Building Proxies that Capture Time-Variation in Expected Returns Using a VAR Approach

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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, and three major sources of risk: future changes in the housing consumption share, future labour income growth, and future consumption growth.

I model the joint dynamics of changes in the housing consumption share, consumption growth, wealth growth, income growth, asset returns, consumption-wealth ratio and dividend-price ratio, and show that asset returns largely reflect expectations about long-run risk. On the other hand, unexpected shocks play a negligible role in the context of forecasting future asset returns.

Combining the intertemporal budget constraint and the forecasting properties of an informative Vector-Autogression (VAR), one can, therefore, generate the predictability of many economically motivated variables developed in the literature on asset pricing, and accommodate the implications of a wide class of optimal models of consumer behaviour without imposing a functional form on preferences.

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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 (Sharpe, 1964; Lintner, 1965; Lucas, 1978; Breeden, 1979).

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 (Flavin, 1981; Shiller, 1982; Hall, 1988; Campbell and Deaton, 1989). Parker and Preston (2005) find that precautionary savings are important for explaining consumption fluctuations. By its turn and in the spirit of Brainard *et al.* (1991),[1] Parker and Julliard (2005) highlight the role of the ultimate risk to consumption.

The literature in asset pricing has, therefore, largely concluded that asset risk premia are not explained by 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 behaviour.

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.[2] Cochrane and Defina (1993) suggest that inflation has a negative effect on stock prices, while Davis and Kutan (2003) refer that both inflation and output can predict stock returns and volatility.[3] Lettau and Ludvigson (2001a) show that the transitory deviation from the common trend in consumption, aggregate wealth and labour 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.* (2007) use the same approach but incorporate the relative price of durable goods, whilst Julliard (2004) shows that the expected changes in labour 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 argues 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.[4] In the same spirit, Lustig and Van Nieuwerburgh (2005) show that 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 valuable information about systematic risk 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 follow Lettau and Ludvigson (2001a) and Julliard (2004), and 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 future labour income growth, *lr*. Moreover, I consider two additional sources of risk: future changes in the housing consumption share, *cr*, and future consumption growth, *lrc*.

Then, I model the joint dynamics of changes in the housing consumption share, consumption growth, wealth growth, income growth, asset returns, consumption-wealth ratio and dividend-price ratio using a Vector-Autoregression (VAR) framework, and obtain measures of expected and unexpected long-run changes in the major determinants of asset returns. I find that: (i) the consumption-wealth ratio, expected changes in future labour income, housing consumption share and consumption growth, and expected ex-ante long-run real returns strongly forecast future ex-post asset returns; (ii) shocks to future consumption growth and to long-run real returns contain some predictive power for ex-post asset returns; and (iii) unexpected variation in future labour income growth and in housing consumption share do not predict future ex-post 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 labour income, expectations of high future consumption growth, and expectations of low housing consumption share are associated with lower stock market returns, and low labour 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 asset 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

If we define W_t as aggregate wealth (given by asset holdings plus human capital), 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,[5] 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:[6]

$$W_{t+1} = (1 + R_{w,t+1})(W_t - C_t - P_t^U U_t) = (1 + R_{w,t+1})(W_t - \tfrac{C_t}{S_t}). \qquad (1)$$

Under the assumption that the consumption-aggregate wealth is stationary and imposing the transversality condition ($\lim_{i \to \infty} \rho_w{}^i (c_{t+i} - w_{t+i}) = 0$, where $\rho_w := (W - C)/W < 1$), Campbell and Mankiw (1989) show that equation (1) can be approximated by Taylor expansion to get

$$c_t - s_t - w_t = \sum_{i=1}^{\infty} \rho_w^i \mathrm{r}_{\mathrm{w,t+i}} + \sum_{i=1}^{\infty} \rho_w^i \Delta \mathrm{s}_{\mathrm{t+i}} - \sum_{i=1}^{\infty} \rho_w^i \Delta \mathrm{c}_{\mathrm{t+i}} + \mathrm{k}_{\mathrm{w}}, \qquad (2)$$

where *c:=logC*, *s:=logS*, *w:=logW*, and k_w is a constant.

One can decompose the aggregate return on wealth as

$$\mathrm{R}_{\mathrm{w,t+1}} = \omega_{\mathrm{t}} \mathrm{R}_{\mathrm{a,t+1}} + (1 - \omega_{\mathrm{t}}) \mathrm{R}_{\mathrm{h,t+1}}, \qquad (3)$$

where ω_{t} is a time varying coefficient and $R_{a,t+1}$ is the return on asset wealth. Following Campbell (1996), equation (3) can be approximated as

$$\mathrm{r}_{\mathrm{w,t}} = \omega_{\mathrm{t}} \mathrm{r}_{\mathrm{a,t}} + (1 - \omega_{\mathrm{t}}) \mathrm{r}_{\mathrm{h,t}} + k_r, \qquad (4)$$

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, one can approximate the log total wealth as

$$\mathrm{w}_{\mathrm{t}} = \omega a_{\mathrm{t}} + (1 - \omega) \mathrm{h}_{\mathrm{t}} + k_a, \qquad (5)$$

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

Campbell (1996) and Jagannathan and Wang (1996) argue that the labour income, Y_t, can be considered as the dividend on human capital, H_t. The return to human capital can then be represented by:

$$1 + R_{h,t+1} = \frac{H_{t+1} + Y_{t+1}}{H_t}. \qquad (6)$$

Assuming that the steady state human capital-labour income ratio is constant ($Y/H = \rho_h^{-1} - 1$, where $0 < \rho_h < 1$),[7] equation (6) can be linearized to get

$$r_{h,t+1} = (1 - \rho_h)k_h + \rho_h(h_{t+1} - y_{t+1}) - (h_t - y_t) + \Delta y_{t+1}, \qquad (7)$$

where *r:=log(1+R), h:=logH, y:=logY,* k_h is a constant. Julliard (2004) shows that imposing the transversality condition ($\lim_{i\to\infty} \rho_h^i (h_{t+i} - y_{t+i}) = 0$), one can write the log human capital to income ratio as a linear combination of future labour income growth and future human capital returns:

$$h_t - y_t = \sum_{i=1}^{\infty} \rho_h^{i-1}(\Delta y_{t+i} - r_{h,t+i}) + k_h. \qquad (8)$$

Replacing equation (4), (5) and (8) into (2), one gets

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

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

where *k* is a constant. Taking time *t* conditional expectation of both sides, one obtains

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

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

where: $lr_t := E_t \sum_{i=1}^{\infty} \rho_h^{i-1} \Delta \mathrm{y}_{\mathrm{t+i}}$ represents the expected growth in future labour income, this is, the labour income risk; $cr_t := E_t \sum_{i=1}^{\infty} \rho_w^{i} \Delta s_{\mathrm{t+i}}$ represents the discounted expected change in the share of non-housing consumption in total consumption, this is, the composition risk; $lrc_t := E_t \sum_{i=1}^{\infty} \rho_w^{i} \Delta c_{\mathrm{t+i}}$ represents the discounted expected growth in future consumption, this is, the long-run consumption risk; $\eta_t := (1-\omega)\sum_{i=1}^{\infty} (\rho_w^{i} - \rho_h^{i-1}) r_{\mathrm{h,t+i}}$, 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 captures the expected long run wealth effect of current and past labour income shocks: when agents expect an increase of their labour income (high lr_t), the equilibrium return on asset wealth will be lower as it reflects abundance of resources. The cr_t term measures the contribution of future changes in non-housing expenditure share, therefore, capturing the composition risk, which may contain valuable information about future asset returns. The lrc_t term captures the contribution of future consumption growth. Parker and Julliard (2005) measure the ultimate consumption risk by looking at the covariance of an asset's return and consumption growth cumulated over many quarters. 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, $r_{a,t+i}$.[8] Based on equation (10), cay_t, lr_t, cr_t, and lrc_t 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 (2001a), Julliard (2004), Parker and Julliard (2005), and Piazzesi *et al.* (2007). I do so by splitting consumption into housing and non-housing components which constitutes the major departure from Julliard (2004).[9]

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 labour income (Lettau and Ludvigson, 2001a). Once the VAR is estimated, it is possible to compute long-run measures of the major variables determining asset returns as well as 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, 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 behaviour 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 one can not observe everything that market participants do, returns are observable 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, labour 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):

$$z_t = Az_{t-1} + \xi_t, \qquad (11)$$

where $A(L)$ is a finite-order distributed lag operator, and ξ_t is a vector of error terms with innovation covariance matrix $E[\xi\xi'] = \Sigma$.[10]

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 Ω_t, one can simply multiply z_t by the k^{th} power of the matrix A, that is, $Et[z_{t+k} \mid \Omega_t] = A_t^k z_t$. It is possible, therefore, to define

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

$$lr_t = E_t \sum_{i=1}^{\infty} \rho_h^{i-1} \Delta \mathrm{y}_{\mathrm{t+i}} = e_4^{'} A(I - \rho_h A)^{-1} z_t \quad (13)$$

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

$$lrdp_t = E_t \sum_{i=1}^{\infty} \rho_w^i (d_{\mathrm{t+i}} - p_{t+i}) = e_7^{'} A(I - \rho_w A)^{-1} z_t \quad (15)$$

$$lrret_t = E_t \sum_{i=1}^{\infty} \rho_w^i r_{\mathrm{t+i}} = e_5^{'} A(I - \rho_w A)^{-1} z_t, \quad (16)$$

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 labour income growth, in consumption growth, in the price-dividend ratio and in ex-ante asset returns, that is:

$$cr_t = (\Delta s)_{t,\infty} = (E_t - E_{t-1})\sum_{i=1}^{\infty}\rho_w^i \Delta s_{\mathrm{t+i}} = e_1^{'}A(I-\rho_w A)^{-1}\zeta_t \tag{17}$$

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

$$lrc_t = (\Delta c)_{t,\infty} = (E_t - E_{t-1})\sum_{i=1}^{\infty}\rho_w^i \Delta c_{\mathrm{t+i}} = e_3^{'}A(I-\rho_w A)^{-1}\zeta_t \tag{19}$$

$$lrdp_t = (dp)_{t,\infty} = (E_t - E_{t-1})\sum_{i=1}^{\infty}\rho_w^i (d_{\mathrm{t+i}} - p_{\mathrm{t+i}}) = e_7^{'}A(I-\rho_w A)^{-1}\zeta_t \tag{20}$$

$$lrret_t = (r)_{t,\infty} = (E_t - E_{t-1})\sum_{i=1}^{\infty}\rho_w^i r_{\mathrm{t+i}} = e_5^{'}A(I-\rho_w A)^{-1}\zeta_t, \tag{21}$$

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 labour 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 cay_t, cr_t, lr_t, lrc_t, $lrdp_t$, $lrret_t$ (based on the expected forecasts generated by the VAR) and the stock market real return, r_t.[11] 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) cay_t increases in recessions and falls in expansions; and (ii) cr_t, lr_t and lrc_t fall in recessions and increase in expansions. It also shows that $lrdp_t$

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 $lrret_t$, that is, the proxy for the ex-ante expected long-run returns capture 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.

[PLACE FIGURE 1 HERE.]

3.2 Consumption-Wealth Ratio

I start by examining the relative predictive power of cay_t for real returns over horizons spanning 1 to 4 quarters.

Lettau and Ludvigson (2001a) argue that fluctuations in the consumption-aggregate wealth ratio, *cay*, summarize changes in expected returns and can be used for predicting stock returns. The preference of investors for a flat consumption path over time leads them to "smooth out" transitory movements in the asset wealth. As a result, when asset returns are expected to be higher in the future, forward-looking investors increase consumption out of current asset wealth and labour income, allowing it to rise above its common trend with those variables. More recently, Sousa (2009) 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. Following Lettau and Ludvigson (2001a) and Sousa (2009), I use dynamic ordinary least squares (DOLS) to estimate *cay* and *cday*. This econometric methodology allows generates *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, labour income, aggregate asset wealth, financial wealth and housing wealth.[12, 13]

Table 1 reports a summary of the results. 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.[14]

Panel A shows that cay has a significant forecasting power for future real returns, particularly at 3 and 4 quarters horizons, with the adjusted R^2 statistic reaching 0.30, consistent with Lettau and Ludvigson (2001a). In accordance with Sousa (2009), Panel B shows that *cday* performs better: the coefficient estimates are larger in magnitude and, for the same horizons, the adjusted R^2 statistic ranges between 0.25 and 0.30. This suggests that the disaggregation of wealth into its main components is an important source of risk and should be taken into account in the context of forecasting future asset returns.[15]

[PLACE TABLE 1 HERE.]

3.3 Long-Run Changes in the Composition of Consumption

In the standard consumption capital asset pricing (CCAPM) model, stock prices exhibit a business cycle pattern as a result of investors' concern with consumption risk. In recessions, investors sell stocks today to increase current consumption, as they expect a higher future consumption.

Yogo (2006) shows that when utility is nonseparable in durable and nondurable consumption and the elasticity of substitution between the two goods is high, then a fall in durable consumption is associated with a rise in marginal utility.[16] The countercyclical pattern of the equity premium is explained by the sharp fall of durable consumption during troughs which leads to low stock returns. Piazzesi *et al.* (2007) present a model where housing is modelled as an asset and as a consumption good. Households care about the composition risk, that is, fluctuations of the relative share of non-housing in their consumption basket, as their preferences are nonsperable. Housing share can, therefore, forecast stock returns. Finally, Lustig and Van Nieuwerburgh (2005) identify two channels through which housing market shocks are transmitted to asset markets: (i) households become more exposed to idiosyncratic income risk when housing prices decrease, as this leads to a destruction of collateral; and (ii) nonseparability of preferences implies that investors try to hedge against consumption composition and rental price shocks. They show that the ratio of housing wealth to human wealth is a good predictor of the returns on stocks.

I analyze the forecasting power of housing share for asset returns. However, instead of imposing nonseparability of preferences, 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 the previous literature was on the forecasting power of housing share, I focus in the long-run changes of the housing share instead. 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 adjusted 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 adjusted R^2 statistic ranges between 0.01 and 0.02) and the root mean squared error (RMSE) is also larger than in Panel A. 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, in the one hand, expected changes in the long-run housing share are an important determinant of real returns. On the other hand, unexpected variation in the long-run housing share does not seem to play an important role in the context of forecasting asset returns. That is, while fluctuations in the relative share of housing can have business cycle properties, it is mainly the expected component that is able to generate stock price movements. 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, news about changes in the composition of consumption have a negligible content.

[PLACE TABLE 2 HERE.]

3.4 Long-Run Labour Income Growth

Julliard (2004) derives an equilibrium relation between expected future labour income growth - summarized by the variable *lr* - and expected future asset returns, using the consumer's budget constraint. Expectations of high future labour income growth are associated with lower stock returns, in reflex of the abundance of resources.

The author models labour income after performing the Box-Jenkins selection procedures over different ARIMA specifications. In the present paper, I use a different methodology in that expected and unexpected labour 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. As in Julliard (2004), the coefficient associated to *lr* is negative, therefore, suggesting that a high *lr* corresponds to a state of the world in which asset returns are low. Moreover, it can be seen that expected growth has a significant forecasting power for future real returns, with the adjusted R^2 statistic ranging from 0.01 to 0.07. In contrast, Panel B shows that unexpected growth has no predictive power. In sum, expectations about long-run labour income growth can help explaining risk premium.

[PLACE TABLE 3 HERE.]

3.5 Long-Run Consumption Growth

Abel (1999) and Bansal and Yaron (2004) show that different exposures of the cash flows of assets to consumption explain differences in risk premium. Similarly, Bansal *et al.* (2005) show that asset prices reflect the discounted value of cash flows and that changes in expectations about cash flows are an important ingredient of the compensation of asset risk. In the same line of reasoning, Parker and Julliard (2005) measure the risk of a portfolio by its ultimate risk to consumption, that is, the covariance of its return and consumption growth over many subsequent quarters. That is, instead of looking at the contemporaneous covariance of return and consumption growth, the authors emphasize the importance of the long-run in pricing risk.

The current paper is based on a similar argument in that I focus on the long-run consumption growth, *lrc*. However, I do not assess the covariance between asset returns and consumption growth, but analyze the predictive power of long-run changes in consumption for asset returns instead. Using the VAR estimated in Section 2.2, I compute the expected and the unexpected long-run consumption growth and use them as explanatory variables in forecasting regressions for real returns.

Table 4 presents a summary of the results: Panel A considers the expected changes, and Panel B includes the unexpected changes. It can be seen that the both contain substantial predictive content for asset returns: while expected changes forecast between 3% and 11% of future real returns, unexpected changes explain between 1% and 9% over the next 1 to 4 quarters. Similarly, the RMSE is slightly larger for unexpected variation than for expected changes in accordance with the lower forecasting precision. The coefficient associated to *lrc* is negative, implying that stocks are used as an hedge against negative future consumption shocks. Therefore, the findings reveal that not only expectations but also shocks about long-run consumption growth can lead to important movements in stock prices.

[PLACE TABLE 4 HERE.]

3.6 Long-Run Dividend-Price Ratio

A vast literature has documented the role of financial indicators in predicting asset returns, namely: (i) the ratios of price to dividends or earnings (Shiller, 1984; Campbell and Shiller, 1998; Fama and French, 1988); (ii) the ratio of dividend to earnings (Lamont, 1998); (iii) the relative T-bill rate, that is, the 30-day T-bill rate minus its 12-month moving average (Campbell, 1991; Hodrick (1992); (iv) the default spread, that is, the difference between the BAA and AAA corporate bond rates (Fama and French, 1989); (v) the term spread, that is, the 10-year Treasury bond yield minus the 1-year Treasury bond yield (Fama and French, 1989); (vi) the dividend payout ratio (Lamont, 1998). In contrast, Lettau and Ludvigson (2001a) show that these predictors do not convey important 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 shows that the long-run dividend to price ratio does not indeed contain explanatory power for real returns. What might be driving these results? It is well known that the dividend-price ratio is a financial indicator that exhibits strong persistence. As a result, a measure such as *lrdp* that captures the long-run changes in the dividend-price ratio will suffer from the same lack of dynamics. Consequently, it is not able to match the fluctuations that characterize asset returns.

[PLACE TABLE 5 HERE.]

3.7 Long-Run Asset Returns

Most of the literature on asset pricing aimed at building proxies of asset returns measure their forecasting power, relating them with ex-post realized asset returns. On the contrary, 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. Long-run expected returns are computed by re-estimating the VAR each point in time and projecting it forward for a long-horizon.

As in Favero (2005), I compute a proxy for the expected long-run asset returns, *lrret*, using the VAR estimated in Section 2.2. However, I also build a measure of the innovation component of long-run asset returns, that is, of the shocks or news about future returns. Moreover, while the focus of Favero (2005) is on assessing the differences between ex-ante and ex-post returns and the predictive power of *cay*, I aim at analyzing the relative importance of the expected and the unexpected components of future returns in generating movements in stock prices and, therefore, explaining risk premium.

Panel A of Table 6 shows that expected ex-ante long-run real returns strongly forecast future ex-post real returns, with the adjusted R^2 statistic ranging between 0.07 to 0.28. Similarly, Panel B shows that unexpected long-run real returns also have some predictive power (as reflected by the R^2 statistic, which ranges between 0.01 and 0.05). This suggests that expectations about long-run asset returns seem to be more important than news in driving stock returns. This empirical feature can be explained as follows. By potentially reflecting asset "fundamentals", expectations about long-run asset returns explain most of the variation that one observes in asset prices. In contrast, shocks to expectations tend to be associated with temporary events, which effects will not last in a persistent manner. As a result, they tend to marginally impact on asset prices.

[PLACE TABLE 6 HERE.]

3.8 A Look at the Composition of the Budget Constraint

The theoretical framework presented in Sub-Section 2.1 shows that one can use the consumer's intertemporal budget constraint to derive a relationship between future asset returns and consumption-wealth ratio, labour income risk, composition risk and long-run consumption risk.

Accordingly, I have so far assessed the predictive power of each factor considered individually. In particular, I have distinguished between the informational content of their expected component vis-à-vis the unexpected portion.

I now discuss the joint predictive power of several combinations of different candidate factors. One should note, however, that because all empirical proxies capture time-variation in future returns and are directly linked by the intertemporal budget constraint, they may be co-move. As a result, the statistical significance of each factor may be downward biased when different factors are included in the same regression. Moreover, given that the empirical proxies track sources of *long-run* risk, one expects to find a stronger predictive power at longer horizons.

Tables 7 and 8 provide a summary of the results for forecasting regressions where different combinations of factors are included in the same specification. In particular, lag returns and the consumption-wealth ratio, *cay*, are kept in the baseline model.[17] Table 7 considers the expected changes, while Table 8 refers to the unexpected changes.

The empirical findings are, broadly speaking, in line with the results where the informational content of a given factor was analysed separately. In particular, one can see that the consumption-wealth ratio emerges as a major predictor of future returns. The other empirical proxies also contribute to explain stock returns as the R^2 statistic improves relative to the previous estimations, while the RMSE becomes smaller with their inclusion. Finally, the signs and magnitudes of the coefficients associated with the different proxies are also in line with the regressions where only one factor was considered.

[PLACE TABLE 7 HERE.]

[PLACE TABLE 8 HERE.]

4. Conclusion

This paper follows Lettau and Luvigson (2001a) and Julliard (2004) and uses the representative consumer's budget constraint to derive an equilibrium relation between the trend deviations among consumption, aggregate wealth and labour income, *cay*, future labour income growth, *lr*, and expected future asset returns. In addition, I consider two major sources of risk: expected future changes in the housing consumption share, *cr*, and expected future consumption growth, *lrc*. Then, I explore the predictive power of these variables for future asset returns.

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 labour 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 labour 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.

Additionally, it is shown that expectations about long-run risk are important determinants of asset returns: expectations of high (low) future labour income growth, high (low) future consumption growth, and low (high) housing consumption share are associated with lower (higher) than average stock market returns. The empirical proxies *cay*, *cday*, *cr*, *lr*, and *lrc* are able to track the risk premium and this explains their success as predictors of asset returns. On the other hand, shocks to long-run expectations play a negligible role in generating movements in stock prices.

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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).

Independent Variable	Equation 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)
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 1954:1 to 2004:1.

C. Notation: Current and Long-Run Innovations

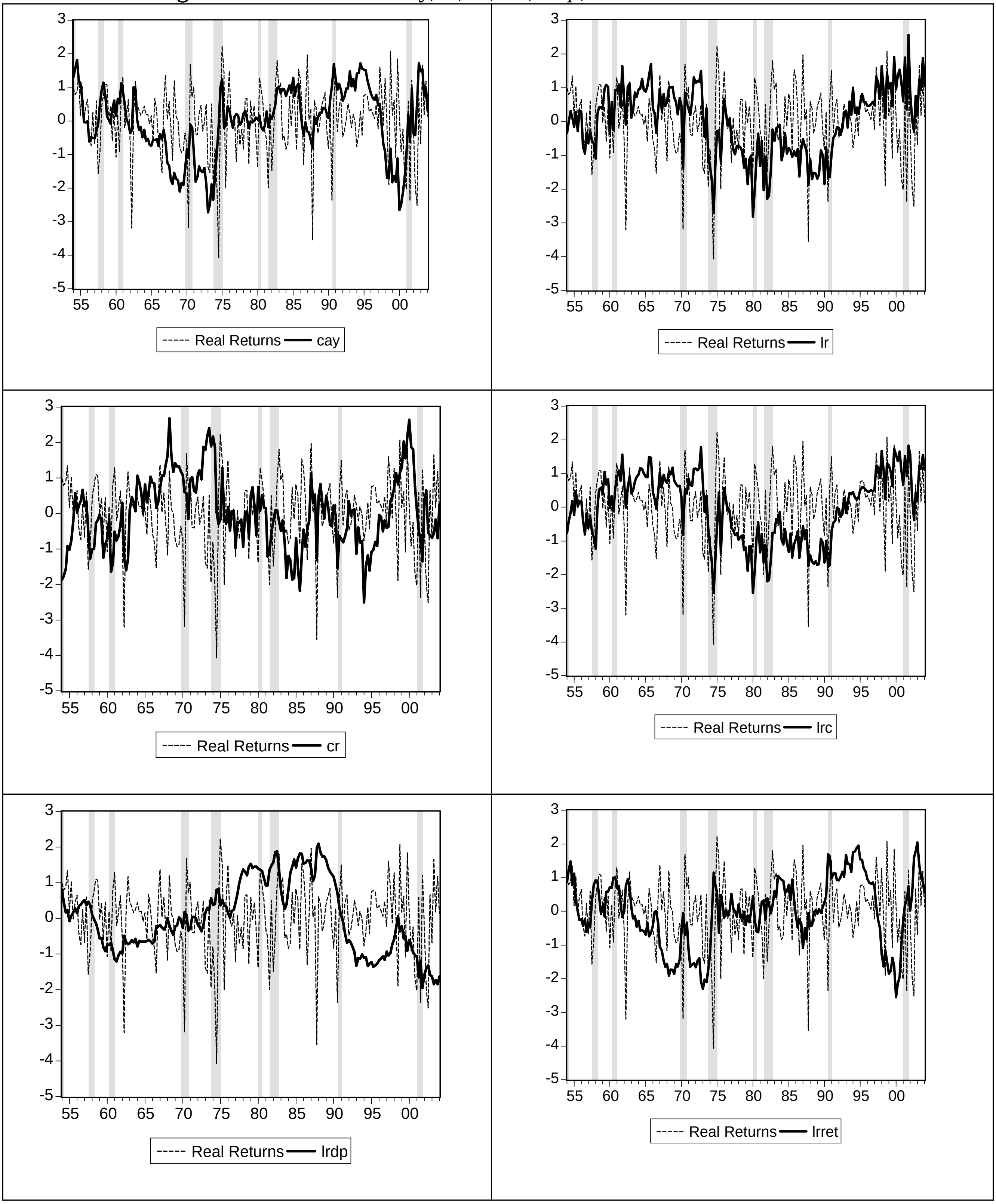
Table C1: Notation: current and long-run innovations.

Label	Definition	Expression
	Current Innovations	
$(\Delta s)_t$	$\Delta s_t - E_{t-1}[\Delta s_t]$	$e_1'\xi_t$
$(\Delta y)_t$	$\Delta y_t - E_{t-1}[\Delta y_t]$	$e_4'\xi_t$
$(\Delta c)_t$	$\Delta c_t - E_{t-1}[\Delta c_t]$	$e_e'\xi_t$
$(dp)_t$	$d_t - p_t - E_{t-1}[d_t - p_t]$	$e_7'\xi_t$
$(r)_t$	$r_t - E_{t-1}[r_t]$	$E_5'\xi_t$
	Long-Run Innovations	
$(\Delta s)_{t,\infty}$	$(E_t - E_{t-1})\sum_{i=1}^{\infty} \rho_w^i \Delta s_{t+i}$	$e_1'A(I-\rho_w A)^{-1}\xi_t$
$(\Delta y)_{t,\infty}$	$(E_t - E_{t-1})\sum_{i=1}^{\infty} \rho_h^{i-1} \Delta y_{t+i}$	$e_4'A(I-\rho_h A)^{-1}\xi_t$
$(\Delta c)_{t,\infty}$	$(E_t - E_{t-1})\sum_{i=1}^{\infty} \rho_w^1 \Delta c_{t+i}$	$e_3'A(I-\rho_w A)^{-1}\xi_t$
$(dp)_{t,\infty}$	$(E_t - E_{t-1})\sum_{i=1}^{\infty} \rho_w^1 (d_{t+i} - p_{t+i})$	$e_7'A(I-\rho_w A)^{-1}\xi_t$
$(r)_{t,\infty}$	$(E_t - E_{t-1})\sum_{i=1}^{\infty} \rho_w^i r_{t+i}$	$e_5'A(I-\rho_w A)^{-1}\xi_t$

The subscript *t* denotes current innovations.
The subscript *t*,∞ denotes current and future innovations.

Figures

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.

Tables

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

Regressor	Forecast Horizon *H* 1	2	3	4
	Panel A: Real Returns, using *cay*			
cay_{t-1}	1.164*	2.325*	3.381*	4.329*
(t-stat)	(4.55)	(4.47)	(4.56)	(4.94)
Adjusted R^2	[0.08]	[0.16]	[0.24]	[0.30]
RMSE	0.082	0.115	0.133	0.146
	Panel B: Real Returns, using *cday*			
$cday_{t-1}$	1.549*	3.055*	4.360*	5.434*
(t-stat)	(4.98)	(4.87)	(4.98)	(5.27)
Adjusted R^2	[0.10]	[0.18]	[0.25]	[0.30]
RMSE	0.082	0.113	0.132	0.145

Symbols *, ** and *** represent significance at a 1%, 5% and 10% level, respectively.
Newey-West (1987) corrected *t*-statistics appear in parenthesis. *RMSE* stands for root mean squared error.
The sample period is 1954:1 to 2004:1.

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)	(-3.92)	(-4.04)	(-4.19)	(-4.60)
Adjusted R^2	[0.09]	[0.15]	[0.18]	[0.23]
RMSE	0.083	0.115	0.138	0.153
	Panel B: Unexpected Changes			
cr_{t-1}	-16.906***	-27.621***	-28.088	-33.344
(t-stat)	(-1.70)	(-1.88)	(-1.54)	(-1.55)
Adjusted R^2	[0.02]	[0.02]	[0.01]	[0.01]
RMSE	0.085	0.124	0.152	0.173

Symbols *, ** and *** represent significance at a 1%, 5% and 10% level, respectively. *RMSE* stands for root mean squared error.
Newey-West (1987) corrected *t*-statistics appear in parenthesis.
The sample period is 1954:1 to 2004:1.

Table 3: Forecasting real returns using *lr*.

Regressor	Forecast Horizon H 1	2	3	4
	Panel A: Expected Changes			
lr_{t-1}	-1.818**	-3.484**	-5.452*	-7.251*
(t-stat)	(-2.28)	(-2.27)	(-2.63)	(-2.88)
Adjusted R^2	[0.01]	[0.03]	[0.05]	[0.07]
RMSE	0.086	0.123	0.148	0.167
	Panel B: Unexpected Changes			
lr_{t-1}	-1.650	-2.588	-6.236	-12.717*
(t-stat)	(-0.65)	(-0.68)	(-1.39)	(-2.85)
Adjusted R^2	[0.00]	[0.00]	[0.00]	[0.03]
RMSE	0.086	0.126	0.152	0.172

Symbols *, ** and *** represent significance at a 1%, 5% and 10% level, respectively. *RMSE* stands for root mean squared error.
Newey-West (1987) corrected *t*-statistics appear in parenthesis.
The sample period is 1954:1 to 2004:1.

Table 4: Forecasting real returns using *lrc*.

Regressor	Forecast Horizon H 1	2	3	4
	Panel A: Expected Changes			
lrc_{t-1}	-2.009*	-3.957*	-5.950*	-7.897*
(t-stat)	(-2.80)	(-2.88)	(-3.20)	(-3.40)
Adjusted R^2	[0.03]	[0.05]	[0.08]	[0.11]
RMSE	0.085	0.122	0.146	0.164
	Panel B: Unexpected Changes			
lrc_{t-1}	-4.593***	-7.662	-13.640*	-24.252*
(t-stat)	(-1.69)	(-1.62)	(-2.48)	(-4.09)
Adjusted R^2	[0.01]	[0.01]	[0.03]	[0.09]
RMSE	0.086	0.125	0.150	0.166

Symbols *, ** and *** represent significance at a 1%, 5% and 10% level, respectively. *RMSE* stands for root mean squared error.
Newey-West (1987) corrected *t*-statistics appear in parenthesis.
The sample period is 1954:1 to 2004:1.

Table 5: Forecasting real returns using *lrdp*.

Regressor	Forecast Horizon *H* 1	2	3	4
	Panel A: Expected Changes			
$lrdp_{t-1}$	0.123	0.242	0.325	0.381
(t-stat)	(1.09)	(1.10)	(1.05)	(1.00)
Adjusted R^2	[0.00]	[0.00]	[0.00]	[0.00]
RMSE	0.086	0.125	0.152	0.174
	Panel B: Unexpected Changes			
$lrdp_{t-1}$	0.335	1.409	1.669	1.419
(t-stat)	(0.46)	(1.30)	(1.43)	(1.04)
Adjusted R^2	[0.00]	[0.00]	[0.00]	[0.00]
RMSE	0.086	0.125	0.152	0.175

Symbols *, ** and *** represent significance at a 1%, 5% and 10% level, respectively. *RMSE* stands for root mean squared error.
Newey-West (1987) corrected *t*-statistics appear in parenthesis.
The sample period is 1954:1 to 2004:1.

Table 6: Forecasting real returns using *lrret*.

Regressor	Forecast Horizon *H* 1	2	3	4
	Panel A: Expected Changes			
$lrret_{t-1}$	0.128*	0.257*	0.377*	0.486*
(t-stat)	(4.46)	(4.36)	(4.41)	(4.75)
Adjusted R^2	[0.07]	[0.14]	[0.21]	[0.28]
RMSE	0.075	0.145	0.135	0.148
	Panel B: Unexpected Changes			
$lrdp_{t-1}$	0.176	0.289***	0.493**	0.720*
(t-stat)	(1.63)	(1.84)	(2.22)	(2.55)
Adjusted R^2	[0.01]	[0.01]	[0.03]	[0.05]
RMSE	0.086	0.125	0.150	0.170

Symbols *, ** and *** represent significance at a 1%, 5% and 10% level, respectively. *RMSE* stands for root mean squared error.
Newey-West (1987) corrected *t*-statistics appear in parenthesis.
The sample period is 1954:1 to 2004:1.

Table 7: Forecasting real returns using different proxies (expected changes).

	Forecast Horizon *H*														
			1					2					4		
Regressor															
r_{t-1}	0.015	-0.016	-0.014	-0.034	-0.199	-0.112	-0.125	-0.125	-0.163**	-0.485**	-0.346***	-0.244*	-0.255**	-0.351***	-0.727**
(t-stat)	(0.19)	(-0.25)	(-0.22)	(-0.59)	(-1.49)	(-1.08)	(-1.28)	(-1.30)	(-1.97)	(-1.95)	(-2.54)	(-1.84)	(-1.95)	(-3.43)	(-2.06)
cay_{t-1}	0.509	1.103***	1.068***	1.166***	3.077**	1.602**	2.200***	2.141***	2.327***	6.049**	4.123***	3.994***	3.891***	4.333***	8.628**
(t-stat)	(0.93)	(3.96)	(3.67)	(4.51)	(1.91)	(2.05)	(3.84)	(-0.75)	(4.43)	(2.15)	(3.20)	(4.25)	(3.97)	(4.92)	(2.11)
cr_{t-1}	-10.86					-11.970					-3.410				
(t-stat)	(-1.13)					(-0.87)					(-0.20)				
lr_{t-1}		-0.593					-1.203					-3.225			
(t-stat)		(-0.67)					(-0.71)					(-1.32)			
lrc_{t-1}			-0.651					-1.234					-2.948		
(t-stat)			(-0.78)					(-0.75)					(-1.23)		
$lrdp_{t-1}$				0.125					0.246					0.389	
(t-stat)				(1.21)					(1.29)					(1.28)	
$lrret_{t-1}$					-0.226					-0.440					-0.507
(t-stat)					(-1.24)					(-1.40)					(-1.09)
Adjusted R^2	[0.09]	[0.08]	[0.08]	[0.09]	[0.09]	[0.16]	[0.16]	[0.16]	[0.17]	[0.17]	[0.29]	[0.31]	[0.31]	[0.31]	[0.30]
RMSE	0.082	[0.083]	0.083	0.082	0.082	0.114	0.115	0.114	0.114	0.114	0.146	0.145	0.145	0.145	0.145

Symbols *, ** and *** represent significance at a 1%, 5% and 10% level, respectively. *RMSE* stands for root mean squared error.
Newey-West (1987) corrected *t*-statistics appear in parenthesis. The sample period is 1954:1 to 2004:1.

Table 8: Forecasting real returns using different proxies (unexpected changes).

Regressor	Forecast Horizon H														
	1					2					4				
r_{t-1}	-0.002	-0.043	-0.037	-0.002	-0.096	-0.136	-0.211	-0.240	-0.049	-0.349**	-0.407***	-0.118	-0.032	-0.219*	-0.519***
(t-stat)	(-0.02)	(-0.39)	(-0.32)	(-0.02)	(-0.89)	(-1.28)	(-1.35)	(-1.06)	(-0.43)	(-2.34)	(-3.03)	(-0.68)	(-0.13)	(-1.69)	(-2.72)
cay_{t-1}	1.089***	1.168***	1.165***	1.181***	1.287***	2.252***	2.348***	2.396***	2.380***	2.698***	4.424***	4.188***	3.995***	4.396***	4.655***
(t-stat)	(4.19)	(4.36)	(3.90)	(4.49)	(4.12)	(4.42)	(4.32)	(3.76)	(6.58)	(6.25)	(4.94)	(4.65)	(4.17)	(5.05)	(8.44)
cr_{t-1}	-6.631					-6.361					8.423				
(t-stat)	(-0.69)					(-0.51)					(0.57)				
lr_{t-1}		0.159					1.048					-6.232*			
(t-stat)		(0.07)					(0.30)					(-1.84)			
lrc_{t-1}			0.005					1.796					-8.480*		
(t-stat)			(0.00)					(0.33)					(-1.67)		
$lrdp_{t-1}$				0.533					1.809**					2.158**	
(t-stat)				(0.87)					(2.14)					(2.07)	
$lrret_{t-1}$					-0.085					-0.259					-0.226
(t-stat)					(-0.73)					(-1.60)					(-1.09)
Adjusted R^2	[0.08]	[0.08]	[0.08]	[0.08]	[0.08]	[0.16]	[0.16]	[0.16]	[0.18]	[0.17]	[0.30]	[0.30]	[0.30]	[0.31]	[0.30]
RMSE	0.083	0.083	0.083	0.083	0.083	0.115	0.115	0.115	0.113	0.114	0.146	0.145	0.145	0.145	0.146

Symbols *, ** and *** represent significance at a 1%, 5% and 10% level, respectively. *RMSE* stands for root mean squared error.
Newey-West (1987) corrected *t*-statistics appear in parenthesis. The sample period is 1954:1 to 2004:1.

Notes

[1] These authors show that CCAPM performs relatively better than the CAPM at longer horizons.

[2] See, for example, Fama and French (1988), Poterba and Summers (1988), Lettau and Ludvigson (2001a, 2004).

[3] Lin *et al.* (2007) also analyze the issue of predictability of asset returns in the context of emerging bond markets. In contrast, Lee (2008) finds that the correlation between unpredictable stock returns and unpredictable inflation is low.

[4] Pakos (2003) argues that there preferences are non-homothetic.

[5] That is, $\boldsymbol{S_t} := \dfrac{\boldsymbol{C_t}}{\boldsymbol{C_t + P_t^U U_t}}$.

[6] The assumption that human capital is included in aggregate wealth explains why labour income does not appear explicitly in this equation.

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

[8] 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:

$$c_t - s_t = \log(C_t) - \log(S_t) = \log(C_t) - \log(\frac{Ct}{Ct + P_t^U U_t} = \log(C_t + P_t^U U_t) = \log(C_t^{ND}) = c_t^{ND}.$$

[9] Note that one could also split consumption into its non-durables and durables components as in Yogo (2006). In this case, the consumer's budget constraint (equation (1)) could be written as:

$$W_{t+1} = (1+R_{w,t+1})(W_t - C_t^{ND} - P_t^D D_t) = (1+R_{w,t+1})(W_t - \frac{C_t^{ND}}{S_t^{ND}}),$$

where W_t represents aggregate wealth, C_t^{ND} is non-durables consumption, D_t is durables consumption, P_t^D is the relative price of durables consumption, S_t is the non-durables consumption share, and $R_{w,t+1}$ is the return on aggregate wealth between period t and $t+1$.

[10] 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.

[11] 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.

[12] I estimate cay_t and $cday_t$ using dynamic OLS with 4 lags and leads. For brevity, I only report the estimates of the coefficients associated with (dis)aggregate wealth and labour income in the cointegrating vector.

[13] Ludvigson and Steindel (1999) suggest that the marginal propensity to consume out of stock market wealth was larger in the late seventies and early eighties. As a result, the estimation of *cay* and *cday* using different sub-samples could potentially improve the precision of the estimated parameters in the cointegrating relationships. Nevertheless, Lettau and Ludvigson (2005) emphasize that the difficulty with this procedure is that it can also strongly understate the predictive power of the regressor, making it difficult for *cay* and *cday* to exhibit forecasting power when the theory is true.

[14] This is because the consumption-(dis)aggregate wealth ratio is computed using the DOLS approach, while the remaining empirical proxies that capture time-variation in asset returns are built upon the VAR approach. By doing so, I keep consistency with the work of Lettau and Ludvigson (2001a), which makes results comparable. Moreover, while the consumption-wealth ratio helps explaining future returns *per se*, in the other factors it is the *long-run* variation that has informational content and their construction requires the use of the VAR framework.

[15] The predictive impact of *cday* on future returns is economically larger than that of *cay*: in the one-period ahead regressions, the point estimate of the coefficient on *cday* is about 1.549 for real returns and only 1.164 in the case of *cay*. Thus, a one-standard-deviation increase in *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, *cay* itself has a standard deviation of about 0.023, implying that a one-standard-deviation increase in *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 at an annual rate.

[16] Dunn and Singleton (1986) and Eichenbaum and Hansen (1990) also find evidence against separabilility of preferences, but this does not help pricing risk.

[17] When *cay* is replaced by *cday* in the several specifications, the results slightly improve in terms of prediction of asset returns, but are qualitatively similar.