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"Expectations, Shocks, and Asset Returns"

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Expectations, Shocks, and Asset Returns

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Abstract

I use the consumer's budget constraint to derive a relationship between stock market returns, the residuals of the trend relationship among consumption, aggregate wealth, and labour income, *cay*, and three major sources of risk: future changes in the housing consumption share, *cr*, future labour income growth, *lr*, and future consumption growth, *lrc*.

Using a VAR, I compute measures of expected and unexpected long-run changes of the major determinants of asset returns and find that: (*i*) *cay*, *cday*, expected *lr*, *cr*, *lrc* and expected long-run changes in ex-ante real returns, *lrret*, strongly forecast future asset returns; (*ii*) unexpected *lrc* and unexpected *lrret* contain some predictive power for asset returns; (*iii*) unexpected *lr* and unexpected *cr* do not predict future asset returns.

One can, therefore, use the intertemporal budget constraint and the forecasting properties of an informative VAR to generate the predictability of many economically motivated variables developed in the literature on asset pricing. The framework presented is sufficiently flexible to accommodate the implications of a wide class of optimal models of consumer behaviour without imposing a functional form on preferences.

Keywords: expectations, shocks, asset returns, wealth, income, consumption, housing share.

JEL classification: E21, E44, D12.

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1 Introduction

Differences in expected returns across assets are the naturally explained by differences in risk and the risk premium is generally considered as reflecting the ability of an asset to insure against consumption fluctuations (Lucas (1978), Breeden (1979), Sharpe (1964), Lintner (1965)).

Despite this, differences in the covariance of returns and contemporaneous consumption growth across portfolios have not proved to be sufficient to justify the differences in expected returns observed in the U.S. stock market (Mankiw and Shapiro, 1986; Breeden et al., 1989; Campbell, 1996; Cochrane, 1996; Lettau and Ludvigson, 2001b).Additionally, Hansen and Singleton (1982) - for the consumption-based models -, and Fama and French (1992) - for the CAPM -, show that these models have considerable difficulty in supporting the differences in a cross-section of asset returns.

As a result, the identification of the economic sources of risks is still an important issue. According to canonical macroeconomic theory, aggregate consumption reflects the optimal choices of a representative consumer and can be explained by changes in the risk-free rate of return and in the information about current wealth, future income, and future rates of return. Whilst this theory is supported by the unpredictability of consumption growth, several studies have shown that predictable movements in aggregate consumption growth are almost uncorrelated with the risk-free rate of return and are significantly correlated with predictable changes in income, therefore, questioning its validity.[1] Parker and Preston (2005) use household-level data to measure the relative importance of new information, the real interest rate, the preference for consumption, and precautionary saving in explaining fluctuations in aggregate consumption growth and find that precautionary savings play an important role in consumption fluctuations.[2,3] By its turn and in the spirit of Brainard et al. (1991),[4] Parker and Julliard (2005) measure the risk of a portfolio by its ultimate risk to consumption, defined as the covariance of its return and consumption growth over the quarter of the return and many following quarters and show that it is able to explain cross-section of asset returns.[5]

[1] See Flavin (1981), Shiller (1982), Hall (1988), Campbell and Deaton (1989), and Campbell and Mankiw (1989).

[2] Nelson (1994), Cochrane (1991), and Attanasio and Davis (1996) reject complete consumption insurance in the U.S. and Rios-Rull (1994), Krusell and Smith (1998) and Gourinchas (2000) study precautionary saving in model economies.

[3] See, for example, Baxter and Jermann (1999), Basu and Kimball (2000), and Ogaki and Reinhart (1998). Carroll (1997) argues that incomplete markets are an important source of bias, whilst Attanasio and Weber (1995) finds that labor supply is an important shifter of the preference for consumption.

[4] These authors show that the longer the horizon of the investor, the better the CCAPM performs relative to the CAPM.

[5] The authors show that this can provide the correct measure of risk under several extant explanations of slow consumption adjustment, such as some models of (*a*) measurement error in consumption; (*b*) costs of adjusting consumption; (*c*) nonseparability of the marginal utility of consumption from factors such as labor supply or housing stock, which themselves are constrained to adjust slowly; or (*d*) constraints on information flow or calculation so that household behavior

The literature in asset pricing has, therefore, largely concluded that differences in expected returns are not due to differences in risk to consumption, but instead arise from inefficiencies of financial markets, time variation in effective risk aversion (Sundaresan, 1989; Constantinides, 1990; Campbell and Cochrane, 1999), in the joint distribution of consumption and asset returns or quite different models of economic behavior. In addition, several papers tried to shed more light on this question and many economically motivated variables have been developed to capture time-variation in expected returns and document long-term predictability.[6] Lettau and Ludvigson (2001) show that the transitory deviation from the common trend in consumption, aggregate wealth and labor income, *cay*, is a strong predictor of asset returns, as long as the expected return to human capital and consumption growth are not too volatile. Fernandez-Corugedo et al. (2003) use the same approach but incorporate the relative price of durable goods, whilst Julliard (2004) shows that the expected changes in labor income are important because of their ability to track time varying risk premia. The nonseparability between consumption and leisure in on the basis of the work of Wei (2005), who argue that human capital risk can generate sufficient variation in the agent's risk attitude to produce equity returns and bond yields with properties close to the observed in the data. Whilst the last two papers emphasize the role of human capital, others have focused on the importance of the housing market instead. Yogo (2006) and Piazzesi et al. (2007) emphasize the role of nonseparability of preferences in explaining the countercyclical variation in the equity premium.[7] In the same spirit, Lustig and Van Nieuwerburgh (2005) show that the ratio of housing wealth to human wealth (the housing collateral ratio) shifts the conditional distribution of asset prices and consumption growth and, therefore, predicts returns on stocks.

More recently, the focus has been directed towards the importance of long-term risk. Abel (1999) and Bansal and Yaron (2004) show that differences in risk compensation on assets mirror differences in the exposure of assets' cash flows to consumption. Bansal et al. (2005) suggest that changes in expectations about the entire path of future cash flows provide very valuable information about systematic risks in asset returns.

Given the current state of the literature, one can ask the following questions: What are the major sources of risk that explain asset returns? What is the importance of long-term risk? Are we able to generate the predictability of asset returns without relying on a specific description of preferences?

In this paper, I use the consumer's budget constraint to derive a relationship between stock market returns, the residuals of the trend relationship among consumption, aggregate wealth, and labour in-

is "near-rational".

[6] See, for example, Fama and French (1988), Campbell and Shiller (1988), Poterba and Summers (1988), Richards (1995), Lettau and Ludvigson (2001, 2004).

[7] Pakos (2003) argues that there is an important non-homotheticity in preferences.

come, *cay*, and three major sources of risk: future changes in the housing consumption share, *cr*, future labour income growth, *lr*, and future consumption growth, *lrc*.

I model the joint dynamics of changes in the non-housing consumption share, consumption growth, wealth growth, income growth, returns, consumption-wealth ratio and dividend-price ratio using a VAR and use it to obtain measures of expected and unexpected long-run changes in the major determinants of asset returns. I find that: (*i*) *cay*, *cday*, expected *lr*, *cr*, *lrc* and expected long-run changes in ex-ante real returns, *lrret*, strongly forecast future asset returns; (*ii*) unexpected *lrc* and unexpected *lrret* contain some predictive power for asset returns; (*iii*) unexpected *lr* and unexpected *cr* do not predict future asset returns.

Moreover, this work suggests that agents' expectations about long-run risk are important and that asset returns largely reflect that information. The results show that expectations of high future labor income, expectations of high future consumption growth, and expectations of high non-housing consumption share are associated with lower stock market returns, and low labor income growth expectations, low consumption growth expectations and low non-housing consumption share expectations are associated with higher than average real returns. Therefore, the success of *lr*, *cr*, and *lrc* as predictors of asset returns seems to be due to their ability to track risk premia. On the other hand, shocks to long-run expectations seem to play a negligible role as its forecasting power for current returns is, in general, very low.

The framework presented is sufficiently flexible to accommodate the implications of a wide class of optimal models of consumer behaviour. Its advantage lies on the fact that it does not impose any functional form on preferences. It, therefore, shows that one can use the intertemporal budget constraint and the forecasting properties of an informative VAR to generate the predictability of many empirical proxies developed in the literature on asset pricing.

The paper is organized as follows. Section 2 presents the theoretical and econometric approach. Section 3 describes the data and presents the estimation results of the forecasting regressions. Finally, in Section 4, I conclude and discuss the implications of the findings.

2 Theory and Econometric Approach

2.1 Deriving the Major Determinants of Asset Returns

Following Campbell (1996) and Jagannathan and Wang (1996), labor income (Y_t) can be thought of as the dividend on human capital (H_t). Under this assumption, the return to human capital can be defined as:

$$1 + R_{h,t+1} = \frac{H_{t+1} + Y_{t+1}}{H_t}. \qquad (1)$$

Under the assumption that the steady state human capital-labor income ratio is constant ($Y/H = \rho_h^{-1} - 1$, where $0 < \rho_h < 1$),[8] this relation can be log-linearized around the steady state to get

$$r_{h,t+1} = (1 - \rho_h)k_h + \rho_h(h_{t+1} - y_{t+1}) - (h_t - y_t) + \Delta y_{t+1} \qquad (2)$$

where $r := log(1 + R)$, $h := logH$, $y := logY$, k_h is a constant of no interest, and the variables without time subscript are evaluated at their steady state value. Assuming that $\lim_{i\to\infty} \rho_h^i(h_{t+i} - y_{t+i}) = 0$, the log human capital income ratio can be rewritten as a linear combination of future labor income growth and future returns on human capital:

$$h_t - y_t = \sum_{i=1}^{\infty} \rho_h^{i-1}(\Delta y_{t+i} - r_{h,t+i}) + k_h. \qquad (3)$$

Equation (2) shows that the log human capital to labor income ration ratio has to be equal to the discounted sum of future labor income growth and human capital returns. Moreover, this equation is similar, both in structure and interpretation, to the relation between the log dividend-price ratio and future returns and dividends derived by Campbell and Shiller (1988): taking time t conditional expectation of both sides, when the log human capital to labor income ratio is high, agents should expect high future labor income growth or low human capital returns.[9]

Defining W_t as aggregate wealth (given by human capital plus asset holdings), C_t as non-housing consumption, U_t as consumption of housing services, P_t^u as relative price of consumption of housing services, S_t as non-housing consumption share,[10] and $R_{w,t+1}$ as the return on aggregate wealth between period t and $t + 1$, the consumer's budget constraint can be written as:[11]

$$W_{t+1} = (1 + R_{w,t+1})(W_t - C_t - P_t^u U_t) = (1 + R_{w,t+1})\left(W_t - \frac{C_t}{S_t}\right). \qquad (4)$$

Campbell and Mankiw (1989) show that, under the assumption that the consumption-aggregate wealth is stationary and that $\lim_{i\to\infty} \rho_w^i(c_{t+i} - w_{t+i}) = 0$, where $\rho_w := (W - C)/W < 1$, equation (4) can be

[8] Baxter and Jermann (1997) calibrate $Y/H = 4.5\%$ implying $\rho_h = 0.955$. In this paper, I set $\rho_w = \rho_h = 0.95$, although results do not significantly change for different values.

[9] Campbell and Shiller (1988), defining the log return of an asset as $r_t = log(P_t + D_t) - logP_{t-1}$, (where P and D are, respectively, price and dividend of the asset) derive the relation $d_t - p_t = E_t\sum_{i=1}\rho^{i-1}(r_{t+i} - \Delta d_{t+i}) + k_d$ where $d := \log d$ and $p := \log P$.

[10] This is, $S_t := \frac{C_t}{C_t + P_t^u U_t}$.

[11] Labor income does not appear explicitly in this equation because of the assumption that the market value of tradable human capital is included in aggregate wealth.

approximated by Taylor expansion obtaining

$$c_t - s_t - w_t = \sum_{i=1}^{\infty} \rho_w^i r_{w,t+i} + \sum_{i=1}^{\infty} \rho_w^i \Delta s_{t+i} - \sum_{i=1}^{\infty} \rho_w^i \Delta c_{t+i} + k_w, \tag{5}$$

where $c := logC$, $s := logS$, $w := logW$, and k_w is a constant. The aggregate return on wealth can be decomposed as

$$R_{w,t+1} = \omega_t R_{a,t+1} + (1-\omega_t) R_{h,t+1} \tag{6}$$

where ω_t is a time varying coefficient and $R_{a,t+1}$ is the return on asset wealth. Campbell (1996) shows that the last expression can be approximated as

$$r_{w,t} = \omega r_{a,t} + (1-\omega) r_{h,t} + k_r \tag{7}$$

where k_r is a constant, ω is the mean of ω_t and $r_{w,t}$ is the log return on asset wealth. Moreover, the log total wealth can be approximated as

$$w_t = \omega a_t + (1-\omega) h_t + k_a \tag{8}$$

where a_t is the log asset wealth and k_a is a constant.

Replacing equation (3), (7) and (8) into (5), one gets

$$c_t - s_t - \omega a_t - (1-\omega)(y_t + \sum_{i=1}^{\infty} \rho_h^{i-1} \Delta y_{t+i}) - \sum_{i=1}^{\infty} \rho_w^i \Delta s_{t+i} + \sum_{i=1}^{\infty} \rho_w^i \Delta c_{t+i} =$$

$$= \sum_{i=1}^{\infty} \rho_w^i (\omega r_{a,t+i}) + (1-\omega) \sum_{i=1}^{\infty} (\rho_w^i - \rho_h^{i-1}) r_{h,t+i} + k. \tag{9}$$

where k is a constant. This equation holds ex-post as a direct consequence of agent's budget constraint, but it also has to hold ex-ante. Taking time t conditional expectation of both sides, we have that

$$\underbrace{c_t - s_t - \omega a_t - (1-\omega) y_t}_{cay_t} - (1-\omega) \underbrace{E_t \sum_{i=1}^{\infty} \rho_h^{i-1} \Delta y_{t+i}}_{lr_t} - \underbrace{E_t \sum_{i=1}^{\infty} \rho_w^i \Delta s_{t+i}}_{cr_t} + \underbrace{E_t \sum_{i=1}^{\infty} \rho_w^i \Delta c_{t+i}}_{lrc_t} =$$

$$= \omega E_t \sum_{i=1}^{\infty} \rho_w^i r_{a,t+i} + \eta_t + k, \tag{10}$$

where: $lr_t := E_t \sum_{i=1}^{\infty} \rho_h^{i-1} \Delta y_{t+i}$ represent the expected growth in future labor income, this is, the labor income risk;[12] $cr_t := E_t \sum_{i=1}^{\infty} \rho_w^i \Delta s_{t+i}$ represent the discounted expected change in the share of

[12] Following Campbell and Shiller (1988) and approximating the log return on human capital as $r_{h,t+1} = r + (E_{t+1} - E_t) \sum_{i=1}^{\infty} \rho_h^{i-1} \Delta y_{t+i}$, we have from equation (2) that the log human capital will depend only (disregarding constant terms) on current and future expected labor income $h_t = y_t + E_t \sum_{i=1}^{\infty} \rho_h^{i-1} \Delta y_{t+i}$,therefore the human capital wealth level will vary as expectations of future labor income change.

non-housing consumption in total consumption, this is, the composition risk; $lrc_t := E_t \sum_{i=1}^{\infty} \rho_h^{i-1} \Delta c_{t+i}$ represent the discounted expected growth in future consumption, this is, the long-run consumption risk; $\eta_t := (1-\omega)\sum^{\infty}(\rho_w^i - \rho_h^{i-1}) r_{h,t+i}$ is a stationary component; and, following Lettau and Ludvigson (2001a, 2001b), $cay_t := c_t - s_t - \omega a_t - (1-\omega) y_t$.

When the left hand side of equation (10) is high, consumers expect high future returns on market wealth. The lr_t term measures the contribution of future labor income growth to the state variable h_t, therefore capturing the expected long run wealth effect of current and past labor income shocks: if agents expect their labor income to grow in the future (high lr_t), the equilibrium return on asset wealth will be lower. One interpretation is that high lr_t represent a state of the world in which agents expect to have abundance of resources in the future, therefore low returns on asset wealth are feared less. The cr_t term measures the contribution of future changes in non-housing expenditure share, therefore, capturing the composition risk, this is the degree of separability of consumer's preferences: if preferences are separable, nondurable consumption and housing will be substitutes, and agents can easily "smooth out" any transitory movement in their asset wealth arising from time variation in expected return; if, however, preferences are non-separable, nondurable consumption and housing will be complements, and agents will not be able to "smooth out" exogenous shocks and, therefore, this term will contain valuable information about future asset returns. Finally, the lrc_t term measures the contribution of future consumption growth. Parker and Julliard (2005) measure risk by the covariance of an asset's return and consumption growth cumulated over many quarters (the ultimate consumption risk), rather than the contemporaneous covariance of an asset's return and consumption growth. I follow the same idea and measure the long-run consumption risk as the expected present value of changes in consumption growth. Finally, equation (10) shows that the consumption-wealth ratio, cay_t, will also be a good proxy for market expectations of future asset returns, $r_{a,t+i}$.[13] Based on equation (10), cay_t, lr, cr, and lrc should carry relevant information about market expectations of future asset returns ($r_{a,t+i}$) and I test the forecasting power of these proxies developed by Lettau and Ludvigson (2001), Julliard (2004), Piazzesi et al. (2007) and Parker and Julliard (2005).

[13] It can be shown that $c_t - s_t$ corresponds to the definition of consumption of nondurable goods and services *including* housing services. Denote by c_t^{ND}, the log consumption of nondurable goods and services *including* housing services, c_t, the log consumption of nondurable goods and services *excluding* housing services, and u_t, the log consumption of housing services. We can write: $c_t - s_t = log(C_t) - log(S_t) = log(C_t) - log(\frac{C_t}{C_t + P_t^U U_t}) = log(Ct + P_t^U U_t) = \log(C_t^{ND}) = c_t^{ND}$.

2.2 Econometric Specification

In this section I propose a method for analyzing the driving sources of risk and their predictive power for asset returns. In the *first stage*, I follow Campbell (1996) and Campbell and Shiller (1987, 1988) and use a Vector Auto-Regression (VAR) model to represent the law of motion for the state vector, exploiting the restrictions imposed by the cointegration of consumption, wealth and labor income (Lettau and Ludvigson, 2001). Once the VAR is estimated, it is possible to compute long-run measures of the major variables determining asset returns as well their innovations. In the *second stage*, I use the standard way to analyze the predictive power for asset returns, that is, regressing the one-period ex-post real return or the return , r_t, on the long-run measures computed before and known at the beginning of period t. If the coefficients on these variables are significant, then they are considered as good proxies for future asset returns.

This approach has some potential advantages over the standard approach. First, it is able to detect long-lived deviations of the major determinants of asset returns, avoiding the low power of single-period returns regressions (Shiller, 1984; Summers, 1986). Second, it does not rely on an optimal behavior model - only on the intertemporal budget constraint - and, therefore, it avoids the need of imposing a functional form on preferences.

Although this methodology is based on the estimation of a VAR, it properly accounts for the extra information that market participants have. This is so because returns are included as one variable in the VAR, enabling the generation of forecasts of consumption, non-housing consumption share, income, wealth, and returns. Moreover, although it is not possible to observe everything that market participants do, returns are observed and summarize the market's relevant information.

The $N \times 1$ state vector z_t used in the first stage of the estimation procedure is given by $z_t' = (\Delta s_t, \Delta w_t, \Delta c_t, \Delta y_t, r_t, cay_t, d_t - p_t)$, and includes non-housing consumption share growth, wealth growth, consumption growth, labor income growth, real returns on financial assets, consumption-aggregate wealth ratio, and the dividend yield. The dynamics of the state vector are described by a Vector Auto-Regressive Model (VAR):

$$z_t = Az_{t-1} + \xi_t, \tag{11}$$

where $A(L)$ is a finite-order distributed lag operator, and ξ_t is a vector of error terms with innovation covariance matrix $E[\xi\xi'] = \Sigma$.[14] The dimensions of Σ and A are $N \times N$, whilst the dimensions of ξ and z are $N \times T$.

The vector z_t has the useful property that to forecast it ahead k periods, given the information set

[14] The selected optimal lag length is 1, in accordance with findings from Akaike and Schwarz tests. However, the results are not sensible to different lag lengths.

H_t, one can simply multiply z_t by the k^{th} power of the matrix A, this is, $E_t[z_{t+k}|H_t] = A_t^k z_t$. It is possible, therefore, to define

$$cr_t = E_t \sum_{i=1}^{\infty} \rho_w^{i-1} \Delta s_{t+i} = e_1' A(I - \rho A)^{-1} z_t \tag{12}$$

$$lr_t = E_t \sum_{i=1}^{\infty} \rho_h^{i-1} \Delta y_{t+i} = e_4' A(I - \rho A)^{-1} z_t \tag{13}$$

$$lrc_t = E_t \sum_{i=1}^{\infty} \rho_w^{i-1} \Delta c_{t+i} = e_3' A(I - \rho A)^{-1} z_t \tag{14}$$

$$lrdp_t = E_t \sum_{i=1}^{\infty} \rho_h^{i-1} \Delta dp_{t+i} = e_7' A(I - \rho A)^{-1} z_t \tag{15}$$

$$lrret_t = E_t \sum_{i=1}^{\infty} \rho_h^{i-1} \Delta r_{t+i} = e_5' A(I - \rho A)^{-1} z_t \tag{16}$$

where e_k is the k^{th} column of an identity matrix of the same dimension as A. I estimate A from the VAR in specification (11) and Appendix B reports a summary of the coefficient estimates.

After the estimation of the VAR, it is possible to extract the current innovations of the variables of major interest in the model and to use them to compute a measure of the long-run innovations, therefore, building proxies for long-run unexpected changes in the housing share, in labor income growth, in consumption growth, in the price-dividend ratio and in ex-ante asset returns, that is:

$$cr_t = (\Delta s)_{t,\infty} = (E_t - E_{t-1}) \sum_{i=1}^{\infty} \rho_h^{i-1} \Delta s_{t+i} = e_1' A(I - \rho A)^{-1} \boldsymbol{\xi}_t \tag{17}$$

$$lr_t = (\Delta y)_{t,\infty} = (E_t - E_{t-1}) \sum_{i=1}^{\infty} \rho_h^{i-1} \Delta y_{t+i} = e_4' A(I - \rho A)^{-1} \boldsymbol{\xi}_t \tag{18}$$

$$lrc_t = (\Delta c)_{t,\infty} = (E_t - E_{t-1}) \sum_{i=1}^{\infty} \rho_h^{i-1} \Delta c_{t+i} = e_3' A(I - \rho A)^{-1} \boldsymbol{\xi}_t \tag{19}$$

$$lrdp_t = (\Delta dp)_{t,\infty} = (E_t - E_{t-1}) \sum_{i=1}^{\infty} \rho_h^{i-1} \Delta dp_{t+i} = e_7' A(I - \rho A)^{-1} \boldsymbol{\xi}_t \tag{20}$$

$$lrret_t = (\Delta r)_{t,\infty} = (E_t - E_{t-1}) \sum_{i=1}^{\infty} \rho_h^{i-1} \Delta r_{t+i} = e_5' A(I - \rho A)^{-1} \boldsymbol{\xi}_t \tag{21}$$

where the subscript t, ∞ denotes current and future innovations. As a final step, the forecasting power of these proxies is estimated in single equation regressions.

3 Expected Changes, Unexpected Shocks and Asset Returns

3.1 Data

In the estimations, I use quarterly, seasonally adjusted data for U.S., variables are measured at 2000 prices and expressed in the logarithmic form of per capita terms, and the sample period is 1954:1 - 2004:1. The main data sources are the Flow of Funds Accounts provided by Board of Governors of Federal Reserve System and Bureau of Economic Analysis of U.S. Department of Commerce. In Appendix A, I present a detailed discussion of data.

The definition of consumption includes nondurable consumption goods and services. Data on income includes only labor income. The definition of total wealth corresponds to net worth of households and nonprofit organizations, this is, the sum of housing wealth and financial wealth. Housing wealth (or home equity) is defined as the value of real estate held by households minus home mortgages. Original data on wealth correspond to the end-period values. Therefore, I lag once the data, so that the observation of wealth in t corresponds to the value at the beginning of the period $t+1$. Finally, asset returns are measured using the value weighted CRSP (CRSP-VW) market return index.

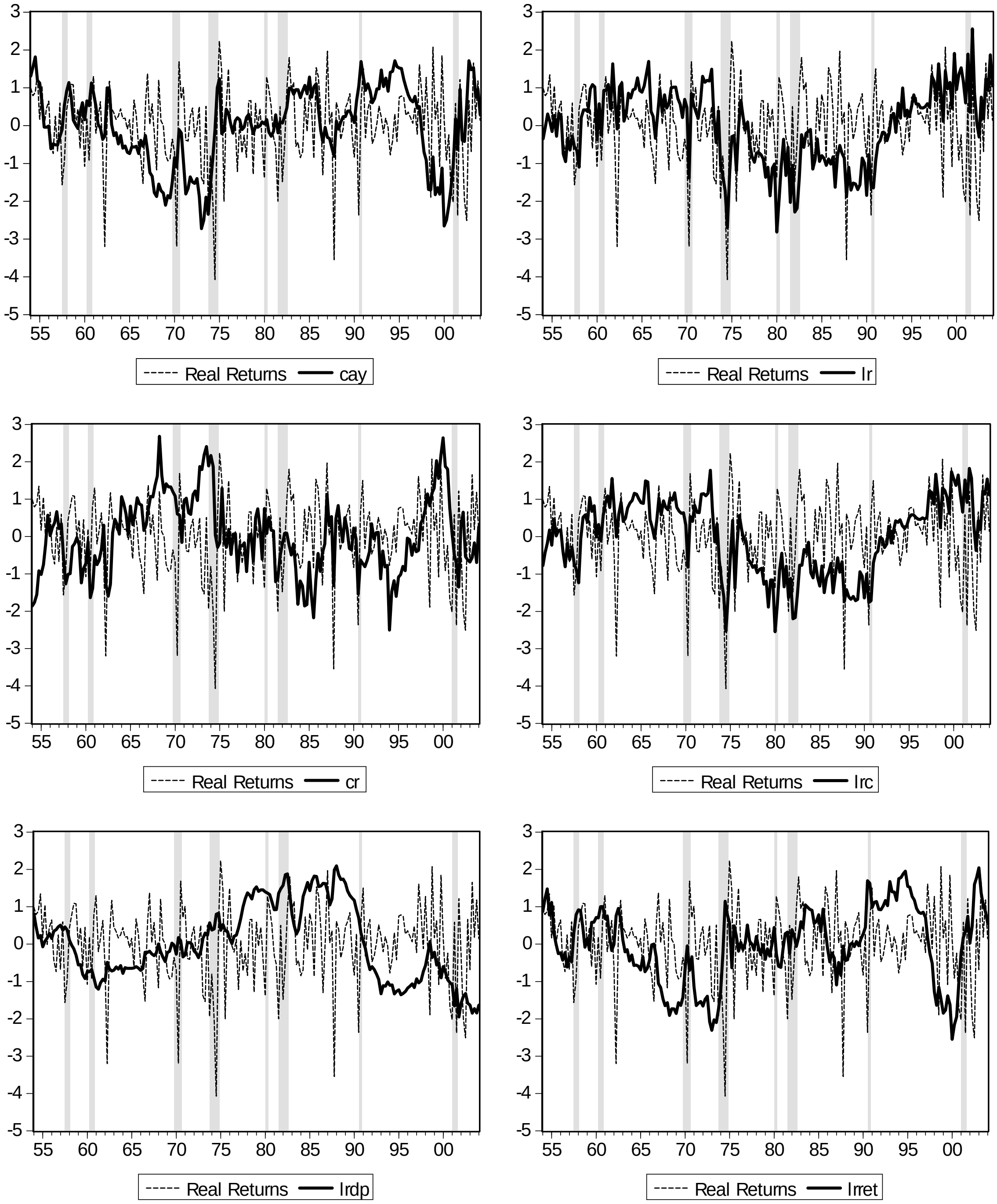
Figure 1 plots the time series of $\widehat{cay}_t$, $\widehat{lr}_t$, $\widehat{cr}_t$, $\widehat{lrc}_t$, $\widehat{lrdp}_t$, $\widehat{lrret}_t$ (based on the expected forecasts generated by the VAR) and the stock market real return, r_t.[15] It shows a multitude of episodes during which sharp increases in these proxies precede large reductions in the real return and it displays interesting business cycle patterns: (i) $\widehat{cay}_t$ and $\widehat{lrc}_t$ increase during recessions and fall during expansions; and (ii) $\widehat{lr}_t$ and $\widehat{cr}_t$ decrease during recessions and increase during expansions. It also shows that $\widehat{lrdp}_t$ does not seem to be a good predictor of future returns, and this may be the result of its high persistence Finally, the pattern of $\widehat{lrret}_t$, this is, the proxy for the ex-ante expected long-run returns captures captures relatively well the pattern of the ex-post returns, which suggests that, for small perturbations around the steady state, the variables included in the VAR should capture most of the relevant information for the asset returns.

[15] Real returns are constructed as the difference between the CRSP-VW market return index and the inflation rate. The time series are standardized to have unit variance and smoothed to facilitate the reading.

Figure 1: Time series of *cay*, *lr*, *cr*, *lrc*, *lrdp*, *lrret* and real returns.

All series are normalized to standard deviations.

The sample period is 1954:1 to 2004:1. Shaded areas denote NBER recessions.



3.2 Consumption-Wealth Ratio

I examine the relative predictive power of $\widehat{cay}_t, \widehat{lr}_t, \widehat{cr}_t, \widehat{lrc}_t, \widehat{lrdp}_t, \widehat{lrret}_t$ for real returns over horizons spanning 1 to 4 quarters. In the estimation of the regressions of real returns, the dependent variable is the H-period log real return on the CRSP-VW Index, $r_{t+1} + .. + r_{t+H}$. For each regression - with the exceptions of *cay* and *cday* in Table 1 -, the tables report the estimates from OLS regressions based on the expected long-run forecasts (Panel A) and on the unexpected long-run deviations (Panel B) and all equations include lag returns as a regressor.

Lettau and Ludvigson (2001) show that fluctuations in the consumption-aggregate wealth ratio, *cay*, summarize changes in expected returns and can be used for predicting stock returns. Investors want to maintain a flat consumption path over time and will attempt to "smooth out" transitory movements in their asset wealth arising from time variation in asset returns. When excess returns are, for example, expected to be higher in the future, forward-looking investors will react by increasing consumption out of current asset wealth and labor income, allowing consumption to rise above its common trend with those variables. More recently, Sousa (2006) shows that fluctuations in the consumption-(dis)aggregate wealth ratio, *cday*, have superior forecasting power due to its ability to track the changes in the composition of asset wealth (financial versus housing wealth) and the faster rate of convergence of the coefficients to the "long-run equilibrium" parameters.

I analyze the forecasting power of *cay* and *cday* for real returns. I estimate *cay* as $cay_t := c_t - 0.42w_t - 0.65y_t$ and *cday* as $cday_t := c_t - 0.29f_t - 0.17u_t - 0.60y_t$, where c_t, y_t, w_t, f_t and u_t represent, respectively, nondurable consumption of goods and services, labor income, aggregate asset wealth, financial wealth and housing wealth.[16]

Table 1 reports a summary of the results. Panel A shows that $\widehat{cay}$ has a significant forecasting power for future real returns, particularly at 3 and 4 quarters horizons, with the $\bar{R}^2$ statistic reaching 0.30, consistent with Lettau and Ludvigson (2001). In accordance with Sousa (2006), Panel B shows that $\widehat{cday}$ performs better: the coefficient estimates are larger in magnitude and, for the same horizons, the $\bar{R}^2$ statistic ranges between 0.25 and 0.30. This suggests that the disaggregation of wealth into its main components is an important issue in the context of forecasting future asset returns.[17]

[16] I estimate cay_t and $cday_t$ using dynamic OLS with 4 lags and leads.

[17] The predictive impact of $\widehat{cday}$ on future returns is economically larger than that of $\widehat{cay}$: in the one-period ahead regressions, the point estimate of the coefficient on $\widehat{cday}$ is about 1.549 for real returns and only 1.164 in the case of $\widehat{cay}$. Thus, a one-standard-deviation increase in $\widehat{cday}$ (standard deviation is 0.019) leads to, approximately, a 82.07 basis points rise in the expected real return on value weighted CRSP index, this is, a 3.32% increase at an annual rate. On the other hand, $\widehat{cay}$ itself has a standard deviation of about 0.023, implying that a one-standard-deviation increase in $\widehat{cay}$ leads to, approximately, a 50 basis points rise in the expected real return on value weighted CRSP index, this is, a 2.02% increase

Table 1: Forecasting real Returns using *cay* and *cday*.

Regressor	Forecast Horizon H 1	2	3	4
	Panel A: Real Returns, using $\widehat{cay}_t$			
cay_{t-1}	1.164*	2.325*	3.381*	4.329*
(t-stat)	(4.554)	(4.466)	(4.560)	(4.944)
$\bar{R}^2$	[0.08]	[0.16]	[0.24]	[0.30]
	Panel B: Real Returns, using $\widehat{cday}_t$			
$cday_{t-1}$	1.549*	3.055*	4.360*	5.434*
(t-stat)	(4.978)	(4.868)	(4.975)	(5.271)
$\bar{R}^2$	[0.10]	[0.18]	[0.25]	[0.30]

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

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

The sample period is 1954:1 to 2004:1.

3.3 Long-Run Changes in the Composition of Consumption

In the standard model, investors' concern with consumption risk implies that stock prices move with the business cycle. In recessions, investors expect higher future consumption and try to sell stocks today to increase current consumption. This intertemporal substitution mechanism drives down stock prices in bad times.

Yogo (2006) shows that when utility is nonseparable in nondurable and durable consumption and the elasticity of substitution between the two consumption goods is sufficiently high, marginal utility rises when durable consumption falls.[18] Stock returns are unexpectedly low at business cycle troughs, when durable consumption falls sharply, and this helps to explain the countercyclical variation in the equity premium. Piazzesi et al. (2007) consider a consumption-based asset pricing model where housing is explicitly modelled both as an asset and as a consumption good. Nonseparable preferences describe households' concern with composition risk, that is, fluctuations of the relative share of non-housing in their consumption basket and the model predicts that the housing share can be used to forecast returns on stocks. Finally, Lustig and Van Nieuwerburgh (2005) show that in a model with housing collateral, the ratio of housing wealth to human wealth shifts the conditional distribution of asset prices

at an annual rate.

[18] Dunn and Singleton (1986) and Eichenbaum and Hansen (1990) report evidence against separabilility of preferences, but they conclude that introducing durables does not help in reducing the pricing errors for stocks.

and consumption growth and, therefore, predicts returns on stocks. The authors consider two main channels that transmit shocks originated in the housing market to the risk premia in asset market: (*i*) when housing prices decrease, collateral is destroyed and households are more exposed to idiosyncratic labor income risk; and (*ii*) households want to hedge against rental price shocks or consumption basket composition shocks when the utility function is nonseparable in nondurable consumption and housing services.

I analyze the forecasting power of housing share for asset returns. However, instead of imposing nonseparability of preferences, as in the works mentioned above, I use the intertemporal budget constraint to derive a relationship between the present discount value of changes in housing share, cr, and asset returns. Moreover, while the focus of previous literature is on the forecasting power of housing share, I focus instead in the long-run changes of the housing share Finally, with the VAR estimated in Section 2.2, I estimate and compare the forecasting power of expected and unexpected changes in housing share.

Table 2 presents a summary of the results. Panel A shows that expected changes in the housing share strongly forecast future real returns, with the $\bar{R}^2$ statistic ranging from 0.09 to 0.23. In contrast, Panel B shows that unexpected growth has only a small predictive power (the $\bar{R}^2$ statistic ranges between 0.01 and 0.02). In both regressions, the coefficient associated to cr is negative, consistent with the fact that a high cr represents a state of the world in which returns on asset wealth are low.

This suggests that while expected changes in the long-run housing share are an important determinant of real returns, unexpected changes do not play an important role in the context of forecasting asset returns, contradicting the results obtained in Lustig and Van Nieuwerburgh (2005) and Piazzesi et al. (2007). The reason lies in the observation that housing share is a macroeconomic variable with a high degree of persistent and, therefore, its changes can largely be forecasted by consumers. As a result, long-run composition risk plays a negligible role in forecasting asset returns.

Table 2: Forecasting real returns using *cr*.

Regressor	Forecast Horizon H 1	2	3	4
Panel A: Expected Changes				
cr_{t-1}	-17.308*	-32.280*	-43.503*	-55.694*
(t-stat)	(-3.918)	(-4.036)	(-4.193)	(-4.595)
$\bar{R}^2$	[0.09]	[0.15]	[0.18]	[0.23]
Panel B: Unexpected Changes				
cr_{t-1}	-16.906***	-27.621***	-28.088	-33.344
(t-stat)	(-1.695)	(-1.875)	(-1.536)	(-1.550)
$\bar{R}^2$	[0.02]	[0.02]	[0.01]	[0.01]

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

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

The sample period is 1954:1 to 2004:1.

3.4 Long-Run Labor Income Growth

Julliard (2004) uses the representative consumer's budget constraint to derive an equilibrium relation between expected future labor income growth rates - summarized by the variable lr - and expected future asset returns. The author shows that expectations of high (low) future labor income growth are associated with lower (higher) stock market excess returns. These results are consistent with the fact that high lr represents a state of the world in which agents expect to have abundance of resources in the future to finance consumption, therefore low returns on asset wealth are feared less and lower equilibrium risk premia are required.

In order to model the labor income process, the author experimented with several specifications in the ARIMA class, and performed the standard set of Box-Jenkins selection procedures.[19] In the present paper, I use a different methodology in that expected and unexpected labor income growth rates are computed directly from the VAR estimated in Section 2.2.

Table 3 presents a summary of the results describing the forecasting power of lr: Panel A considers the expected long-run growth as the major explanatory variable, while Panel B includes only the unexpected long-run shocks. In both regressions, the coefficient associated to lr is negative, consistent with the fact that a high lr represents a state of the world in which returns on asset wealth are low. Moreover, it can be seen that, consistently with Julliard (2004), expected growth has a significant

[19]In particular, the ARIMA(0,1,2) specification for log income fits well the data.

forecasting power for future real returns, with the $\bar{R}^2$ statistic ranging from 0.01 to 0.07. In contrast, Panel B shows that unexpected growth has no predictive power. In sum, long-run labor income growth is an important determinant of real returns, while unexpected changes do not play an important role in the context of forecasting asset returns.

Table 3: Forecasting real returns using lr.

	Forecast Horizon H			
Regressor	1	2	3	4
Panel A: Expected Changes				
lr_{t-1}	-1.818**	-3.484**	-5.452*	-7.251*
(t-stat)	(-2.279)	(-2.266)	(-2.632)	(-2.882)
$\bar{R}^2$	[0.01]	[0.03]	[0.05]	[0.07]
Panel B: Unexpected Changes				
lr_{t-1}	-1.650	-2.588	-6.236	-12.717*
(t-stat)	(-0.648)	(-0.676)	(-1.394)	(-2.852)
$\bar{R}^2$	[0.00]	[0.00]	[0.00]	[0.03]

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

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

The sample period is 1954:1 to 2004:1.

3.5 Long-Run Consumption Growth

Bansal et al. (2005) show that asset prices reflect the discounted value of cash flows and that return news reflect revisions in expectations about the entire path of future cash flows and discount rates. Changes in expectations of cash flows is an important ingredient determining asset return news. Systematic risks in cash flows therefore should have some bearing on the risk compensation of assets. In particular, assets whose cash flows have higher aggregate consumption risks should also carry a higher risk premium. This intuition is also captured in the consumption-based models presented in Abel (1999) and Bansal and Yaron (2004), who show that differences in risk compensation on assets mirror differences in the exposure of assets' cash flows to consumption. Economic risks in cash flows, an important ingredient determining asset returns, provide very valuable information about systematic risks in asset returns.

By its turn, Parker and Julliard (2005) study the Fama and French size and book-to-market portfolios and reevaluate the central insight of the consumption capital asset pricing model that an asset's expected return is determined by its equilibrium risk to consumption. Rather than measure the risk of a portfolio by the contemporaneous covariance of its return and consumption growth, the authors measure the risk of a portfolio by its ultimate risk to consumption, defined as the covariance of its return and consumption growth over the quarter of the return and many following quarters.

This paper is based on a similar argument: instead of looking at the forecasting power of current consumption's growth for asset returns, the focus is on the long-run consumption growth, lrc. Using the VAR estimated in Section 2.2, I compute the expected and the unexpected long-run consumption growth and then use them as explanatory variables for one-period ahead real returns.

Table 4 presents a summary of the results: Panel A includes the expected changes as the major explanatory variable, while Panel B includes the unexpected changes. It can be seen that the coefficient associated to lrc is negative in both regressions, consistent with the fact that a high lrc represents a state of the world in which returns on asset wealth are low. This also implies that consumers try to hedge future fluctuations in consumption by investing in the stock markets, that is, stocks are used as an hedging device against negative future consumption shocks. The results are, therefore, in line with the findings of Parker and Julliard (2005).

Table 4: Forecasting real returns using lrc.

	Forecast Horizon H			
Regressor	1	2	3	4
Panel A: Expected Changes				
lrc_{t-1}	-2.009*	-3.957*	-5.950*	-7.897*
(t-stat)	(-2.795)	(-2.877)	(-3.202)	(-3.399)
$\bar{R}^2$	[0.03]	[0.05]	[0.08]	[0.11]
Panel B: Unexpected Changes				
lrc_{t-1}	-4.593***	-7.662	-13.640*	-24.252*
(t-stat)	(-1.692)	(-1.621)	(-2.475)	(-4.090)
$\bar{R}^2$	[0.01]	[0.01]	[0.03]	[0.09]

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

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

The sample period is 1954:1 to 2004:1.

3.6 Long-Run Dividend-Price Ratio

Shiller (1984), Campbell and Shiller (1998), and Fama and French (1988) all find that the ratios of price to dividends or earnings have predictive power for excess returns. Lamont (1998) finds that the ratio of dividend to earnings has forecasting power at quarterly horizons. Campbell (1991) and Hodrick (1992) find that the relative T-bill rate (the 30-day T-bill rate minus its 12-month moving average) predicts returns, and Fama and French (1989) study the forecasting power of the term spread (the 10-year Treasury bond yield minus the 1-year Treasury bond yield) and the default spread (the difference between the BAA and AAA corporate bond rates). Lamont (1998) argues that the dividend payout ratio should be a potentially potent predictor of excess returns, a result of the fact that high dividends typically forecast high returns whereas high earnings typically forecast low returns. On the other hand, Lettau and Ludvigson (2001a) show that these predictors do not convey significant information about future asset returns.

I use the VAR estimated in Section 2.2 to build measures of the long-run dividend-price ratio, *lrdp*, and test its forecasting power over different horizon spans. Table 5 presents a summary of the results and shows that the long-run dividend to price ratio does not contain explanatory power for real returns in accordance with the findings of Lettau and Ludvigson (2001a). Empirically, this result can be explained by the poor dynamics (and huge persistence) of *lrdp*, which does not enable it to match the fluctuations that characterize asset returns.

Table 5: Forecasting real returns using *lrdp*.

	Forecast Horizon H			
Regressor	1	2	3	4
Panel A: Expected Changes				
$lrdp_{t-1}$	0.123	0.242	0.325	0.381
(t-stat)	(1.086)	(1.102)	(1.047)	(0.995)
$\bar{R}^2$	[0.00]	[0.00]	[0.00]	[0.00]
Panel B: Unexpected Changes				
$lrdp_{t-1}$	0.335	1.409	1.669	1.419
(t-stat)	(0.463)	(1.299)	(1.430)	(1.044)
$\bar{R}^2$	[0.00]	[0.00]	[0.00]	[0.00]

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

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

The sample period is 1954:1 to 2004:1.

3.7 Long-Run Asset Returns

Most of the literature on asset pricing aimed at building proxies of asset returns measure the forecasting power relating these proxies with ex-post realized asset returns. Favero (2005) tries to highlight the differences between ex-ante expected returns and ex-post realized returns. The author derives a proxy for the long-run expected returns using a VAR that includes asset returns, *cay*, consumption growth and asset returns. After realization, the VAR is re-estimated each point in time and projected forward for a long-horizon, so that long-run expected returns are computed.

I compute a proxy for the expected and unexpected long-run asset returns, *lrret*, using the VAR estimated in Section 2.2. While the focus of Favero (2005) is on assessing the differences between these and the predictive power of *cay*, I aim at analyzing to which extent asset returns reflect expectations about future returns and the importance of unexpected shocks.

Table 6 presents a summary of the results. Panel A shows that expected ex-ante changes in long-run real returns strongly forecast future real returns, with the $\bar{R}^2$ statistic ranging from 0.07 to 0.28. Panel B shows that unexpected ex-ante changes in long-run real returns also have some predictive power (the $\bar{R}^2$ statistic ranges between 0.01 and 0.05). This suggests that both expected and unexpected changes in the ex-ante long-run asset returns are important determinants of real returns. This means that expectations about future returns represent only a small component of the behaviour of observed asset returns and that other forces drive this variable.

Table 6: Long-run horizon regressions using *lrret*.

	Forecast Horizon H			
Regressor	1	2	3	4
Panel A: Expected Changes				
$lrret_{t-1}$	0.128*	0.257*	0.377*	0.486*
(t-stat]	(4.463)	(4.356)	(4.414)	(4.745)
$\bar{R}^2$	[0.07]	[0.14]	[0.21]	[0.28]
Panel B: Unexpected Changes				
$lrret_{t-1}$	0.176	0.289***	0.493**	0.720*
(t-stat]	(1.628)	(1.841)	(2.218)	(2.546)
$\bar{R}^2$	[0.01]	[0.01]	[0.03]	[0.05]

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

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

The sample period is 1954:1 to 2004:1.

4 Conclusion

This paper uses the representative consumer's budget constraint to derive an equilibrium relation between the trend deviations among consumption, aggregate wealth and labor income, cay, expected future changes in the housing consumption share, cr, expected future labor income growth, lr, expected future consumption growth, lrc, and expected future asset returns, and explores the predictive power of these variables for future asset returns.

The novelty of the paper is in the methodology. Instead of relying on a model of consumer behaviour that explicitly assumes a functional form for preferences, I use the intertemporal budget constraint to derive the major determinants of asset returns. Then, I explore the forecasting properties of an informative VAR to build proxies for the long-run determinants of asset returns. Finally, the forecasting power of these proxies for future asset returns is assessed and this is used as a way of indirectly testing the assumptions about preferences considered in many optimal models of consumer behaviour.

Using a Vector Autoregressive System (VAR), I compute measures of expected and unexpected long-run changes of the major determinants of asset returns and find that: (*i*) cay, $cday$, expected future labor income growth, expected future changes in the composition of consumption, expected future consumption growth, expected changes in ex-ante long-run real returns strongly forecast future asset returns; (*ii*) unexpected long-run consumption growth and unexpected changes in ex-ante long-run real returns contain some predictive power for asset returns; (*iii*) unexpected future labor income growth and unexpected changes in the housing share do not predict future asset returns; and (*iv*) neither expected nor unexpected changes in the dividend price-dividend ratio forecast asset returns.

Moreover, this work suggests that agents' expectations about long-run risk are important and that asset returns largely reflect that information. The results show that expectations of high future labor income, expectations of high future consumption growth, and expectations of high non-housing consumption share are associated with lower stock market returns, and low labor income growth expectations, low consumption growth expectations and low non-housing consumption share expectations are associated with higher than average real returns. Therefore, the success of lr, cr, and lrc as predictors of asset returns seems to be due to their ability to track risk premia. On the other hand, shocks to long-run expectations seem to play a negligible role as their forecasting power for current returns is, in general, very low.

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Appendix

A Data Description

Consumption

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

Aggregate Wealth

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

After-Tax Labor Income

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

Asset Returns

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

Population

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

Price Deflator

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

Inflation Rate

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

Interest Rate ("Risk-Free Rate")

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

B Vector-Autoregression (VAR) Estimation

Table B1: Estimates from vector-autoregressions (VAR).

	Equation						
Dependent variable	Δs_t	Δw_t	Δc_t	Δy_t	r_t	cay_t	$d_t - p_t$
Δs_{t-1}	0.443*	-1.886*	-0.670**	-0.916	-8.303	0.717	0.039
	(5.889)	(-2.818)	(-2.319)	(-1.474)	(-1.376)	(1.422)	(0.660)
Δw_{t-1}	-0.000	-0.019	-0.009	-0.038	0.146	0.024	0.002
	(-0.063)	(-0.556)	(-0.585)	(-1.192)	(0.477)	(0.929)	(0.577)
Δc_{t-1}	-0.059*	0.585*	0.280*	0.583*	1.138	-0.345**	0.002
	(-2.712)	(3.010)	(3.329)	(3.228)	(0.649)	(-2.355)	(0.130)
Δy_{t-1}	0.017***	0.132	0.080**	-0.111	-0.577	0.096	0.006
	(1.799)	(1.580)	(2.213)	(-1.428)	(-0.766)	(1.532)	(0.822)
r_{t-1}	0.001	0.212*	0.011*	0.020*	-0.045	-0.091*	0.001
	(1.002)	(25.924)	(3.247)	(2.666)	(-0.606)	(-14.743)	(1.284)
cay_{t-1}	-0.007***	-0.036	-0.026***	-0.024	1.153*	1.004*	-0.008*
	(-1.830)	(-1.137)	(-1.930)	(-0.821)	(4.040)	(42.182)	(-2.982)
$d_{t-1} - p_{t-1}$	-0.003	0.055**	-0.075*	-0.048***	-0.667*	-0.067*	1.005*
	(-1.034)	(1.955)	(-6.199)	(-1.853)	(-2.631)	(-3.165)	(408.095)
$\bar{R}^2$	[0.16]	[0.80]	[0.20]	[0.08]	[0.07]	[0.91]	[0.91]

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

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

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

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

C Notation: Current and Long-Run Innovations

Table C1: Notation - current and long-run innovations.

Label	*Definition*	*Expression*
Current Innovations		
$(\Delta s)_t$	$\Delta s_t - E_{t-1}[\Delta s_t]$	$e_1' \boldsymbol{\xi}_t$
$(\Delta y)_t$	$\Delta y_t - E_{t-1}[\Delta y_t]$	$e_4' \boldsymbol{\xi}_t$
$(\Delta c)_t$	$\Delta c_t - E_{t-1}[\Delta c_t]$	$e_3' \boldsymbol{\xi}_t$
$(\Delta dp)_t$	$\Delta(dp_t) - E_{t-1}[dp_t]$	$e_7' \boldsymbol{\xi}$
$(\Delta r)_t$	$\Delta r_t - E_{t-1}[\Delta r_t]$	$e_5' \boldsymbol{\xi}_t$
Long-Run Innovations		
$(\Delta s)_{t,\infty}$	$(E_t - E_{t-1})\sum_{i=1}^{\infty} \rho_h^{i-1} \Delta s_{t+i}$	$e_1' A(I - \rho A)^{-1} \boldsymbol{\xi}_t$
$(\Delta y)_{t,\infty}$	$(E_t - E_{t-1})\sum_{i=1}^{\infty} \rho_h^{i-1} \Delta y_{t+i}$	$e_4' A(I - \rho A)^{-1} \boldsymbol{\xi}_t$
$(\Delta c)_{t,\infty}$	$(E_t - E_{t-1})\sum_{i=1}^{\infty} \rho_h^{i-1} \Delta c_{t+i}$	$e_3' A(I - \rho A)^{-1} \boldsymbol{\xi}_t$
$(\Delta dp)_{t,\infty}$	$(E_t - E_{t-1})\sum_{i=1}^{\infty} \rho_h^{i-1} \Delta dp_{t+i}$	$e_7' A(I - \rho A)^{-1} \boldsymbol{\xi}_t$
$(\Delta r)_{t,\infty}$	$(E_t - E_{t-1})\sum_{i=1}^{\infty} \rho_h^{i-1} \Delta r_{t+i}$	$e_5' A(I - \rho A)^{-1} \boldsymbol{\xi}_t$

The subscript t denotes current innovations.

The subscript t, ∞ denotes current and future innovations.

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