j=1}^{\infty}\rho^j(1-\nu_{t+j})r^a_{t+1+j} \\ &+(1-\sigma)(E_{t+1}-E_t)\sum_{j=1}^{\infty}\rho^j\nu_{t+j}r^y_{t+1+j} \end{aligned} \tag{19}$$

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

$$W^1_{t+1} = (E_{t+1} - E_t)\sum_{j=1}^{\infty} \rho^j \tilde{\nu}_{t+j} r^a_{t+1+j}$$
$$W^2_{t+1} = (E_{t+1} - E_t)\sum_{j=1}^{\infty} \rho^j \tilde{\nu}_{t+j} r^y_{t+1+j}.$$

Using these definitions, the expression for consumption innovations reduces to:

$$c_{t+1} - E_t c_{t+1} = (1 - \bar{\nu} - \tilde{\nu}_t)(a)_{t+1} + (\tilde{\nu}_t + \bar{\nu})(d^y)_{t+1} - (\tilde{\nu}_t + \sigma\bar{\nu})(h^y)_{t+1} + (1-\sigma)(1-\bar{\nu})(h^a)_{t+1} - (1-\sigma)(W^1_{t+1} - W^2_{t+1}). \quad (20)$$

When the human wealth share is constant ($\nu_t = \bar{\nu}$ or $\tilde{\nu} = 0$), we recover equation (8). In the log case, variation in future human wealth shares has no bearing on consumption innovations today, but in any other case, our single agent responds to news about future returns weighted by the portfolio shares.

In *Campbell*'s model, the conditional moments of future asset returns and human wealth returns are identical. As a result, $(h^y)_t = (h^a)_t$, which also implies $W^1_t - W^2_t = 0$ for all t. The latter can be shown by applying the law of iterated expectations. In *Shiller*'s model, $h^y = 0$ and $W^2_t = 0$. In the *JW* model, $W_2 = (E_{t+1} - E_t)\sum_{j=1}^{\infty} \rho^j \tilde{\nu}_{t+j} \Delta y_{t+1+j}$. We compute the function $W^1_t(z_t)$ and $W^2_t(z_t)$, using value function iteration. With the portfolio weights ν_t we can construct consumption innovations according to equation (45).

Define the news about weighted future asset returns as $\widetilde{W}^1_{t+1} = E_{t+1}\sum_{j=1}^{\infty} \rho^j \tilde{\nu}_{t+j} r^a_{t+1+j}$ and $\widetilde{W}^2_{t+1} = E_{t+1}\sum_{j=1}^{\infty} \rho^j \tilde{\nu}_{t+j} r^y_{t+1+j}$. In section B.4 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:

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

where P solves the matrix Sylvester equation

$$P_{j+1} = R + \rho A' P_j A. \quad (21)$$

We solve this equation by iteration, starting from $P_0 = 0$, and $R = \rho D e'_1 A$. The constant

d in the value function equals $d = \frac{\rho}{1-\rho} tr(P\Sigma)$. This also implies that the news about future returns is a simple, quadratic function of the VAR innovations and the matrix P:

$$W_1(z_{t+1}) = (E_{t+1} - E_t)\tilde{W}^1_{t+1}(z_{t+1}) = \varepsilon'_{t+1} P \varepsilon_{t+1} - \sum_{i=1}^{N}\sum_{j=1}^{N} \Sigma_{ij} P_{ij}.$$

which turns out to be a simple quadratic function of the VAR shocks and the matrix P. In the same manner we calculate W^2, replacing R in equation (21) by $S = \rho DC'$.

C. Three Benchmark Models Revisited

Figure 8 plots the variation in the human wealth share over time, for different models alongside the labor income share. The *Shiller* and *JW* model 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 *Campbell*'s model, the human wealth shares follow the exact opposite pattern.

In Table VII, we report the model-implied moments of consumption, human wealth returns and the market return (as in table V, but allowing for time-varying human wealth shares). Rows 5 and 6 show that allowing for time-varying human wealth shares helps only marginally to reduce the volatility of consumption innovations and their correlation with stock return innovations. Overall, the models still don't match the two moments of consumption we are interested in. The reason is that all three models imply a very high correlation between financial asset returns and the market return (line 11). Because financial market returns are so volatile, consumption ends up too volatile and too highly correlated with financial asset returns. The same conclusions apply to the model with stock returns (Table XV in appendix D).

D. Model 5: Consumption Growth Accounting

This section redoes the consumption growth accounting exercise, but in a slightly more sophisticated way. We estimate the process for $\{h^y_t\}$ that is consistent with the observed volatility of consumption innovations and with its correlation with innovations in financial

Figure 8. Labor Income Share and Human Wealth Share for Models 2, 3, and 4
The return on financial assets is return on Firm Value.

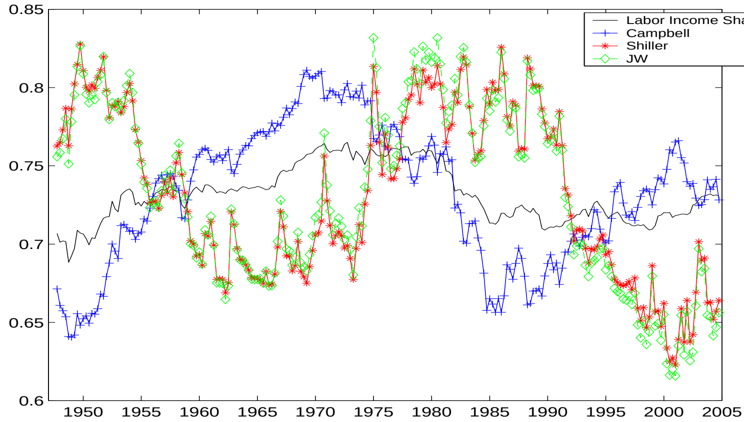


Table VII
Moments for Consumption Growth and Human Capital Returns - Models 2, 3 & 4 - Time-Varying Wealth Shares

This table uses firm value returns and is computed for the full sample 1947.II-2004.III). In each panel, the first column represents the *Campbell* specification for human capital returns (equation 8). The second column represents the constant discounter model (equation 9), and the third column represents the autarkic model (equation 10). The last column gives the corresponding moments in the data, when available. (a), (y), and (m) stand for innovations in current asset, human capital and total market returns. (h^a), (h^y) and (h^m) stand for news in future financial asset returns, future human wealth returns and future market returns. Computations are done for time-varying, human wealth share ν_t and $\sigma = .2789$.

Moments	*Campbell*	*Shiller*	*JW*	*data*
V_{h^y}	32.67	0	.54	
$Corr_{a,h^y}$	-.477	0	.485	
$Corr_{d^y,h^y}$	-.525	0	.752	
$Corr_{h^a,h^y}$	1.000	0	-.306	
$Corr_{y,a}$	.487	.337	.081	
$Corr_{y,h^a}$	-.986	-.525	-.511	
V_y	41.91	1.61	.75	
V_c	5.65	3.84	3.46	.333
$Corr_{c,a}$	.922	.848	.853	.168
V_m	34.62	5.69	4.21	
$Corr_{m,a}$	.707	.917	.937	
$Corr_{m,y}$	.961	.667	.392	
$Corr_{m,h^m}$	-.948	-.584	-.430	

asset returns. We label the resulting model *Model 5*.

Minimize Distance between Model and Data We minimize the distance between the same two moments of consumption innovations in the model and the data by optimizing over the vector C. This vector relates the expected return on human wealth to the state vector z: $E_t[r^y_{t+1}] = C'z_t$.

This procedure also delivers all the moments of the human wealth returns.[7] We 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. Of course, we cannot rule out that the C vector is not uniquely identified from these two (non-linear) moments.

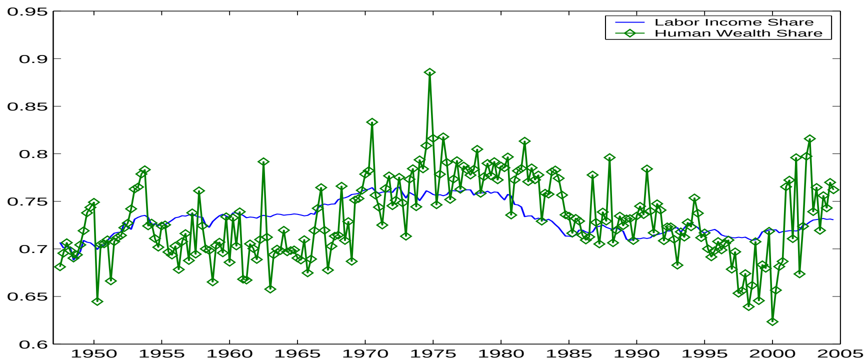
Figure 9 plots the model-implied human wealth share at the optimal parameter values, alongside the observed labor income share. The human wealth share is much more volatile than the labor income share.

Table VIII shows the moments for h^y that replicate the two moments in consumption innovations. In the baseline case σ is set to .27 (column 1). We match the standard deviation of consumption innovations and the correlation of consumption and stock return innovations (Rows 8 and 9). As before, our C estimates imply negatively correlated financial asset and human wealth returns, both for current innovations (-.88) and news about future expected returns (-.15) (Rows 4 and 7). Reading across the columns, for each of the calibrations, we get a strong negative correlation between news about current (future) financial and human wealth returns. Figure 10 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.

The correlation between innovations in the market return and innovations in the human wealth returns is close to one in the baseline case (row 12), whereas the correlation with innovations in financial asset returns is around -7 (row 11). The implied market

[7]Implied by this specification is a process for h^y_t (equation 11) and a process for the (demeaned) dividend yield on human wealth (equation 16). We still have that $\tilde{\nu}_t = D'z_t$, where $D = e_6 - \bar{s}(1-\bar{s})B + \bar{s}(1-\bar{s})e_3$. We proceed as before to form W_1 and W_2, where we use $R = \rho D e_1' A$ and $S = \rho D C'$ and solve for P and Q from Sylvester equations like (C). For a given value of C, the algorithm computes the implied consumption innovations from equation (19), holding σ fixed at its previous value of .2789. We form the volatility of model-implied consumption innovations, and their covariance with model-implied financial asset return innovations.

Figure 9. Labor Income Share in Data and Human Wealth Share in Model Implied by Consumption Moments.
The return on financial assets is the return on firm value.



returns are strongly mean-reverting, as shown by the correlation between m and h^m of -.98 (row 13). Increasing the EIS to .7 lowers the correlation between the market and human wealth returns to .65 and increases the correlation with financial asset returns to -.5. The opposite is true in the more-than-log case, but because the market return displays mean aversion , we have argued that we need to rule out this case.

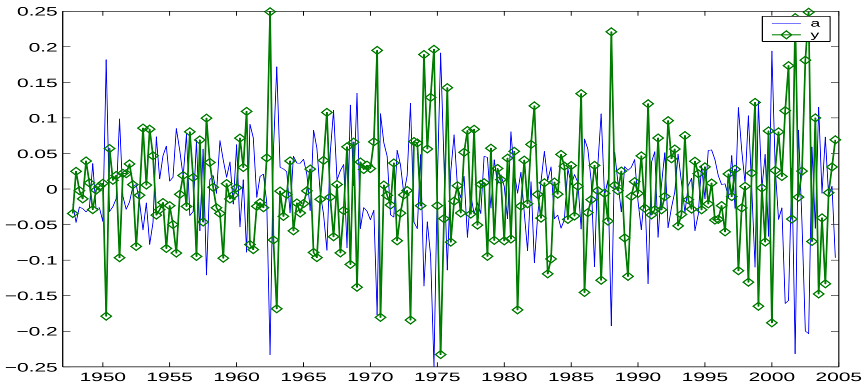
In the baseline case, innovations to human wealth return innovations are more variable than financial asset returns: $V_y = 61.1$ (annualized standard deviation of 15 percent) versus $V_a = 48.2$, but as we increase σ, this number drops quickly to around 10 (annualized standard deviation of 6 percent). Allowing for time-varying human wealth shares makes the h^y "residual" process implied by consumption data less volatile. The volatility of news about future human capital returns is almost cut in half: $V_{h^y} = 69$ instead of 107 (annualized standard deviation of 20 percent). The same is true for the variance of news in current human wealth returns (61 versus 100). Furthermore, (h^y) is more strongly positively (negatively) correlated with d^y (h^a), relative to the case with constant human wealth share. Using stock returns, our results are mostly unchanged (Table XVI in appendix D). The only difference is that the resulting market return process is weakly positively correlated with financial asset returns.

Table VIII
Moments for Consumption Growth and Human Capital Returns - Model 5 - Time-Varying Wealth Shares

The first column is for $\sigma = .2789$, the second column is for .7368, and the last column is for $\sigma = 1.5$. The sample is 1947.II-2004.III. Financial asset returns are firm value returns.

Moments	$\sigma = .2789$	$\sigma = .7368$	$\sigma = 1.5$	*data*
V_{h^y}	69.00	12.87	5.91	
$Corr_{a,h^y}$	.879	.972	.914	
$Corr_{d^y,h^y}$	.543	.514	.604	
$Corr_{h^a.h^y}$	-.153	-.444	-.758	
$Corr_{y,a}$	-.879	-.977	-.922	
$Corr_{y,h^a}$	.077	.296	.603	
V_y	61.05	9.79	3.79	
V_c	.518	.333	.333	.333
$Corr_{c,a}$	.168	.168	.168	.168
V_m	18.89	.59	.82	
$Corr_{m,a}$	-.758	-.509	.613	
$Corr_{m,y}$	.971	.635	-.318	
$Corr_{m,h^m}$	-.987	-.680	.779	

Figure 10. Innovations in Current Financial Asset and Human Wealth Returns Implied by Consumption Moments.
The return on financial assets is the return on firm value.



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. The left column of table XVII in appendix D 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 .98, whereas the correlation with innovations in financial asset returns is -.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 61.1 in the benchmark model. This is also much less variable than financial asset return innovations: $V_a = 48.3$. These results are consistent with the effects of an increase in $\bar{\nu}$ discussed in section V.C. Interestingly, a higher labor income share also lines up the long-run responses of consumption and the market return much better.

E. Heteroscedasticity Revisited

As pointed out in section IV.C.1, a theoretical possibility is that our consumption innovation residual measures up future return volatility rather than future human wealth 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:

$$V_t^a \equiv V_t[r_{t+1}^a] = e_1' A z_t z_t' A' e_1 + e_1' \Sigma e_1. \tag{22}$$

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.

VII. The Consumption-Consistent CAPM

The last 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:

$$E_t r^i_{t+1} - r^f_t + \frac{V_{ii}}{2} = \frac{\theta}{\sigma} V_{ic} + (1-\theta) V_{im} \quad (23)$$

$$= \gamma V_{im} + (\gamma - 1) V_{ih^m} \quad (24)$$

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 24). Campbell (1993) substitutes out consumption, replacing V_{ic} by $V_{im}+(1-\sigma)V_{ih^m}$, which leads to asset pricing equation (24). 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 (23), and evaluate the performance of the three canonical models and our model in pricing the cross-section of stock returns.

Taking expectations of (23) delivers an unconditional asset pricing equation. Following Campbell, we define the excess returns on I assets $er^i_{t+1} = r^i_{t+1} - r^f_t$ with unconditional means μ_i. Both vectors have dimension $I \times 1$. We define $\eta^i_{t+1} \equiv er^i_{t+1} - \mu^i$. Rather than estimating the mean returns, we take them from the data and use sample means.[8] We estimate the market prices of risk, p_k off the ex-post version of equation (23):

$$\frac{1}{T}\sum_{t=1}^{T}\left[er^i_{t+1} + \frac{1}{2}(\eta^i_{t+1})^2 - p_c \eta^i_{t+1} \Delta c^{pred}_{t+1} - p_m \eta^i_{t+1} r^{m,pred}_{t+1}\right] = 0,\ \forall i \in \{1, 2, \cdots, I\} \quad (25)$$

[8] Our results are unchanged if we estimate the mean returns.

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.[9] 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 IX show the expected return and the expected return with a variance correction for the 25 size and book-to-market decile portfolios (data 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 $p_m \times V_{im}$). Panel A is for our model with time-varying human wealth share and the optimal vector C, i.e. the one that is consistent with aggregate consumption moments. Panel B is the Campbell model ($C' = e_1' A$) with constant human wealth shares.

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 value 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 11 shows that growth firms (B1) are more exposed to consumption risk than value firms. The bottom panel shows that growth firms form a better hedge against future market risk than value firms. The last two columns of Table IX show that returns of growth firms are lower mostly because they

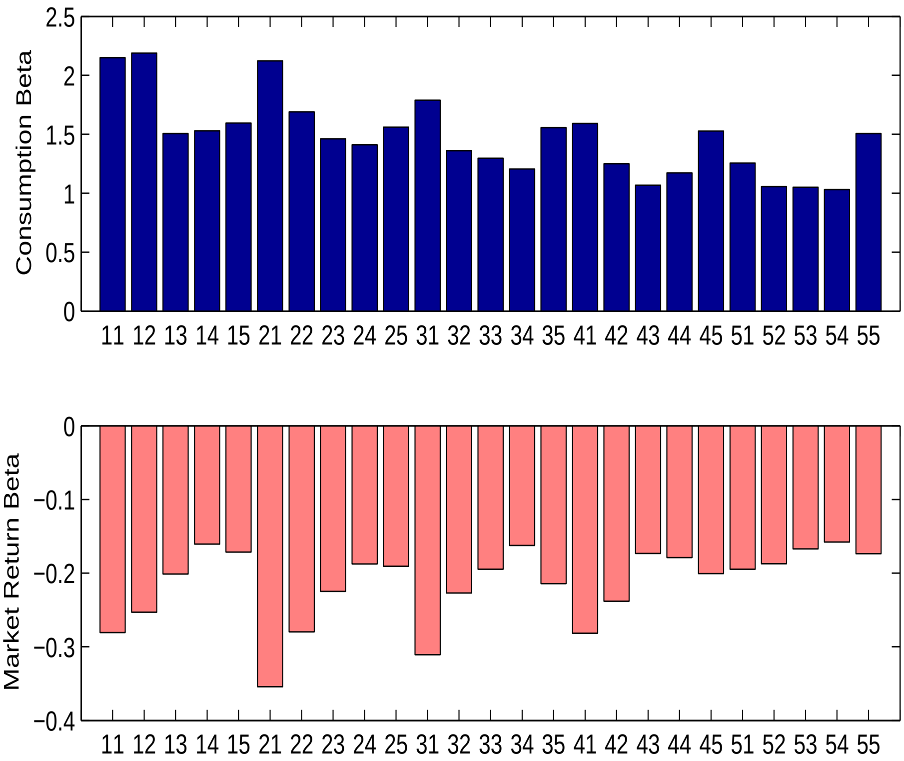
[9] Alternatively, we can estimate the factor risk prices by GMM. Equations (25) define I moments to identify 2 parameters.

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

The first column gives the average log excess return per quarter. The second column adjusts for the Jensen effect by adding 1/2 times the variance of the log excess return. Columns 3-4 give the model's predicted adjusted return and the pricing 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. 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^{pred}_{adj}	er^{pred}_{adj}	$error$	p_o	$p_c V_{ic}$	$p_m V_{im}$
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

Figure 11. Value Portfolios: Risk Contributions of m and h^m



form a good hedge against future market risk.

Table X 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 8 columns denotes a different model, each with a different implied consumption growth and market return process. The first and second columns are the *Campbell* model *without* and *with* time-varying human wealth share. Columns three and four report the *Shiller* model *without* and *with* time-varying human wealth share. Likewise, columns five and six are for the *Jagannathan-Wang* model, and the last two columns are for our model. In our model with constant human

Table X
Model Comparison

The table shows the market prices of risk obtained from the cross-sectional regression $\overline{er}^i = \lambda_0 + \lambda_c V_{ic} + \lambda_m V_{im} + \epsilon^i$. 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	Campbell	$Campbell_{TV}$	Shiller	$Shiller_{TV}$	JW	JW_{TV}	Optimal	$Optimal_{TV}$
λ_0	4.02	3.36	2.95	3.22	2.80	3.20	4.25	3.78
σ_{λ_0}	0.82	0.75	1.04	0.90	1.28	1.10	1.21	0.92
λ_c	−0.63	−0.51	0.50	0.32	0.53	0.58	0.63	0.53
σ_{λ_c}	0.40	0.40	0.73	0.68	0.76	0.78	0.33	0.88
λ_m	2.03	−3.11	−0.67	−0.66	−0.92	−0.73	4.12	11.99
σ_{λ_m}	2.14	1.73	0.44	0.42	0.46	0.43	1.57	4.75
RMSE	0.82	0.84	0.82	0.83	0.78	0.80	0.71	0.76
adj. R^2	36.37	31.13	37.12	35.06	50.11	45.87	65.03	47.33

wealth shares (column 7), we used 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.[10] Our model with time-varying wealth shares in column 8 finds the optimal vector C to match the variance of consumption innovations, the correlation of consumption innovations with financial asset return innovations to the ones in the data. For 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.[11] In all models, the financial asset return is the firm value return, and consumption series are computed for $\sigma = .27$.

The main finding of table X is that the market price of risk on the market return has the opposite in our model compared to the three canonical models: 12 in column 8 versus -3, -.7, and -.7 in columns 2, 4, and 6 respectively. This is unsurprising, given the negative

[10]In this procedure, we back out h^y from consumption data. 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 the Jagannathan-Wang model, the model the closest to ours. This procedure does not affect the RMSE in column 7.

[11]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.

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. Among the models with constant wealth shares, our model (column 7) has the lowest root mean-squared pricing error and the highest cross-sectional R^2 (65%). Among the models with time-varying wealth shares, our model also delivers the lowest RMSE (0.7% per quarter). The Jagannathan-Wang model, 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 returns because they are a better hedge against market risk. Such pattern is absent in the Campbell model.

Predictability by the Consumption-Wealth Ratio Lettau & Ludvigson (2001a) have shown that the consumption wealth ratio forecasts stock returns. They construct a proxy for the consumption-wealth ratio, *cay*, estimated as the cointegration residual between consumption, financial assets (stock returns) and labor income. Implicit in the construction of *cay* is the assumption that future human wealth returns are discounted at the same rate as future financial asset returns. This is the empirical counterpart to the consumption-wealth ratio in the Campbell economy with constant human wealth shares. We have shown that returns on human wealth need to be discounted differently from financial wealth returns for the model to be consistent with consumption data. In this section, we compute the consumption-consistent consumption-wealth ratio and compare it to *cay*. In particular, we are interested in how *cay* forecasts the returns on the market, on financial assets, and on human wealth relative to our consumption-wealth ratio.

From the linearization of the budget constraint and the Euler equation, we obtain an expression for the demeaned log consumption wealth ratio $c - w$:

$$c_t - w_t = (1 - \sigma) E_t \sum_{j=1}^{\infty} \rho^j r_{t+1}^m. \tag{26}$$

When $\sigma < 1$, the consumer is reluctant to substitute intertemporally, and the income effect of higher market returns dominates the substitution effect. The consumer raises consumption as a fraction of total wealth. In the economy with constant human wealth share, the right hand side of equation (26), can be written as:

$$c_t - w_t = (1 - \sigma) \left[(1 - \bar{\nu}) e_1' \rho A (I - \rho A)^{-1} + \bar{\nu} C' \rho (I - \rho A)^{-1} \right] z_t = F' z_t. \tag{27}$$

Note that the log consumption wealth ratio in the Campbell economy ($C' = e_1' A$) is the same as in the economy without human wealth ($\bar{\nu} = 0$). In the economy with time-varying wealth shares, we have to adjust the previous expression slightly:

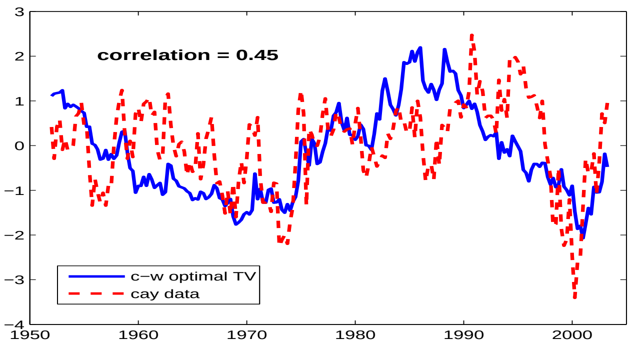
$$c_t - w_t = F' z_t - (1 - \sigma)(\tilde{W}_t^1 - \tilde{W}_t^2). \tag{28}$$

Figure 12 plots the consumption-wealth ratio implied by our model with time-varying human wealth shares, the consumption-consistent C matrix, stock market returns as financial assets and $\sigma = .2789$ (equation 28) alongside *cay*. Both series are demeaned and normalized by their standard deviation. The correlation between the two series for the longest available period (1952-2003) is 0.45. This low correlation reflects the different assumptions on the expected future human wealth returns as well as sampling error in *cay*.

How does the predictability of the consumption-wealth ratio for long-horizon returns compare to the predictability of *cay*? Figure (13) and figure (14) show the slope coefficients and the R^2 of a time series regression of normalized cumulative long-horizon returns $(r_{t+1} + r_{t+2} + \cdots + r_{t+h})/h$ on $c_t - w_t$ in the top panel and on cay_t in the bottom panel. The horizons we consider are 1 through 20 quarters. The most striking difference between the two measures is the predictability of financial asset returns. Relative to the consumption-consistent consumption-wealth process, *cay* over-predicts financial asset returns, both in terms of coefficient magnitude and regression R^2. The regression coefficient on *cay* is

Figure 12. The Consumption-Wealth Ratio and *cay*

The figure plots the consumption-wealth ratio implied by our model with time-varying human wealth shares, the consumption-consistent C matrix, and $\sigma = .2789$. It also plots *cay*, data are obtained from Martin Lettau. Both series are demeaned and normalized by their standard deviation.



almost 50 percent higher than the regression coefficient on $c - w$ at the short end, but the difference disappears at horizon of 20 quarters. The R^2 is twice as high at the short end and the discrepancy disappears at the 5-year horizon. These results seem to suggest that the consumption-wealth ratio is a weaker predictor of stock returns than previously thought, once the restriction is imposed that the consumption-wealth ratio is consistent with consumption data.

VIII. Housing Wealth

In appendix C, we augment the model for a third source of wealth: housing wealth. Consumption is now non-durable and services consumption *excluding* housing services. We solve the model with constant and time-varying human wealth shares. 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 model with housing. Our main conclusions go through: To match consumption moments, human wealth returns must be negatively correlated with financial wealth returns. 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

Figure 13. Long Horizon Return Predictability: Coefficients

The figure plots the regression coefficient β_{cw} in $(r_{t+1} + r_{t+2} + \cdots + r_{t+h})/h = \beta_0 + \beta_{cw}(c_t - w_t) + \xi_{t+1,t+h}$ in the top panel for horizons $h = 1, \cdots, 20$. The bottom panels uses cay_t as a predictor. Both series $c_t - w_t$ and cay_t are demeaned, normalized by their standard deviation, and go from 1952.1-2003.3. The returns are demeaned realized returns on (1) the market portfolio (r^m), (2) the returns on the CRSP value-weighted index (r^a), and (3) the returns on human wealth (r^y) implied by our model with time-varying human wealth shares, the consumption-consistent C matrix, and $\sigma = .2789$.

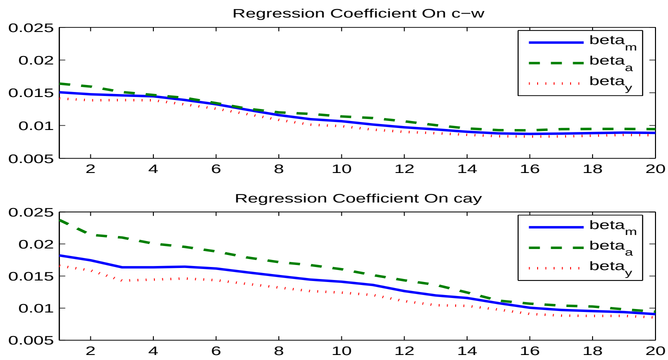
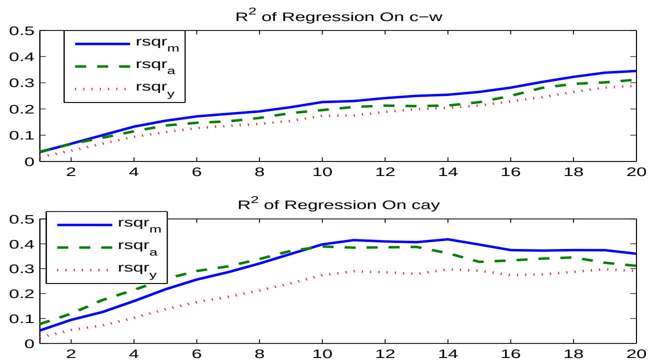


Figure 14. Long Horizon Return Predictability: R^2

The figure plots the regression R^2 of $(r_{t+1}+r_{t+2}+\cdots+r_{t+h})/h = \beta_0+\beta_{cw}(c_t-w_t)+\xi_{t+1,t+h}$ in the top panel for horizons $h = 1, \cdots, 20$. The bottom panels uses cay_t as a predictor. Both series $c_t - w_t$ and cay_t are demeaned, normalized by their standard deviation, and go from 1952.1-2003.3. The returns are demeaned realized returns on (1) the market portfolio (r^m), (2) the returns on the CRSP value-weighted index (r^a), and (3) the returns on human wealth (r^y) implied by our model with time-varying human wealth shares, the consumption-consistent C matrix, and $\sigma = .2789$.



are also negatively correlated with housing returns. Appendix C describes the results in more detail.

IX. Future Research

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 Table I rows 7 and 8 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 III). 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 XVIII 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 & Syverson (2004) develop a model that can deliver these stylized facts.

X. Conclusion

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.

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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.[12] 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

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

[12]Federal Reserve Board of Governors, downloadable at www.federalreserve.gov/ releases/z1/current/data.htm.

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:

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

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:

$$(c)_t = (1 - \bar{\nu})(a)_t + \bar{\nu}(d^y)_t + (1 - \sigma)(1 - \bar{\nu})(h^a)_t - \sigma\bar{\nu}(h^y)_t. \tag{29}$$

The variance of consumption innovations is readily found as:

$$
\begin{aligned}
V_c = (1 - \bar{\nu})^2 V_a + \bar{\nu}^2 V_{d^y} \\
+(1 - \sigma)^2(1 - \bar{\nu})^2 V_{h^a} \\
+\sigma^2\bar{\nu}^2 V_{h^y} + 2(1 - \bar{\nu})\bar{\nu} Corr_{a,d^y}\sqrt{V_a}\sqrt{V_{d^y}} \\
+2(1 - \sigma)(1 - \bar{\nu})^2 Corr_{a,h^a}\sqrt{V_a}\sqrt{V_{h^a}} \\
-2\sigma(1 - \bar{\nu})\bar{\nu} Corr_{a,h^y}\sqrt{V_a}\sqrt{V_{h^y}} + 2(1 - \sigma)(1 - \bar{\nu})\bar{\nu} Corr_{h^a,d^y}\sqrt{V_{d^y}}\sqrt{Vh^a} \\
-2\sigma\bar{\nu}^2 Corr_{h^y,d^y}\sqrt{V_{d^y}}\sqrt{V_{h^y}} - 2\sigma(1 - \sigma)(1 - \bar{\nu})\bar{\nu} Corr_{h^a,h^y}\sqrt{V_{h^a}}\sqrt{(}V_{h^y}).
\end{aligned} \tag{30}
$$

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

$$
\begin{aligned}
V_{c,a} = (1 - \bar{\nu})V_a + \bar{\nu} Corr_{a,d^y}\sqrt{V_a}\sqrt{V_{d^y}} \\
+(1 - \sigma)(1 - \bar{\nu}) Corr_{a,h^a}\sqrt{V_a}\sqrt{V_{h^a}} - \sigma\bar{\nu} Corr_{a,h^y}\sqrt{V_a}\sqrt{h^y}.
\end{aligned} \tag{31}
$$

Note that $Corr_{a,h^y} > 0$, $Corr_{d^y,h^y} > 0$, and $Corr_{h^a,h^y} > 0$ 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:

$$V_c = (1-\bar{\nu})^2 V_a + \bar{\nu}^2 V_{d^y} + \bar{\nu}^2 V_{h^y} + 2(1-\bar{\nu})\bar{\nu}$$
$$\left(Corr_{a,d^y}\sqrt{V_a}\sqrt{V_{d^y}} - Corr_{a,h^y}\sqrt{V_a}\sqrt{V_{h^y}}\right) - 2\bar{\nu}^2 Corr_{h^y,d^y}\sqrt{V_{d^y}}\sqrt{V_{h^y}}, \tag{32}$$

while the covariance is given by:

$$V_{c,a} = (1-\bar{\nu})V_a + \bar{\nu}\left(Corr_{a,d^y}\sqrt{V_a}\sqrt{V_{d^y}} - Corr_{a,h^y}\sqrt{V_a}\sqrt{h^y}\right). \tag{33}$$

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 (7) 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. Habits

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

$$s_{t+1} = \phi s_t + \lambda(s_t)\left(c_{t+1} - E_t c_{t+1}\right),$$

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

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

where S_{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:

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

where the intercept is time-varying because of s_t:

$$\begin{aligned}
\mu_{m,t} &= \sigma \log \beta + \frac{1}{2}\frac{\theta}{\sigma} var_t[\Delta c_{t+1} + \Delta s_{t+1} - \sigma r_{m,t+1}] \\
&= \sigma \log \beta + \frac{1}{2}\frac{\theta}{\sigma} var_t[\Delta c_{t+1} + (\phi - 1)\, s_t + \lambda(s_t)\Delta c_{t+1} - \sigma r_{m,t+1}] \\
&= \sigma \log \beta + \frac{1}{2}\frac{\theta}{\sigma} \left\{ \begin{array}{c} (1+\lambda(s_t))^2 \;\; var_t[\Delta c_{t+1}] \\ -\sigma\,(1+\lambda(s_t))\, cov_t\,(\Delta c_{t+1}, r_{m,t+1}) \\ +\sigma^2 var_t r_{m,t+1} \end{array} \right\}
\end{aligned}$$

This implies expected consumption growth can be restated as:

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

Since we have already discussed heteroscedasticity in the previous section, we assume that $\lambda(s_t) = \lambda$ 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:

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

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

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

All of this implies in turn that:

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

which can be simplified further into:

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

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

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

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

B.3. 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.[13] We can linearize the logistic function for the human wealth share ν_t from equation (18) using a first order Taylor approximation around $(s_t = \bar{s}, w_t = 0)$. We obtain:

$$\begin{aligned} \nu_t(s_t, w_t) &\approx \nu_t(\bar{s}, 0) + \frac{\partial \nu_t}{\partial s_t}|_{s_t=\bar{s}, w_t=0}(s_t - \bar{s}) + \frac{\partial \nu_t}{\partial w_t}|_{s_t=\bar{s}, w_t=0}(w_t), \\ &\approx \bar{s} + (s_t - \bar{s}) - (\bar{s}(1-\bar{s}))w_t, \\ &\approx s_t - \bar{s}(1-\bar{s}) dp_t^y + \bar{s}(1-\bar{s}) dp_t \end{aligned} \tag{34}$$

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 (34) and $\tilde{\nu}_t = D' z_t$:

$$D = e_6 - \bar{s}(1-\bar{s})B + \bar{s}(1-\bar{s})e_3. \tag{35}$$

[13] The mean of w_t must be zero to be able to use the same linearization constant ρ for human wealth and financial wealth.

B.4. Sylvester Equations

With the portfolio weights ν_t we can construct consumption innovations according to equation (45). 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

$$\begin{aligned}
\widetilde{W}_1(z_{t+1}) &= E_{t+1}\sum_{j=1}^{\infty}\rho^j\tilde{\nu}_{t+j}r^a_{t+1+j} \\
\widetilde{W}_1(z_{t+1}) &= \tilde{\nu}_{t+1}E_{t+1}\rho r^a_{t+2} + E_{t+1}\sum_{j=2}^{\infty}\tilde{\nu}_{t+j}\rho^j E_{t+j}r^a_{t+1+j} \\
\widetilde{W}_1(z_{t+1}) &= \tilde{\nu}'_{t+1}\rho e'_1 A z_{t+1} + \rho E_{t+1}\sum_{j=2}^{\infty}\tilde{\nu}_{t+j}\rho^{j-1}E_{t+j}r^a_{t+1+j} \\
&= z'_{t+1}D\rho e'_1 A z_{t+1} + \rho E_{t+1}\widetilde{W}_1(z_{t+2}) \qquad (36)
\end{aligned}$$

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

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

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

$$P_{j+1} = R + \rho A' P_j A, \qquad (37)$$

starting from $P_0 = 0$, and $R = \rho D e'_1 A$. The constant d in the value function equals

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

We are interested in:

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

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 (37) by $S = \rho DC'$. C takes on different values for the three canonical models.

B.5. Market Return

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

$$\begin{aligned}
(m)_{t+1} &\equiv r^m_{t+1} - E_t[r^m_{t+1}] \\
&= (\tilde{\nu}_t + \bar{\nu})(r^y_{t+1} - E_t[r^y_{t+1}]) + (1 - \tilde{\nu}_t - \bar{\nu})(r^a_{t+1} - E_t[r^a_{t+1}]) \\
&= (\tilde{\nu}_t + \bar{\nu}) ICYR_{t+1} + (1 - \tilde{\nu}_t - \bar{\nu}) ICAR_{t+1} \\
&= \left[(\tilde{\nu}_t + \bar{\nu})(e_2' - \rho C')(I - \rho A)^{-1} + (1 - \tilde{\nu}_t - \bar{\nu})e_1'\right] \varepsilon_{t+1}
\end{aligned}$$

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

$$\begin{aligned}
(h^m)_{t+1} &\equiv (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r^m_{t+1+j} \\
&= (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j \left[(\tilde{\nu}_{t+j} + \bar{\nu}) r^y_{t+1+j} + (1 - \tilde{\nu}_{t+j} - \bar{\nu}) r^a_{t+1+j}\right] \\
&= \bar{\nu} NFYR_{t+1} + W_{2,t+1} + (1 - \bar{\nu}) NFAR_{t+1} - W_{1,t+1} \\
&= \rho \left[\bar{\nu} C' + (1 - \bar{\nu}) e_1' A\right] (I - \rho A)^{-1} \varepsilon_{t+1} - (\varepsilon'_{t+1}(P - Q)\varepsilon_{t+1}) - q
\end{aligned}$$

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:

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

B.6. Asset Pricing

Using the definition of $(m)_t$ in equation (38),

$$V_{im} = \sum_{k=1}^{N} \left[(\tilde{\nu}_t + \bar{\nu})(e_2' - \rho C')(I - \rho A)^{-1} + (1 - \tilde{\nu}_t - \bar{\nu})e_1'\right]_k V_{ik} \qquad (38)$$

Likewise, we can define V_{ih} as a linear combination of V_{ik} terms. Recalling the definition of $(h^m)_t$ in equation (38), 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:

$$V_{ih} = \sum_{k=1}^{N} \left[\rho \left[\bar{\nu} C' + (1 - \bar{\nu}) e_1' A\right] (I - \rho A)^{-1}\right]_k V_{ik} \qquad (39)$$

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:

$$W_{t+1} = R^m_{t+1}\left(W_t - C_t - P^h_t H_t\right) = R^m_{t+1}\left(W_t - \frac{C_t}{A_t}\right). \tag{40}$$

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

$$\Delta w_{t+1} = r^m_{t+1} + \log\left(1 - \exp(c_t - a_t - w_t)\right).$$

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

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

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):

$$c_{t+1} - E_t c_{t+1} = (E_{t+1} - E_t)\sum_{j=0}^{\infty}\rho^j r^m_{t+1+j} + (E_{t+1} - E_t)\sum_{j=0}^{\infty}\rho^j \Delta a_{t+1+j} - (E_{t+1} - E_t)\sum_{j=1}^{\infty}\rho^j \Delta c_{t+1+j} \tag{41}$$

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

$$1 = E_t[\exp(m_{t+1} + r^m_{t+1})],$$

where the log stochastic discount factor is:

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

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:

$$E_t \Delta c_{t+1} = \mu_m + \sigma E_t r^m_{t+1} - \left(\frac{\sigma-\varepsilon}{\varepsilon-1}\right) E_t \Delta a_{t+1}, \tag{42}$$

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 (42) back into the consumption innovation equation in (41), to obtain an expression with only returns on the right hand side:

$$\begin{aligned} c_{t+1} - E_t c_{t+1} \quad = \quad & r^m_{t+1} - E_t r^m_{t+1} + (1-\sigma)(E_{t+1} - E_t)\sum_{j=1}^{\infty} \rho^j r^m_{t+1+j} + \\ & \left(\frac{\sigma-1}{\varepsilon-1}\right)(E_{t+1} - E_t)\sum_{j=0}^{\infty} \rho^j \Delta a_{t+1+j}, \end{aligned} \tag{43}$$

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 $\sigma < \varepsilon$.

VAR Additions To the 7 elements in the VAR without housing we add: the log real return on housing (r^h, element 8), the log growth rate in the non-housing expenditure share (Δa, element 9), the housing income share (s^h, element 10), and the log dividend price ratio on housing ($dp^h, element 11$). To avoid confusion, redefine the notation for the labor income share as s^y (element 6).

Once the VAR has been estimated, we can construct the three new series: innovations in current housing returns $\{(h)_t\}$, news about future housing returns $\{(h^h)_t\}$, and news about current and future growth rates on the non-housing expenditure share $\{(d^a)_t\}$:

$$\begin{aligned}
(h)_{t+1} &= r^h_{t+1} - E_t[r^h_{t+1}] = e_8'\varepsilon_{t+1} \\
(h^h)_{t+1} &= (E_{t+1} - E_t)\sum_{j=1}^{\infty}\rho^j r^h_{t+1+j} = e_8'\rho A(I-\rho A)^{-1}\varepsilon_{t+1} \\
(d^a)_{t+1} &= (E_{t+1} - E_t)\sum_{j=0}^{\infty}\rho^j \Delta a_{t+1+j} = e_9'(I-\rho A)^{-1}\varepsilon_{t+1}
\end{aligned} \tag{44}$$

Lastly, we can compute news in current and future housing dividend growth as: $(d^h)_t = (h)_t + (h^h)_t$ and innovations in current housing dividend growth as $(f^h)_t = (e_8 + \rho e_1 1)'\varepsilon_t$.

Housing Return Data We construct data on the log change in the value of the aggregate housing stock (Δp^h_{t+1}) and the log change in the dividend payments on the aggregate housing stock (Δd^h_{t+1}). 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).[14] We construct housing returns from the Campbell-Shiller decomposition:

$$r^h_{t+1} = k + \Delta d^h_{t+1} + (d^h_t - p^h_t) - \rho(d^h_{t+1} - p^h_{t+1})$$

where ρ and k are Campbell Shiller linearization constants.[15] 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.[16]

[14]In the model the mean dividend price ratios are the same on all assets.

[15]In the model, these constants must be the same for all assets (financial wealth, housing wealth and human wealth). We use stock market data: $\rho = \frac{1}{1+\overline{d^a - p^a}} = .9901$ and $k = -\log(\rho) - (1-\rho)\log(\rho^{-1} - 1) = .0556$.

[16]Those 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

We note that the log dividend price ratio on housing dp^h helps predict financial asset returns and labor income growth. The R^2 on the firm value return in the new VAR is 10.7%, much higher than the 6.1% in the VAR without the housing variables. The R^2 on the CRSP stock return in the new VAR is 13.6%, also higher than the 7.3% in the VAR without the housing variables. Lustig & VanNieuwerburgh (2005) also show that housing related variables, such as the housing collateral ratio, can help forecast financial asset returns. Likewise the R^2 in the labor income growth equation increases from 27% to 32%. The variable also enters significantly in the forecasting equations for dp^a, rtb, Δc, and s^h.

Moments of the Data Table XIX summarizes the moments from the data using the firm value returns and stock returns. The return innovations on housing (computed from the VAR) are not very volatile (2.3% standard deviation per year) and have a low correlation with financial asset returns (0.10 with firm value returns and 0.16 with stock returns). Innovations in current housing returns are strongly correlated with news in current and future labor income growth ($Corr_{h,d^y} = .7$). News about changes in the non-housing expenditure share d^a has a very low variance. This term will play a negligible role in the analysis.

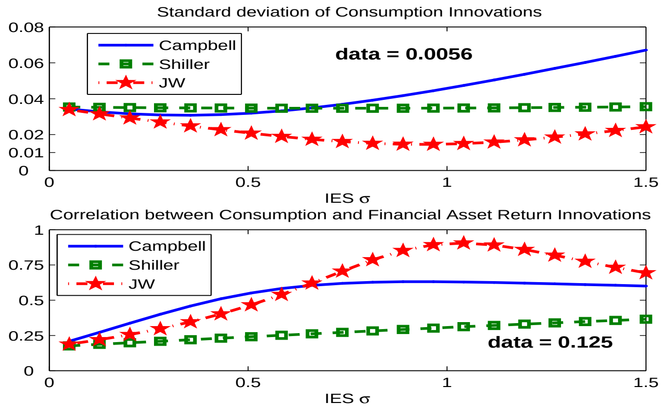
The main changes of the inclusion of housing returns in the other moments are in news about future labor income growth: d^y has a much higher variance than without housing: 1.6 to 21.2 for firm value returns (1.65 to 25.06 for stock returns). This is because the dividend price ratio on housing significantly improves the predictability of labor income growth. It now has a positive correlation with h^a: This correlation switched from -.53 to .49 for firm value returns (-.34 to .53 for stock returns) after the inclusion of housing. This makes it harder to match the low volatility of consumption and its low correlation with asset returns. The correlation between d^y and a dropped from 0.34 to -.07 (0.49 to .34 for stocks), making it easier to match the correlation. This is counteracted by the high positive correlation between h and d^y. Financial asset returns have less mean reversion, especially for stock returns (-.92 to -.56). In terms of the target moments of consumption, non-housing consumption c is slightly less volatile and has an even lower correlation with financial asset returns (0.12 versus 0.17).

The correlation pattern between the pay-outs on the wealth components also changes. News about current and future pay-out innovations on housing and human wealth is close to 1. Pay-out innovations on financial and human wealth are higher now than they were in the model without housing.

Consumption Growth Accounting Table XXI compares the moments of human wealth returns, consumption, and implied market returns for the three benchmark models (Models 2, 3, and 4 in columns 1-3 in each panel) to the moments that result from backing out human wealth returns from consumption data (Model 5 in column 4). The failure of the benchmark models in terms of their implied consumption variance is more spectacular than in the model without housing. Also, consumption is still

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 15. The *EIS* and Consumption Innovation Volatility and Correlation - Using Returns on Firm Value, Quarterly Data 1947-2003
The labor share $\bar{\nu}^y$ is .70, the housing income share is $\bar{\nu}^h = 0.11$. The parameter $\varepsilon = .50$.



much too highly correlated with financial asset returns, but the failure is less pronounced than before. As before, matching the moments of consumption implies a negative correlation between return innovations on financial and human wealth ($Corr_{y,a} = -.70$). It also implies a negative correlation of human wealth returns and housing returns (-.5). The resulting market return process is again negatively correlated with financial asset returns, as well as with housing returns. It is strongly positively correlated with human wealth returns. The resulting market return process is mean strongly reverting ($Corr_{m,h^m} = -.91$ or -.95). Our main conclusions remain unaffected.

Figure 15 graphically illustrates the failure of the three benchmark models of human wealth returns for different values of the *IES* σ. Consumption is too volatile by at least an order of 3 (and often much more), and the correlations with financial asset returns is uniformly too high.

Time-Varying Wealth Shares The procedure with time-varying wealth shares goes through in the model with financial wealth, human wealth and housing wealth. The market return is

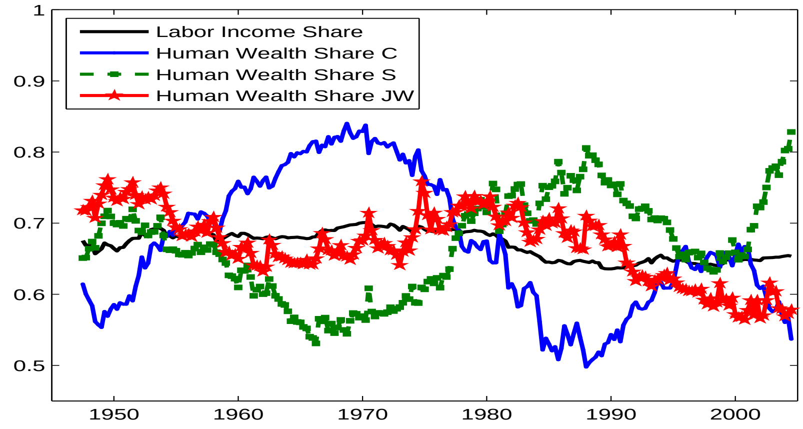
$$r^m_{t+1} = (1 - \nu^y_t - \nu^h_t) r^a_{t+1} + \nu^y_t r^y_{t+1} + \nu^h_t r^h_{t+1}$$

The human wealth shares and housing wealth shares are logistic functions of the state. We use a linear specification:

$$\tilde{\nu}^y_t \equiv \nu^y_t - \bar{\nu}^y = D'_y z_t$$

$$\tilde{\nu}^h_t \equiv \nu^h_t - \bar{\nu}^h = D'_h z_t$$

Figure 16. The Human Wealth Share - Using Returns on Stocks, Quarterly Data 1947-2003



and we pin down D_y and D_h (each $N \times 1$) using a first order Taylor approximation. Let s_t^y (s_t^h) be the labor (housing) income share with mean $\bar{s}^y$ ($\bar{s}^h$). After lengthy algebra, the linearization results in:

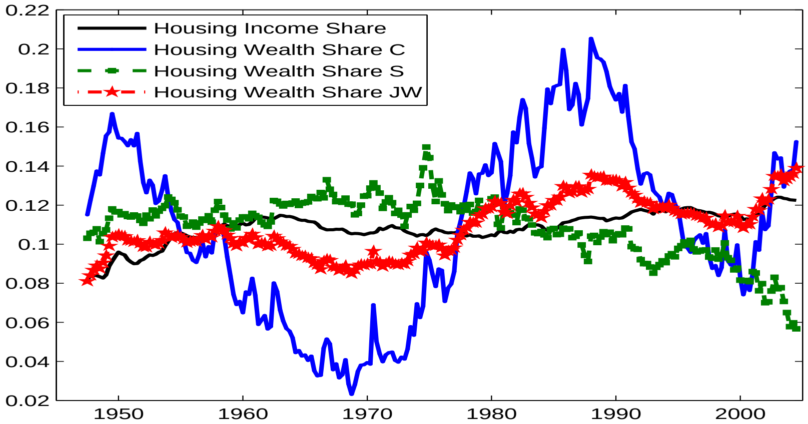
$$\nu_t^y = s_t^y - \bar{s}^y \left[(1-\bar{s}^y)dp_t^y - \bar{s}^h dp_t^h - (1-\bar{s}^y-\bar{s}^h)dp_t^a\right],$$
$$\nu_t^h = s_t^h - \bar{s}^h \left[-\bar{s}^y dp_t^y + (1-\bar{s}^h)dp_t^h - (1-\bar{s}^y-\bar{s}^h)dp_t^a\right],$$

The average human (housing) wealth share is the average labor (housing) income share: $\bar{\nu}^y = \bar{s}^y$ ($\bar{\nu}^h = \bar{s}^h$). If dp_t^a is the third element of the VAR, $dp_t = e_3' z_t$, $s_t^y - \bar{s}^y$ the sixth, $s_t^h - \bar{s}^h$ the tenth, dp_t^h the eleventh and if $dp_t^y = B' z_t$, then we can solve for D_h and D_y as

$$D_y = e_6 - \bar{s}^y(1-\bar{s}^y)B + \bar{s}^y\bar{s}^h e_{11} + \bar{s}^y(1-\bar{s}^y-\bar{s}^h)e_3,$$
$$D_h = e_{10} + \bar{s}^y\bar{s}^h B - \bar{s}^h(1-\bar{s}^h)e_{11} + \bar{s}^h(1-\bar{s}^y-\bar{s}^h)e_3,$$

Figures 16 and 17 shows the time-varying human wealth and housing wealth shares in the three benchmark models.

Figure 17. The Housing Wealth Share - Using Returns on Stocks, Quarterly Data 1947-2003



Consumption innovations The expression for consumption innovations with time-varying human wealth share is:

$$\begin{aligned} c_{t+1} - E_t c_{t+1} &= (1 - \bar{\nu}^y - \bar{\nu}^h - \tilde{\nu}_t^y - \tilde{\nu}_t^h)(a)_{t+1} + (\tilde{\nu}_t^h + \bar{\nu}^h)(h)_{t+1} + \\ &\quad (\tilde{\nu}_t^y + \bar{\nu}^y)(d^y)_{t+1} - (\tilde{\nu}_t^y + \sigma\bar{\nu}^y)(h^y)_{t+1} + \\ &\quad (1-\sigma)(1 - \bar{\nu}^y - \bar{\nu}^h)(h^a)_{t+1} + (1-\sigma)\bar{\nu}^h(h^h)_{t+1} \\ &\quad -(1-\sigma)(W_{t+1}^{ah} + W_{t+1}^{ay} - W_{t+1}^{hh} - W_{t+1}^{yy}) + \\ &\quad \tfrac{\sigma-1}{\varepsilon-1}(d^a)_{t+1}. \end{aligned} \tag{45}$$

where

$$W_{t+1}^{kl} = (E_{t+1} - E_t)\sum_{j=1}^{\infty} \rho^j \tilde{\nu}_{t+j}^l r_{t+1+j}^k, \; k = a, h, y, \qquad l = y, h.$$

We use value function iteration to pin down W^{kl}:

$$W_{t+1}^{kl} = \varepsilon_{t+1}' P^{kl} \varepsilon_{t+1} - \sum_{i=1}^{N}\sum_{j=1}^{N} \Sigma_{ij} P_{ij}^{kl}$$

and P^{kl} solves the Sylvester equation:

$$P_{j+1}^{kl} = R^{kl} + \rho A' P_j^{kl} A,$$

where

$$\begin{aligned} R^{ah} &= \rho D_h e_1' A, \\ R^{ay} &= \rho D_y e_1' A, \\ R^{hh} &= \rho D_h e_8' A, \\ R^{yy} &= \rho D_h C'. \end{aligned}$$

We can compute a solution to this recursive equation by iterating on it starting from $P_0^{kl} = 0$.

Market Return Finally, we compute innovations in current and future market returns as:

$$\begin{aligned} (m)_{t+1} &= (1 - \bar{\nu}^y - \bar{\nu}^h - \tilde{\nu}_t^y - \tilde{\nu}_t^h)(a)_{t+1} + (\tilde{\nu}_t^h + \bar{\nu}^h)(h)_{t+1} + (\tilde{\nu}_t^y + \bar{\nu}^y)(y)_{t+1} \\ (h^m)_{t+1} &= (1 - \bar{\nu}^y - \bar{\nu}^h)(h^a)_{t+1} + \bar{\nu}^h(h)_{t+1} + \bar{\nu}^y(h^y)_{t+1} - (W_{t+1}^{ah} + W_{t+1}^{ay} - W_{t+1}^{hh} - W_{t+1}^{yy}) \end{aligned}$$

Results with Time-Varying Wealth Shares The results with time-varying wealth shares are close to the results with constant wealth shares. Matching the moments of consumption requires current financial wealth and human wealth returns to be negatively correlated. The resulting market return is negatively correlated with returns on both financial wealth and housing wealth, and strongly positively correlated with returns on human wealth.

D. Additional Tables

Table XI
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.

	Firm Value Returns							
Variable	r^a_{t-1}	Δy_{t-1}	dp^a_{t-1}	rtb_{t-1}	ysp_{t-1}	s_{t-1}	Δc_{t-1}	R^2
r^a_t	0.0586	−0.2325	0.0290	−0.9373	−0.1186	−0.1222	−1.1222	6.06
se	(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
se	(0.0070)	(0.1372)	(0.0034)	(0.0748)	(0.0728)	(0.0462)	(0.1224)	
dp^a_t	0.1024	−1.4521	0.9061	2.2013	0.5850	−0.2164	1.0603	83.01
se	(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
se	(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
se	(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
se	(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
se	(0.0054)	(0.0541)	(0.0024)	(0.0468)	(0.0373)	(0.0323)	(0.1239)	
	Stock Returns							
Variable	r^a_{t-1}	Δy_{t-1}	dp^a_{t-1}	rtb_{t-1}	ysp_{t-1}	s_{t-1}	Δc_{t-1}	R^2
r^a_t	0.0336	−0.0317	0.0479	−0.8253	0.4970	−0.1364	−0.6616	7.31
se	(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
se	(0.0067)	(0.1330)	(0.0025)	(0.0771)	(0.0640)	(0.0464)	(0.1255)	
dp^a_t	0.0532	0.5213	0.9728	1.3571	−0.0181	0.0971	0.5055	93.17
se	(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
se	(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
se	(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
se	(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
se	(0.0046)	(0.0545)	(0.0017)	(0.0478)	(0.0372)	(0.0276)	(0.1260)	

Table XII
Moments for Consumption Growth and Human Capital Returns: Models 2, 3, & 4 - Constant Wealth Shares - Annual Data

The left panel uses firm value returns over the full sample (1947-2004). The right panel uses firm value returns over the full sample (1947-2004). In each panel, the first column represents the *Campbell* specification for human capital returns (equation 8). The second column represents the constant discounter model (equation 9), and the third column represents the autarkic model (equation 10). The last column gives the corresponding moments in the data, when available. a (y) denotes innovations in current asset (human capital) returns $r^a_{t+1} - E_t r^a_{t+1}$ ($r^y_{t+1} - E_t r^y_{t+1}$). h^a is news in future asset returns $(E_{t+1} - E_t)\sum_{j=1}^{\infty} \rho^j r^a_{t+1+j}$. c denotes innovations in current consumption $(c_{t+1} - E_t c_{t+1})$. Computations are done for $\bar{\nu} = .7000$ and $\sigma = .2789$.

Moments	*Campbell*	*Shiller*	*JW*	*data*	*Campbell*	*Shiller*	*JW*	*data*
	Panel A: Firm Value				*Panel B: Stocks*			
V_{h^y}	47.44	0	2.83		231.85	0	1.94	
$Corr_{a,h^y}$	-.487	0	.861		-.760	0	.693	
$Corr_{d^y,h^y}$	-.818	0	.676		-.196	0	.767	
$Corr_{h^a,h^y}$	1.000	0	-.306		1.000	0	-.285	
$Corr_{y,a}$	.526	.559	-.003		.780	.329	-.055	
$Corr_{y,h^a}$	-.986	-.818	-.666		-.987	-.196	-.066	
V_y	83.20	6.67	3.62		254.55	6.95	3.25	
V_c	27.19	20.07	17.55	.681	28.54	15.99	14.04	.642
$Corr_{c,a}$	.963	.975	.975	.163	.943	.695	.691	.208

Table XIII
Moments for Consumption Growth - Models 2, 3, and 4 - Sensitivity Analysis

This panel uses the returns on firm value over the full sample 1947.II-2004.III. The left panel reports the variance of model-implied innovations in consumption V_c. The right panel reports the model-implied correlation between innovations in consumption and innovations in current asset returns $Corr_{c,a}$. The results are computed for three values of the *IES* σ and two values of the labor income share ν.

Labor Share	*EIS*	*Campbell*	*Shiller*	*JW*	*Campbell*	*Shiller*	*JW*
		V_c			$Corr_{c,a}$		
$\bar{\nu} = .70$	$\sigma = .27$	6.05	4.29	3.94	0.95	0.87	0.87
	$\sigma = .73$	19.96	5.27	4.24	0.80	0.94	0.96
	$\sigma = 1.5$	73.65	9.64	7.23	0.66	0.90	0.90
$\bar{\nu} = .85$	$\sigma = .27$	5.13	2.07	1.71	0.78	0.77	0.78
	$\sigma = .73$	21.45	2.58	1.64	0.65	0.81	0.84
	$\sigma = 1.5$	79.16	4.11	2.27	0.57	0.79	0.77

Table XIV: Consumption Growth Accounting: Using Stock Return Data

The table displays moments for consumption growth, human capital returns and market returns implied by the consumption growth accounting exercise. Panel A displays moments of current human wealth and market returns; Panel B displays moments of expected future human wealth and market returns. We use the full sample 1947.II-2004.III. The measure of financial asset returns is returns on the stock market. The symbols are as in Table V. Computations are done for $\bar{\nu} = .70$ and $\sigma \in \{.2789, .7368, 1.50\}$.

				Panel A: Current Returns						
EIS	V_y	$Corr_{y,a}$	$Corr_{y,d^y}$	$Corr_{y,h^a}$		V_m	$Corr_{m,a}$	$Corr_{m,d^y}$	$Corr_{m,h^a}$	$Corr_{m,y}$
$\sigma = .27$	46.22	−0.44	−0.60	0.09		18.29	0.07	−0.40	−0.41	0.87
$\sigma = .73$	11.91	−0.94	−0.48	0.77		0.74	0.15	0.01	−0.38	0.21
$\sigma = 1.5$	11.97	−0.95	−0.26	0.96		0.54	0.11	0.73	0.16	0.19
				Panel B: Future Returns						
EIS	V_{h^y}	$Corr_{h^y,a}$	$Corr_{h^y,d^y}$	$Corr_{h^y,h^a}$	$Corr_{h^y,y}$	V_{h^m}	$Corr_{h^m,a}$	$Corr_{h^m,d^y}$	$Corr_{h^m,h^a}$	
$\sigma = .27$	58.37	0.48	0.70	−0.14	−0.99	33.42	−0.04	0.47	0.40	−0.99
$\sigma = .73$	17.82	0.91	0.70	−0.73	−0.96	4.79	−0.04	0.47	0.40	−0.75
$\sigma = 1.5$	15.94	0.98	0.55	−0.94	−0.95	1.16	−0.04	0.47	0.40	0.64

Table XV
Moments for Consumption Growth and Human Capital Returns - Models 2, 3, and 4 - Time-Varying Wealth Shares - Using Stock Returns

The results use the stock market return as measure of financial asset returns and are for the full sample 1947.II-2004.III. The first column represents the *Campbell* specification for human capital returns (equation 8). The second column represents the constant discounter model (equation 9), and the third column represents the autarkic model (equation 10). The last column gives the corresponding moments in the data, when available. (a), (y), and (m) stand for innovations in current asset, human capital and total market returns. (h^a), (h^y) and (h^m) stand for news in future financial asset returns, future human wealth returns and future market returns. Computations are done for time-varying, human wealth share ν_t and $\sigma = .2789$.

Moments	*Campbell*	*Shiller*	*JW*	*data*
V_{h^y}	103.07	0	.79	
$Corr_{a,h^y}$	-.918	0	.644	
$Corr_{d^y,h^y}$	-.336	0	.735	
$Corr_{h^a,h^y}$	1.000	0	-.453	
$Corr_{y,a}$	.934	.491	.065	
$Corr_{y,h^a}$	-.994	-.336	-.032	
V_y	113.48	1.65	.76	
V_c	8.00	2.77	2.41	.328
$Corr_{c,a}$	.955	.511	.473	.185
V_m	96.09	7.75	5.46	
$Corr_{m,a}$	.961	.939	.937	
$Corrm, y$	.996	.736	.353	
$Corrm, h^m$	-.987	-.810	-.748	

Table XVI
Moments for Consumption Growth and Human Capital Returns - Model 5 - Time Varying Wealth Shares - Using Stock Returns

The first column is for $\sigma = .2789$, the second column is for .7368, and the last column is for $\sigma = 1.5$. The sample is 1947.II-2004.III. Financial asset returns are returns on the CRSP value-weighted stock market index.

Moments	*model*	*data*		
Moments	$\sigma = .2789$	$\sigma = .7368$	$\sigma = 1.5$	*data*
V_{h^y}	36.38	13.98	11.81	
$Corr_{a,h^y}$	.504	.907	.978	
$Corr_{d^y,h^y}$	.874	.724	.643	
$Corr_{h^a,h^y}$	-.209	-.696	-.905	
$Corr_{y,a}$	-.487	-.937	-.978	
$Corr_{y,h^a}$	.168	.737	.960	
V_y	24.50	8.68	7.79	
V_c	.469	.328	.409	.328
$Corr_{c,a}$	.185	.185	.185	.185
V_m	10.10	.65	.66	
$Corr_{m,a}$	.067	.095	.188	
$Corrm, y$	.825	.207	-.056	
$Corrm, h^m$	-.980	-.703	.625	

Table XVII
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.

Moments	*model*	*data*	*model*	*data*
	Proprietor's Income		Non-Fin. Business	
V_{h^y}	30.58		33.44	×
$Corr_{a,h^y}$	.828		.628	×
$Corr_{d^y,h^y}$	.643		.937	×
$Corr_{h^a,h^y}$	-.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 XVIII
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 ($Diff^{NAPM}$).

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

Table XIX
Moments from Data: With Housing Data

The asset return is the return on firm value in the left column and the return on stocks in the right column. The moments for quarterly data are from own calculations for the 1947.II-2004.III. 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; d^y denotes news in current and future labor income growth; c denotes innovations to non-durable and services consumption, excluding housing services consumption; h denotes innovations in current housing returns, h^h denotes news in future housing returns, and d^a denotes news in current and future non-housing expenditure share growth.

Moments	*Firm Value Returns*	*Stock Returns*
Previous		
V_a	45.92	59.25
V_{d^y}	21.22	25.06
V_{h^a}	35.94	121.18
$Corr_{a,h^a}$	-.434	-.557
$Corr_{a,d^y}$	-.072	.342
$Corr_{d^y,h^a}$	.489	.526
Housing		
V_h	1.33	1.32
V_{h^h}	10.73	12.83
V_{d^a}	0.17	.20
$Corr_{h,a}$	.098	.160
$Corr_{h,d^y}$	.711	.773
$Corr_{h,h^a}$	.204	.438
$Corr_{h,h^h}$	.510	.615
Pay-outs		
$Corr_{d^d,d^y}$	.357	.909
$Corr_{d^d,d^h}$	.378	.918
$Corr_{d^y,d^h}$	.997	.998
$Corr_{f^d,f^y}$	-.086	.105
$Corr_{f^d,f^h}$	.120	.103
$Corr_{f^y,f^h}$	.133	.138
Consumption		
V_c	0.312	0.312
$Corr_{c,a}$	0.125	0.119

Table XX
Moments for Consumption Growth, Human Capital Returns, and the Market Return - Constant Wealth Shares

The left panel uses firm value returns over the full sample (1947.II-2003.IV). The right panel uses firm value returns over the full sample (1947.II-2003.IV). In each panel, the first column represents the *Campbell* specification for human capital returns. The second column represents the constant discounter model, and the third column represents the autarkic model. The last column gives the result of our consumption accounting exercise, where we back out h^y from consumption data. Computations are done for the model with constant human wealth shares $\bar{\nu}^y = .70$, $\bar{\nu}^h = .11$, $\sigma = .7368$, and $\varepsilon = 0.50$.

	Panel A: Firm Value				*Panel B: Stock Returns*			
Moments	*Campbell*	*Shiller*	*JW*	*Reverse*	*Campbell*	*Shiller*	*JW*	*Reverse*
Human Wealth								
V_{h^y}	35.49	0	19.48	44.11	121.18	0	24.47	71.63
$Corr_{a,h^y}$	-.434	0	-.083	.255	-.557	0	.340	.521
$Corr_{d^y,h^y}$	.489	0	.984	.929	.526	0	.986	.971
$Corr_{h^a,h^y}$	1.000	0	.572	.403	1.000	0	.536	.372
V_y	30.17	21.22	.70	8.49	88.22	25.06	.70	14.44
$Corr_{y,a}$	.413	-.072	.040	-.696	.824	.342	.038	-.710
$Corr_{y,h^a}$	-.682	.489	-.324	-.146	-.891	.526	-.020	-.134
$Corr_{y,h}$	.374	.711	.276	-.491	-.101	.773	.277	-.569
$Corr_{y,h^h}$	.207	.964	.260	-.489	-.084	.973	.072	-.854
Consumption								
V_c	13.60	12.01	2.70	.312	33.63	19.09	4.08	.312
$Corr_{c,a}$	.620	.272	.682	.125	.949	.536	.730	.119
Market								
V_m	20.75	11.71	2.73	1.96	60.33	18.79	3.42	3.39
$Corr_{m,a}$	.666	0.377	.930	-.085	.899	.663	.945	-.221
$Corr_{m,y}$	.954	0.896	.396	.773	.992	.930	.357	.843
$Corr_{m,h}$	.362	0.721	.259	-.535	-.031	.690	.300	-.627
$Corr_{m,h^m}$	-.653	.412	-.136	-.913	-.819	.318	.028	-.952

Table XXI
Moments for Consumption Growth, Human Capital Returns, and the Market Return - Time-Varying Wealth Shares

The left panel uses firm value returns over the full sample (1947.II-2003.IV). The right panel uses firm value returns over the full sample (1947.II-2003.IV). In each panel, the first column represents the *Campbell* specification for human capital returns. The second column represents the constant discounter model, and the third column represents the autarkic model. The last column gives the result of our consumption accounting exercise, where we back out h^y from consumption data. Computations are done for the model with time-varying human wealth shares and $\sigma = .7368$, $\varepsilon = 0.50$.

	Panel A: Firm Value				*Panel B: Stock Returns*			
Moments	*Campbell*	*Shiller*	*JW*	*Reverse*	*Campbell*	*Shiller*	*JW*	*Reverse*
Human Wealth								
V_{h^y}	35.94	0	19.48	52.50	121.18	0	24.47	78.11
$Corr_{a,h^y}$	-.434	0	-.083	.267	-.557	0	.340	.543
$Corr_{d^y,h^y}$	.489	0	.984	.852	.526	0	.986	.952
$Corr_{h^a,h^y}$	1.000	0	.572	.419	1.000	0	.536	.341
V_y	30.17	21.22	.70	16.82	88.22	25.06	.70	18.93
$Corr_{y,a}$	.413	-.072	.040	-.552	.835	.342	.038	-.710
$Corr_{y,h^a}$	-.682	.489	-.324	-.191	-.891	.526	-.020	-.086
$Corr_{y,h}$	.374	.711	.276	-.170	-.101	.773	.277	-.611
$Corr_{y,h^h}$	.207	.964	.260	-.426	-.084	.973	.072	-.766
Consumption								
V_c	13.46	12.26	3.04	2.260	32.62	19.50	4.94	.980
$Corr_{c,a}$	.659	.323	.761	.125	.961	.558	.757	.119
Market								
V_m	20.75	12.23	2.80	5.60	59.20	18.93	3.64	4.43
$Corr_{m,a}$	.663	0.364	.918	-.007	.904	.654	.925	-.174
$Corr_{m,y}$	.954	0.886	.400	.828	.987	.927	.361	.792
$Corr_{m,h}$	.363	0.707	.248	-.083	-.038	.676	.287	-.690
$Corr_{m,h^m}$	-.654	.405	-.143	-.770	-.813	.339	.033	-.876