# Consumption, Money, Intratemporal Substitution and Cross-sectional Asset Returns


**Abstract**

When utility is specified as a function of both consumption and money recursively, real money growth becomes a common factor in addition to the market excess return and consumption growth. The risk premium on the money factor is negative because money complements consumption and is positively related to the stochastic discount factor. Growth portfolios, short-term loser portfolios and long-term winner portfolios tend to have higher loadings on the money factor and thus earn lower premia on money.

# 1 Introduction

A significant portion of asset pricing research is devoted to common risk factors in stock returns. Most of these factors seem to come from the real side of the economy and a less explored variable is the real money supply growth.[1] Some studies actually attempt to show that real money growth is a priced common factor (Chan, Foresi and Lang, 1996, Balvers and Huang 2009), but a weakness of their approaches is that little is known about preference parameters in their model, thus making risk exposures and premia estimation ad hoc. This paper, on one hand, explores how risk premia estimates on money are affected by structural preference parameters, thus putting money on a more solid theoretical ground for cross-sectional asset pricing. On the other hand, this paper provides new empirical evidences on how real money supply growth helps to explain cross-sectional differences in asset returns using various one-way sorted portfolios. Lewellen, Nagel and Shanken (2010) find that the typical 25 portfolios formed on size and value used in many asset pricing studies may have an inherent factor structure, and they forcefully suggest that one-way sorted portfolios should be used (See also, Liu, Whited and Zhang 2009).

In our setting, the representative agent has Epstein-Zin (1989, 1991) and Weil (1990) preference and optimally chooses non-durable goods consumption and real money holdings. The approach of including money in the utility function was first proposed in Sidrauski (1967) and then adopted by a large body of literature on monetary economics. Although this specification induces a demand for money in a reduced-form manner, it is consistent with other approaches where money is granted more explicit roles (Feenstra, 1986; Walsh, 2010). For example, money is required before an agent buys consumption goods in cash-in-advance models, and in shopping time models, money is held to reduce shopping time and thus increase leisure. The recursive preference allows separation of risk

[1]Cochrane (2007, p. 314) refers to money as "missing" for cross-sectional asset pricing in his review article on the financial markets and the real economy.

aversion from the inverse of intertemporal elasticity of substitution. As a result, money enters into the stochastic discount factor, and money growth becomes the additional common factor in addition to consumption growth and market return after linearization.

The new component in the stochastic discount factor takes the form of a money-consumption ratio, and it raises the stochastic discount factor or marginal utility when the parameter that governs the intratemporal elasticity of substitution between money and consumption is less than the parameter that controls the intertemporal substitution. An asset that co-varies positively with money-consumption ratio or money growth pays highly when the stochastic discount factor or the marginal utility is high, and this asset pays highly at the right time and is considered to be a good "hedge." Money thus earns a negative premium because money and consumption are essentially "complements," and money mitigates risk. Assets that have positive loadings on the money factor thus earn lower premia on money.

Our main testing assets are collections of one-way sorted decile portfolios formed on book-to-market, short-term past returns and long-term past returns. We find that, regardless of model specification, portfolios with lower book-to-market ratios, lower short-term past returns, or higher long-term past returns (growth, short-term loser, long-term winner portfolios), tend to have higher betas on money growth. Since the premia on money growth are negative, ceteris paribus, these portfolios earn lower premia on money growth and lower average returns.

Specifically, using monthly data from 1959 to 2009 and the proposed model with money, consumption and market return, the money betas for growth, short-term loser, and long-term winner portfolios are 0.55, 0.97, and 0.46, while those for value, short-term winner, and long-term loser portfolios are 0.26, 0.46, and 0.15. The risk premia for portfolios formed on book-to-market, short-term past returns, and long-term past returns are -0.39%, -2.77%, and -0.37%, and the OLS adjusted r-squares are 28%, 65%, and 69% respectively. When three sets of decile portfolios are put together as the testing assets and the second-pass constant is restricted to zero, the risk premia on the market, consumption, and money are 0.27%, 0.23%, -0.19%, consistent with our expectations. Most of the explanatory power stems from money. Indeed, when money growth is used alone, betas and risk premia estimates are similar, and the OLS adjusted r-squares are 24%, 38%, and 48% for portfolios formed on book-to-market, short-term past returns and long-term past returns, much better than the 4%, 7%, and 0% of the CAPM and 15%, 2%, and 7% of the CCAPM.

We estimate the nonlinear stochastic discount factor using one-stage Generalized Method of Moments; we find that the intratemporal elasticity of substitution between money and consumption equals 0.08, less than the intertemporal elasticity of substitution, which is 0.48. This result confirms the proposition that the stochastic discount factor is an increasing function of money-to-consumption ratio. The risk aversion parameter is around 280, which means the model cannot explain the equity premium puzzle.

Closely related studies include Chan, Foresi and Lang (1996), Yogo (2006), Balvers and Huang (2009), and Lioui and Maio (2010). By invoking a cash-in-advance constraint, Chan, Foresi and Lang (1996) replace consumption with insiders' money, which is measured as M2 minus cash, and they show that a money factor constructed based on nominal insiders' money growth is priced using monthly nominal returns on 20 portfolios formed on market capitalization.

Yogo (2006) shows that the common factors are non-durable goods consumption growth, durable goods consumption growth and the market return, and he shows that quarterly durable goods consumption growth contributes significantly to average return differences of portfolios formed on various characteristics. Our approach is similar to Yogo, but the newly proposed factor is real money growth.

Balvers and Huang (2009) incorporate money into representative agent's intertemporal decisions, assuming money provides transaction services and holding money lowers transaction cost. They propose the common factors to be either consumption plus money or market plus money. In contrast with Epstein-Zin and Weil preferences, this paper examines the role of money in a more general framework that includes consumption, money and market returns, which subsumes Balvers and Huang (2009) as one of the special cases. More importantly, estimation of parameters in the utility function in this paper provides insights on why money mitigates risk and should earn a negative risk premium. Using quarterly data on 25 portfolios formed size and value, Balvers and Huang (2009) show that money earns a positive premium in cross sectional asset pricing test. Nevertheless, with monthly data, we find that money indeed earns negative premia when various one-way sorted portfolios are used as testing assets. Our findings supports Lewellen, Nagel and Shanken (2010) in that tests based on portfolios with inherent factor structure may provide misleading results. Our study also confirms that, in asset pricing tests, risk premia and exposures are certainly sensitive to the testing assets and the frequency of the data, as in Jagannathan and Wang (2007), who show that year over year fourth quarter consumption growth, rather than year over year December consumption growth, bears the most consumption risk. We opt to take advantage of the long sample of monthly data because real money growth seems to be measured more accurately, and more importantly, it is unclear whether consumption and money are priced when monthly data are used.

Lioui and Maio (2010), with a similar framework, show that changes in short-term interest rates explain well the average returns of 25 portfolios formed on size and book-to-market and 25 portfolios formed on size and long-term past returns. Our study differs from and extends their work in several ways. First, we expand the set of assets to include portfolios formed on short-term past returns, which is a very challenging anomaly. Second, we focus on a bigger set of one-way sorted portfolios to avoid the potential factor structure in testing assets as argued in Lewellen, Nagel and Shanken (2010). Third, and perhaps most important, our model allows the elasticity of intratemporal substitution between money and consumption to deviate from one. This is essential to explaining why money earns a negative premium.

The paper is organized as follows. We first introduce money into the representative agent's intertemporal choices and derive why money can be a common factor in section 2. In section 3, we show pricing, structural estimation and robustness check results. and section 4 offers some conclusions.

# 2 An Asset Pricing Model with Money

## 2.1 Preferences and the Stochastic Discount Factor

Yogo (2006) introduces non-durable goods consumption into the Epstein-Zin (1989) and Weil (1990) type of non-separable utility function and it provides a perfect framework for us to study the effect of money on cross-sectional asset pricing. The main difference is that, in Yogo (2006), non-durable goods consumption and durable good consumption are substitutes while in our study, non-durable goods consumption and money are complements. At each time $t$, the agent chooses to buy $C_t$ units of nondurable consumption goods, and holds $L_t$ extra units of real money. Over time, the stock of real money balance, $H_t$, evolves according to

$$H_t = \frac{1}{1+\pi_t} H_{t-1} + L_t \tag{1}$$

where $\pi_t$ is the inflation rate. In addition, there are $N+1$ tradable assets. The agent invests $A_{i,t}$ units of wealth in asset $i$ and $R_{i,t+1}$ is the gross return this asset yields. Given that the agent starts with initial wealth of $W_t$, funds available for investing are given by

$$\sum_{i=0}^{N} A_{i,t} = W_t - C_t - P_{L,t} L_t \tag{2}$$

where $P_{L,t}$ is the price of additional money holdings in terms of nondurable consumption goods, and this price is essentially the risk-free rate. When all funds are invested, the agent's wealth at period $t+1$ is given by

$$W_{t+1} = \sum_{i=0}^{N} A_{i,t} R_{i,t+1} \tag{3}$$

We follow the money-in-utility approach to specify the agent's intraperiod utility. It features constant elasticity of substitution between consumption and money

$$u(C, H) = [(1-\alpha) C^{1-1/\rho} + \alpha H^{1-1/\rho}]^{\frac{1}{1-1/\rho}} \tag{4}$$

where $\alpha$ is between 0 and 1 and $\rho$, greater than 0, is the elasticity of substitution between consumption goods and money. When $\rho$ equals 1, the intraperiod utility is Cobb–Douglas, i.e. $u(\mathrm{C}, \mathrm{D}) = C^{1-\alpha} H^{\alpha}$. In any period $t$, the lifetime utility is given by two components: one, the current utility derived from the combination of consumption and money at time $t, u(C_t, H_t)$; the other, a certainty equivalent of random future utilities $\mu[\tilde{U}_{t+1}|I_t]$. This preference is the same as those in Epstein & Zin (1991), Ogaki & Reinhart (1998) and Yogo (2006), except now they are defined over combinations of consumption and money pairs. The lifetime utility is represented recursively by an aggregator function, $J$, and it is given by

$$U_t = J(u(C_t, H_t), \mu[\tilde{U}_{t+1}|I_t]) \tag{5}$$

Our certainty equivalent function $\mu$ is

$$\mu[\tilde{U}_{t+1}|I_t] = (E_t[\tilde{U}_{t+1}^{1-\gamma}])^{\frac{1}{1-\gamma}} \tag{6}$$

where $E_t$ is conditional expectation given information up to time $t$, $I_t$. Our aggregator function is

$$J = [(1-\beta)u^{1-1/\sigma} + \beta\mu^{1-1/\sigma}]^{\frac{1}{1-1/\sigma}} \tag{7}$$

where $\beta$ is the time preference and the agent chooses consumption, money and equity holdings to maximize the following recursive utilities

$$U_t = [(1-\beta)u(C_t, H_t)^{1-1/\sigma} + \beta(E_t[\tilde{U}_{t+1}^{1-\gamma}])^{\frac{1}{1-\theta}}]^{\frac{1}{1-1/\sigma}} \tag{8}$$

where $\theta = \frac{1-\gamma}{1-\frac{1}{\sigma}}$. This form of utility allows separation of risk aversion, $\gamma$, from intertemporal elasticity of substitution (IES), $\sigma$. So basically the relative risk aversion is reflected in the certainty equivalent function $\mu$, and the IES is reflected in aggregator function $J$. Following Epstein & Zin (1991) and Yogo (2006), the intertemporal marginal rate of substitution (IMRS) or the stochastic discount factor can be written exclusively in terms of observable variables as

$$\begin{aligned} M_{t+1} &= \beta^{\theta}(\frac{C_{t+1}}{C_t})^{-\theta/\sigma}(\frac{u_{t+1}}{u_t})^{\theta/\rho-\theta/\sigma}R_{w,t+1}^{\theta-1} \\ &= [\beta(\frac{C_{t+1}}{C_t})^{-1/\sigma}(\frac{v_{t+1}}{v_t})^{1/\rho-1/\sigma}R_{w,t+1}^{1-1/\theta}]^{\theta} \end{aligned} \tag{9}$$

where

$$v = [1-\alpha+\alpha(\frac{H}{C})^{1-1/\rho}]^{\frac{1}{1-1/\rho}} \tag{10}$$

and $R_{w,t+1}$ is return on wealth which we will simply proxy with value-weighted return of all CRSP firms.

## 2.2 Some Special Cases

When risk aversion is the reciprocal of the IES, $\theta$ equals one. The model reduces to a standard CRRA case of expected utility but now with two goods. The stochastic discount factor becomes

$$M_{t+1} = \beta(\frac{C_{t+1}}{C_t})^{-1/\sigma}(\frac{v_{t+1}}{v_t})^{1/\rho-1/\sigma} \tag{11}$$

which is similar to Marshall (1992) and Balvers and Huang (2009), and the common factors specified by this stochastic discount factor are consumption growth and money growth. If $\alpha$, the share on money, is set to zero, the stochastic discount factor now reduces further to a CRRA case with just consumption

$$M_{t+1} = \beta(\frac{C_{t+1}}{C_t})^{-1/\sigma} \tag{12}$$

which is the stochastic discount factor in the Consumption-based Asset Pricing Model of Breeden (1979), and the common factor in this case is simply consumption growth. If instead $\theta$ does not equal one and $\alpha$ is kept at zero, then the stochastic discount factor becomes

$$M_{t+1} = \beta(\frac{C_{t+1}}{C_t})^{-\theta/\sigma} R_{w,t+1}^{\theta-1} \tag{13}$$

which is the one used in Epstein and Zin (1991), and the common factors are consumption growth and market return. Further, if we allow $\theta$ to be zero, the stochastic discount factor is

$$M_{t+1} = \beta R_{w,t+1}^{-1} \tag{14}$$

which specifies market return as the stochastic discount factor and the only common factor.

## 2.3 Pricing Equations

It is straightforward to show that all assets are priced by the proposed stochastic discount factors. We have

$$E_t[M_{t+1}R_{i,t+1}] = 1 \tag{15}$$

for gross returns and

$$E_t[M_{t+1}(R_{i,t+1} - R_{0,t+1})] = 0 \tag{16}$$

for excess returns when asset 0 is used as the benchmark asset. Assets that covary negatively with the stochastic discount factor earn a higher rate of return because, for example, these assets pay highly when the marginal utility of consumption is low as in the case of the Consumption-based CAPM. In our case, the stochastic discount factor has an extra term $(\frac{v_{t+1}}{v_t})^{(1/\rho - 1/\sigma)\theta}$. If $\theta$ is positive and $\rho$ is less than $\sigma$, the stochastic discount factor increases in the ratio of money and consumption for a given level of consumption. Then assets that are positively correlated with the movement of the money-consumption ratio are, in fact, paying higher when marginal utility is high and will earn lower returns. Money mitigates risks. $\theta$ is positive if the risk aversion is greater than one and IES is less than one, which seems reasonable. The proposition that $\rho$ less than $\sigma$ means that the intratemporal IES between consumption and money is less than the intertemporal IES. In short, similar to Walsh (2010), high money holdings increase marginal utility, and this perhaps requires that money and consumption be complements.

Let $u_h$ and $u_c$ be the marginal utility of money and consumption, then the marginal rate of substitution between money and consumption is

$$\frac{u_h}{u_c} = \frac{\alpha}{1-\alpha}(\frac{H}{C})^{-1/\rho} \tag{17}$$

and optimal decisions on money holdings require that

$$\frac{u_{h,t}}{u_{c,t}} = P_{L,t} - E_t[M_{t+1}\frac{P_{L,t+1}}{1+\pi_{t+1}}] \tag{18}$$

which states that the marginal rate of substitution must equal the relative price of money.

### 2.4 Empirical Methods

The empirical method we adopt is to estimates betas, risk premia using the standard two-pass approach and the five parameters in the nonlinear stochastic discount factor using the Generalized Method of Moments. We then investigate if the parameter estimates support our evidence on risk premia. For the two-pass regression, we need to rewrite the pricing equation in a beta-return form. To do so, we first take the logs of both sides of the stochastic discount factor and approximate it around Cobb-Douglas intraperiod utility. We then have

$$m_{t+1} = \theta \log \beta - b_1 R_{w,t+1} - b_2 \Delta c_{t+1} - b_3 \Delta h_{t+1} \tag{19}$$

where $b_1 = 1-\theta$, $b_2 = \theta[1/\sigma+\alpha(1/\rho-1/\sigma)]$, $b_3 = \theta\alpha(1/\sigma-1/\rho)$, lower case represents logs and $\Delta$ represents differences. Since $1 + m_{t+1} - E[m_{t+1}] = M_{t+1}/E[M_{t+1}]$ approximately, the above equation and the stochastic discount factor show that

$$M_{t+1}/E[M_{t+1}] = k - b_1 R_{w,t+1} - b_2 \Delta c_{t+1} - b_3 \Delta h_{t+1} = k + b' f_{t+1} \tag{20}$$

where $k$ is a constant, $b$ is a column vector of $b$s, and $f_{t+1}$ is a column vector that contains the excess market return, consumption growth and money growth. Let the variance-covariance matrix of the three factors be $\Sigma_{ff}$ and the covariance matrix between factors and excess returns be $\Sigma_{fi}$; the pricing equation shows that

$$\begin{aligned} E[R_{i,t+1} - R_{0,t+1}] &= Cov[\frac{M_{t+1}}{E(M_{t+1})}, R_{i,t+1} - R_{0,t+1}] \\ &= b'\Sigma_{fi} \end{aligned} \tag{21}$$

If the beta of the asset is defined as $\beta_i = \Sigma_{ff}^{-1}\Sigma_{fi}$ and the factor risk premia are defined as $\lambda = \Sigma_{ff}b$, then we have the usual beta-return form for expected returns

$$E[R_{i,t+1} - R_{0,t+1}] = \lambda'\beta_i \tag{22}$$

which we can test using the standard two-pass regressions. We can also estimate equation (21), but with three estimates on the prices of covariances, we will not be able to identify four structural parameters (in particular $\rho$ from $\alpha$) associated with those covariance prices. Therefore, we opt to estimate the nonlinear stochastic discount factor directly.

# 3 Empirical Results

## 3.1 Data

We obtain the following monthly macro and interest rates data from the St. Louis Fed website: money supply (M2), non-durable consumption, population, consumer price index (CPI), yields on Baa rated bonds and on Aaa rated bonds, and yields on 10-year Treasury bonds and on 3-month Treasury bills.[2] Following convention, we construct variables as follows: the money growth rate ($\Delta h$) is the log difference of M2 per capita adjusted for inflations; growth rate of nondurable and service ($\Delta c$) is the log difference of nondurable and service per capita adjusted for inflations; money-consumption ratio

[2]http://research.stlouisfed.org/fred2/

(Xmct) is M2 divided by consumption; default premium (Xdef) is the difference of yields on Baa rated bonds and Aaa rated bonds; and term premium (Xterm) is the difference of yields on 10-year Treasury bonds and 3-month Treasury bills. Fama-French (1993) three factors ($R_w$, SMB and HML) are obtained from French's web-site.[3]

In asset pricing, the proposed model is often tested with portfolios based on economically interesting characteristics such as size, value, momentum, etc. In addition, using portfolios very likely allows betas to be estimated more precisely, especially when the factors are based on macro variables; thus, we follow the portfolios approach. And as noted by Lewellen, Nagel and Shanken (2010), asset pricing models, especially multi-factor models, often perform well in explaining testing portfolios such as 25 size-value sorted portfolios that have built-in factor structures in them. Therefore, our main focus is one-way sorted portfolios. Our main testing portfolios are as follows: 10 portfolios formed on book-to-market; 10 portfolios formed on short-term past returns; and 10 portfolios formed on long-term past return, where the long-term return is measured as the returns 60 to 12 months prior to the portfolio formation. For the 10 portfolios formed on short-term past returns, we adopt the benchmark case in Jegadeesh and Titman (1993), which requires us to use all firms listed on the New York Stock Exchange, American Stock Exchange and NASDAQ, to apply a six-month sorting period and a six-month holding period, and to skip one month between the sorting period and the holding period. At each month $t + 6$, we hold stocks selected in the month $t$, as well as those selected by strategies in the previous five months prior to $t$. The momentum portfolio returns for each month are the average of equal-weighted returns of the six portfolios. A short-term winner (loser) portfolio buys stocks with the highest (lowest) past six-month returns.

It is well-known that consumption is measured poorly, especially at higher frequencies, but real money supply (M2) seems to be measured much more accurately. And consumption alone is found to contribute little to cross-sectional asset pricing regardless

[3]http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

of whether it is measured at quarterly frequency or monthly frequency; we thus opt to set the bar higher for money and other models. We test the model with monthly data and expect all tests to have higher power. We obtain all other return data from French's web-site. Due to availability of money supply data, our sample is from January 1959 to December 2009.

Table 1 shows summary statistics and average returns for various testing portfolios. The means of real per capita money supply growth and non-durable consumption growth are 0.13% and 0.16% per month, and the correlation between consumption growth and money growth is 0.29, suggesting that, on average, when consumption increases, money also increases. Figure 1 plots the money-to-consumption ratio and the growth of money-to-consumption ratio, which is the difference between real money growth and real consumption growth, across business cycles measured by the NBER. It is clear from the figure that there are high frequency variations in the difference between real money growth and real consumption growth, and this variation is beyond what the NBER recession dates can measure. As noted earlier, an asset is risky if it pays poorly when marginal utility (stochastic discount factor) is high. As long as the money-consumption ratio varies, it provides an additional source for the variation in the stochastic discount factor. Since we find that portfolios with lower book-to-market ratios, lower short-term past returns and higher long-term past returns tend to co-vary more with money growth, it means that these portfolios earn lower expected returns because they deliver relatively higher returns when money happens to increase the stochastic discount factor, ceteris paribus.

## 3.2 Betas and Risk Premia

This section shows that cross-sectional differences in average asset returns are related to differences in exposure to risk related to money. To evaluate the importance of money, we use the conventional two-pass regression, where the factor exposures (betas) are obtained in the first pass and risk premia are obtained in the second pass. Specifically we obtain betas from the following time series regression

$$R_{i,t+1} - R_{0,t+1} = \alpha_i + \beta_{i,w} R_{w,t+1} + \beta_{i,c} \Delta c_{t+1} + \beta_{i,h} \Delta h_{t+1} + \varepsilon_{i,t+1} \tag{23}$$

where $\beta_{i,w}$, $\beta_{i,c}$, and $\beta_{i,h}$ are asset's betas on market return, consumption growth, and money growth. Betas are then used as explanatory variables in a cross sectional regression specified as

$$E[R_{i,t+1} - R_{0,t+1}] = \beta_{i,w}\lambda_w + \beta_{i,c}\lambda_c + \beta_{i,h}\lambda_h \tag{24}$$

where $\lambda$s are risk premia for the three factors. We regress the market excess return on real money growth and consumption growth, and take the sum of the residual and the constant as an orthogonalized market factor, as in Fama and French (1993). This way the market factor captures common variations in returns left by money growth and consumption growth, and the regressions provide a cleaner picture of the separate role of the market and real money growth in stock returns.[4] Fama and French (1993) show that bond-market factors as represented by term premium and default premium explain stock returns. They find that information in the bond-market factor is partially spanned by the market factor since the market factor acts as a hodgepodge of all factors, and using an orthogonalized market factor improves the significance of bond market factors. Results are similar for money. That is, some of the explanation power in money is spanned by the market return and money becomes less significant in the presence of the market return in the first-pass regression. Nevertheless, the risk premia estimates on money in the second-pass are not affected whether or not the market return is orthogonalized. After all, the model is judged by a combination of criteria.

As shown in Lewellen et al., an asset pricing model may achieve high OLS R-square

[4] Using a constant plus residuals from regressing the market excess return on just money yields similar pricing results.

without satisfying theoretical restrictions on betas and risk premia, and judging a model simply by its overall fit measured by OLS R-square or any other single criteria is insufficient. In that spirit, we evaluate the role of money along several dimensions including 1) the pattern of the betas; 2) sign and significance of risk premia using one way sorted portfolios; 3) overall fitness of the model measured by GLS R-square and OLS R-square; and 4) the $F$ statistics of Gibbons, Ross and Shanken (1989).

Our theory firstly predicts that value portfolios, portfolios with high short-term past returns (short-term winners) and portfolios with low long-term past returns (long-term losers) have lower money beta. Secondly, we predict that money carries negative risk premia because it mitigates risks, and the reason to use decile portfolios is to avoid potential factor structure in 25 portfolios sorted by size and some firm characteristics. Thirdly, GLS R-square measures the maximum return an investor with mean-variance preference can get if she uses the model implied expected return as input for her portfolio optimization. And finally, the GRS statistics have attractive portfolio implications and are often used when factors are returns or tradable. If the reward to variability of a combination of the testing portfolios is higher than that of the factors, then the joint test on $\alpha$s will be significant.

## 3.3 Tests on 10 portfolios

We start by showing results for a model with all components: market return, consumption and money. Table 2 shows the $\alpha$s, $\beta$s, and risk premia estimates for each of the 10 portfolios. In panel A, for 10 portfolios formed on book-to-market, the first row shows their average returns and the second row shows the first pass $\alpha$s. The $\alpha$ of the value portfolio is 0.44% and $\alpha$ of the growth portfolio is -0.18%, which are small relative to their sample average of 1.3% and 0.76%. The beta of value portfolio is 0.26 and is less than the beta of growth portfolio, which is 0.55. Although betas across ten portfolios are not monotonic, this spread of 0.29, together with a risk premium estimate of -0.39% on money, contributes an average return of 1.36% per annum to the value premium. While this is not large, it is roughly equal to one-fourth of the value premium in the sample.

The results for 10 portfolios formed on short-term past returns are more encouraging. The average returns and $\alpha$s for portfolios with high (low) short-term past returns are 1.61% (1.01%) and 0.54% (-0.15%). Now the betas on money monotonically decrease from 0.97 to 0.46 going from portfolios with low past short-term returns to portfolios with high past short-term returns, and most of the betas are two standard errors away from zero. A beta spread of 0.51 and a premium of -2.77% generate an annual momentum premium of 16.9%, which is unrealistically high enough to cover the momentum premium in the sample.[5] We show in the next section that money growth used alone yields a more reasonable premium of -0.81%. We also note that the Shanken's (1992) t-value for the risk premium on money is only -0.52, and this t-value considers the fact that betas are estimated regressors which tend to be much lower than the conventional t-values in the current category of testing assets, reflecting the challenge posed by using a portfolio formed on short-term past return as the testing asset and the weakness of using macro factors as the common factors.[6] Nevertheless, the conventional t-value on money is high at -3.53. The results for 10 portfolios formed on long-term past returns are similar. The long-term returns here are measured using cumulative returns from past 60 to 12 months before portfolio formation. The highest $\alpha$ is only 0.26% and betas in general increase going from a portfolio with low past long-term returns to a portfolio with high past long-term returns.

Overall, money seems to explain portfolios formed on short-term and long-term past

[5]Note that when short-term past return is measured as returns from 12 to 2 months prior to portfolio formation and the portfolios are value weighted, the premium on money again is -0.4%, close to estimates from the other two sets of portfolios. Equal weighted momentum portfolios based on a six month holding period and six month sorting period are, however, the benchmark scenario in Jegadeesh and Titman (1993) and seem to pose more challenge for asset pricing models.

[6]We also note that the size factor and value factor are highly insignificant when testing portfolios are one-way sorted decile portfolios.

returns better than portfolios formed on book-to-market, provided that the OLS (GLS) r-squares for the former are 65% and 69% (40% and 10%), while for the latter they are only 28% (10%). A caveat, though, is that market return and consumption seem to help little with pricing, possibly because of measurement errors in these two variables. In particular, assets tend to have erroneous loadings patterns and risk premia on the market return and consumption. In order to achieve correct signs on risk premia estimates, we must invoke a theoretical restriction on the second-pass $\alpha$ to set it to zero. Using all 30 portfolios together, we find that the premia on the market, consumption, and money are 0.27%, 0.23%, and -0.19%, and the Shanken's t-values are 0.73, 1.43, and -1.22, respectively. Taking the evidence with pricing all portfolios and all diagnostics together, we view our results as supportive evidence for the existence of a risk premium on money.

The GRS statistic tests first-pass $\alpha$ jointly and this test results in Table 2 are mixed. It supports the model according to results from portfolios formed on book-to-market but not on results from portfolios formed on short-term past returns and long-term past returns. One thing we learn along this dimension of investigating the model is that including the market return lowers the GRS statistic, and according to Fama and French (1996), the reason is that for an average of portfolio that has a unit market beta, its return will be lowered by approximately 6% per year when we adjust for the market risk. Therefore, including the market return as a factor will make first-pass $\alpha$s to better center around zero. Measurement issues aside, our overall GRS test results indicate that the model with market, consumption and money is insufficient to explain average asset returns over the risk-free rate because the GRS statistic is designed for first-pass $\alpha$s. These findings, however, do not conflict with the main theme of the current paper since we ask whether money as a factor helps in explaining cross-sectional differences in average asset returns instead of average returns over the risk-free rate.

### 3.4 Parameter Estimates

The negative premia on money is based on the proposition that the stochastic discount factor is an increasing function of the money-to-consumption ratio. In this section, we estimate preference parameters in the nonlinear stochastic discount factor using the one stage Generalized Method of Moments (GMM). In particular, the moment conditions are

$$E[M_{t+1}(R_{i,t+1} - R_{0,t+1})z_t] = 0 \tag{25}$$

where $z_t$ are instruments and we consider default premium, term premium and dividend yields, which are shown to predict future stock returns or capture states of the economy. The testing assets are 30 portfolios used in the previous section plus the risk-free rate, so there are 31 moment restrictions without instruments and 124 moment restrictions with instruments. We estimate by one-stage generalized GMM because, first, it allows us to focus on the economically more interesting anomalies, and, second, it avoids the unrealistic weights that a two-stage estimation may put on some moments.[7]

The estimation results for the case without instruments are shown in panel A in Table 3. We find that the $\rho$, the intratemporal elasticity of substitution between money and consumption, is 0.07. It suggests that money is a complement to consumption. The $\sigma$, the intertemporal elasticity of substitution, is 0.48. It is consistent with the evidences in Hall (1988), but different from those argued by Bansal and Yaron (2004), who requires large intertemporal substitution parameters to explain equity premium puzzles. We find that, the $\gamma$, the risk aversion, is 277. This means that our model can not explain the equity premium puzzle. It is clear that this recursive preference breaks the link between $\sigma$ and the inverse of $\gamma$ since a $z$-test on whether $\sigma$ is less than $\rho$ has a p-value of 4.2%. $\beta$ is relatively small at 0.79, which is in contrast to a negative time of preference (i.e.

[7] When the intratemporal optimality condition on money and consumption is included as an additional moment, the estimates are largely similar.

$\beta > 1$) that is needed to explain the low average T-bill rate in a case where the model is specified using $\sigma = \rho = 1/\gamma$. The $\alpha$, the share of money in the utility function, is 0.27. All estimates are highly significant.

In panel B, we show estimation results using instruments, and the results are largely similar. The notable difference is that $\alpha$ now is much higher at 0.8. This finding is not inconsistent with one of the findings for money supply measured by M1 in Walsh (2010, p. 72), and it indicates that money has a relatively important role in explaining the stochastic discount factor and asset returns. The over-identifying tests now cannot reject the model given more degrees of freedom. Our estimates are economically plausible and as a comparison, Yogo (2006), in his durable consumption goods model, find that the risk aversion to be 206, share for durable consumption to be 0.8, discount rate to be 0.94, intratemporal substitution between nondurable goods consumption and durable good consumption to be 0.7, and intertemporal substitution to be 0.02. In our model, there is little substitution across time and there is even less across goods. Taking everything together, we argue that the stochastic discount factor is an increasing function of the money-to-consumption ratio.

### 3.5 Discussion

In our study, real money growth becomes a risk factor for the same reason that real non-durable goods consumption growth is a risk factor because both appear in the utility function. The approach that grants money more explicit role, as shown in Marshall (1992) and Balvers and Huang (2009), is to have non-durable goods consumption as the only variable in the utility function, as in the the standard consumption based CAPM, and assume an investor needs to hold money to lower transaction costs. Therefore, money provides liquidity and it raises the marginal value of consumption. The real money growth then captures liquidity risk. A stock that pays well when liquidity is good earns lower returns because it pays exactly at the time when marginal utility of consumption is high.

The money factor is certainly related to the inflation factors. Fama (1981), Marshall (1992) and many others show that stock returns are negatively related to expected inflation and unexpected inflation computed from T-bill yields. Chen, Roll and Ross (1986) use changes in expected inflation and unexpected inflation as two of their five common factors. Campbell and Vuolteennaho (2004) show that inflation explains 80% of the mispricing of SP500 returns. In contrast, Bekaert and Engstrom (2010) argue that high expected inflation tends to coincide with periods of heightened uncertainty about real economic growth and unusually high risk aversion, both of which rationally raise equity yields. Similar to Bekaert and Engstrom (2010), our goal is to explain cross-sectional stock returns rationally. The real money growth factor consists of three components: the change in nominal money supply component, expected inflation component and unexpected inflation component, where the last two components add up to the inflation. If increase in nominal money supply is matched by inflation, then there is no role of real money growth because it is a constant. If increase in nominal money supply is matched one-on-one with expected inflation, then only unexpected inflation matters. Both are extreme scenarios and the most logical scenario is that changes in nominal money supply are not fully reflected in expected inflation or inflation, possibly because of information frictions and price rigidities. Thus, using real money growth as the factor is a simple way to capture information in changes in nominal money supply, expected inflation and unexpected inflation.

An interesting competing explanation for why real money matters for stock returns follows from Modigliani and Cohn (1979), Campbell and Vuolteennaho (2004), and Cohen, Polk and Vuolteenaho (2005). They argue that the stock market is irrational, and nominal discount rates that vary directly with inflation are used by the market to price real payoffs generated by equities. Again, the channel through which real money matters is inflation. That is, given nominal money growth, when inflation is high or real money growth is low, irrational investors adjust the nominal discount rate but not the real payoffs, and stocks are undervalued. Chordia and Shivakumar (2005, 2006) apply this story to portfolios formed on short-term past returns (price momentum) and past earnings (earnings momentum). They find that the earnings momentum subsumes the price momentum, and portfolios formed on past earnings have different exposure to inflation and accordingly are undervalued to a different degree and thus drift after earnings. The implication of the money/inflation illusion story for our real money factor is that, when inflation is high or real money growth is low, some portfolios are more undervalued, and they are likely to be portfolios with high book-to-market, high short-term past return, or low long-term past return. The main difference between the money illusion and our approach is again that we attempt to explain cross-sectional stock returns from an efficient market perspective.

As noted earlier, our real money growth factor is related to Lioui and Maio (2010). They propose changes in short-term interest rates as the additional factor, and we are related to each other through the simple money demand theory. The money demand theory indicates that real money holdings are determined by real activity, typically measured by industrial production or GDP, and the cost of holding money, which is measured by the short-term interest rate. Thus changes in real money holdings capture information in changes in real activity and changes in short-term rates. Or conversely, one can claim that changes in short-term interest captures information in changes in real money holdings and changes in real activity.

More generally speaking, this paper contributes to the ongoing debate on what the common factors in stock returns are. The well known empirical result in financial economics is that expected excess stock returns are not related to either the market $\beta$s of the Sharpe (1964) and Lintner (1965) capital asset pricing model (CAPM) or the consumption $\beta$s of the intertemporal asset pricing model (CCAPM) of Breeden (1979). Fama and French (1992, 1993, 1996) show that the expected return of a portfolio over the risk-free rate is explained by exposure to three factors: the market excess return, a size factor measured as the difference on return of a portfolio of small stocks and return of a portfolio of big stocks (SMB), and a value factor measured as the difference on return of a portfolio of value stocks and return of a portfolio of growth stocks (HML). They show that the three-factor model captures returns on portfolios formed on size, book-to-market, earnings-price ratio, cash flow-price ratio, sales growth, and long-term past returns (De Bondt and Thaler, 1985). They also concede that their three-factor model cannot explain the continuation of short-term returns documented by Jegadeesh and Titman (1993) because they find that stocks with low short-term past returns (losers) have higher loading on HML than winners do and, as a result, their model predicts reversal rather than continuation for future returns.

The common critiques for factors such as SMB and HML are that they are a-theoretical and are likely to perform well in pricing portfolios formed on size and value because these factors are constructed based exactly on size and value. Therefore, lots of studies attempt to tie SMB and HML to economics theories or explain stock returns directly based on agent's optimal intertemporal choices. Jagannathan and Wang (1996) show that labor income should be considered when constructing return on wealth. Cochrane (1996) shows that stock return equals return on firm's capital investment, and thus investment growth is a common factor. Lettau and Ludvigson (2001) show that a co-integrating relation between consumption, labor income, and wealth, dubbed as *cay*, predicts future excess returns; and, when used as a conditioning variable, greatly improves the performance of CAPM and CCAPM. Bansal and Yaron (2004) and Parker and Julliard (2005) emphasize the role of long-run consumption growth. More recently, Chen, Novy-Marx and Zhang (2010) show that factors from portfolios formed on capital expenditure growth and expected future profitability, together with market excess returns, explain even more anomalies than those originally proposed in Fama and French (1996).

### 3.6 A Robustness Check: Alternative Formulation

As noted earlier, several leading asset pricing models are special cases of our model with market return, consumption and money. This section considers some of those alternative formulations. In particular, we compare the pricing results of the following models: 1) the Capital Asset Pricing Model of Sharpe (1964) and Linter (1965); 2) the Consumption-based Asset Pricing model of Breenden (1979); 3) an *ad hoc* extreme case where the effect of consumption is very small such that money is the only factor; 4) the Balvers and Huang (2009) model that combines money and consumption; and 5) the current model with market return, consumption and money. Table 4 reports betas, and Table 5 reports risk premia.

For 10 portfolios formed on book-to-market, starting with the CAPM and C-CAPM, the regressions attempt to explain differences in average returns by generating lower market betas and consumption betas for value portfolios and negative premia for market returns and consumption growth. These findings are exactly opposite to what we expect. We expect market and consumption to carry positive premia and value portfolios to have higher exposures. When money is used alone, the beta for the growth portfolio is 1.06 and the beta for the value portfolio is 0.71. Combined with a premium of -0.36% per month, this contributes 1.5% to the value premium, which is about one-fourth of the value premium as illustrated in Table 1. When consumption and money are included in turn, betas and risk premia on money are similar. The difference is that money is only marginally significant according to the t-value of Shanken (1992), which adjusts for the fact that betas are generated regressors.

For 10 portfolios formed on short-term past returns, money alone achieves an OLS R-square of 37.7%, which is a significant improvement compared to the 7.4% of the CAPM and 2.3% of the C-CAPM. The premium on money is -0.81%. Together with a beta spread of 0.5, the winner minus loser return spread due to money is 4.9% per annum, which is about two-thirds of 7.2%, the momentum premium in our sample. Including either consumption alone or market return and consumption increases the OLS R-square, but again money dominates consumption and the market return.

For 10 portfolios formed on long-term past returns, we find that money alone achieves an OLS R-square of 47.7%, much better than the 0.02% of the CAPM and 7.1% of the C-CAPM. In all three models that include money as an additional factor, the premia are relatively stable, around -0.5%. The beta spreads between the portfolio with the worst long-term past return and the portfolio with the best long-term past return vary between 0.25 and 0.35, and the premium due to money is about 1.8%, slightly over one-third of the difference between the returns on portfolios with the worst and the best long-term past returns.

# 4 Conclusion

Extensive studies exist on the common factors in stock returns, but, without a theory that specifies the exact form of common factors in returns, the choice of any particular version of factors is somewhat arbitrary. We show that money, consumption and the market return are the common factors assuming a recursive utility that consists of both money and consumption, and we test our model using a set of *one-way* sorted portfolios including portfolios formed on book-to-market, short-term prior returns, and long-term prior returns. It is critical to test an asset pricing model using one-way sorted portfolio because the typical 25 portfolios formed on size and some other firm characteristic may have a strong factor structure and thus results in biased estimates, as suggested by

Lewellen et al. (2010). Although industry portfolio is another interesting dimension, we do not include them as testing assets because average return spreads among these portfolio are much smaller than those return spreads among value, momentum and contrarian portfolios.

Our results indicate that growth portfolios, short-term winner loser portfolios, and long-term winner portfolios earn lower average rates of return because these portfolios correlate positively with money; and, those times when money goes up, marginal utility goes up. Therefore, these portfolios are less risky and earn lower premia on money. The challenges are that the consumption growth and the market return do not add much explanatory power, and it maybe because a very challenging anomaly such as portfolios formed on short-term past returns are included as testing assets or because there are measurement errors in consumption and the return on wealth. Regarding better measures, we may consider durable goods consumption and human capital in addition to the stock market wealth, but this is beyond the scope of the current paper, and we will leave it for future research.

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## Table 1: Descriptive Statistics

This table reports summary statistics for factors and testing portfolios. Panel A reports the mean and standard deviation of the money growth rate ($\Delta h$), growth rate of nondurable and service ($\Delta c$), money-consumption ratio (Xmct), Fama-French (1993) three factors ($R_w$, SMB and HML), default premium (Xdef) and term premium (Xterm). $\Delta h$ is per capita growth of M2 per capita adjusted for inflation. $\Delta c$ is the per capita growth of nondurable and service per capita adjusted for inflation. Xmct is M2 divided by consumption. Xdef is the difference between yields on Baa rated bonds and Aaa rated bonds. Xterm is the difference between yields on 10-year Treasury bonds and 3-month Treasury bills. Panel B reports correlation among these variables together with NBER recession indicator. Panel C reports the mean and standard deviation of testing portfolios. BM portfolios are formed on past book-to-market ratios. Momentum equal-weighted portfolios (Mom EW) are formed on short-term past returns and reversal portfolios are formed on long-term past returns. The sample period is from January 1959 to December 2009.

Panel A Mean and Standard Deviation of Factors

| | $\Delta h$ | $\Delta c$ | Xmct | $R_w$ | SMB | HML | Xdef | Xterm |
|---|---|---|---|---|---|---|---|---|
| Mean | 0.0013 | 0.0016 | 0.9985 | 0.0043 | 0.0022 | 0.0041 | 0.0101 | 0.0144 |
| Std | 0.0048 | 0.0041 | 0.1226 | 0.0446 | 0.0309 | 0.0287 | 0.0047 | 0.0124 |

Panel B Correlation Coefficients between Factors and NBER Recession Indicator

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $\Delta c$ | 0.291 | | | | | | | |
| Xmct | 0.084 | 0.075 | | | | | | |
| $R_w$ | 0.087 | 0.173 | -0.016 | | | | | |
| SMB | 0.065 | 0.133 | 0.020 | 0.302 | | | | |
| HML | -0.083 | -0.079 | 0.020 | -0.319 | -0.237 | | | |
| Xdef | 0.168 | -0.069 | -0.016 | 0.055 | 0.084 | -0.049 | | |
| Xterm | 0.211 | 0.142 | -0.175 | 0.084 | 0.048 | -0.009 | 0.290 | |
| Recession | -0.035 | -0.199 | -0.011 | -0.101 | -0.020 | 0.010 | 0.387 | -0.100 |

Panel C Mean Return and Standard Deviation of Testing Portfolios

| | | | | | B/M Decile | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Growth | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Value |
| Mean | 0.0076 | 0.0088 | 0.0091 | 0.0090 | 0.0093 | 0.0098 | 0.0101 | 0.0111 | 0.0117 | 0.0130 |
| Std | 0.0518 | 0.0471 | 0.0460 | 0.0471 | 0.0442 | 0.0447 | 0.0438 | 0.0456 | 0.0475 | 0.0570 |
| | | | | | Momentum EW Decile | | | | | |
| | Loser | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Winner |
| Mean | 0.0101 | 0.0089 | 0.0101 | 0.0112 | 0.0118 | 0.0122 | 0.0130 | 0.0137 | 0.0147 | 0.0161 |
| Std | 0.0980 | 0.0733 | 0.0624 | 0.0560 | 0.0520 | 0.0500 | 0.0496 | 0.0514 | 0.0566 | 0.0692 |
| | | | | | Reversal Decile | | | | | |
| | Low | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | High |
| Mean | 0.0124 | 0.0114 | 0.0109 | 0.0099 | 0.0101 | 0.0100 | 0.0096 | 0.0090 | 0.0080 | 0.0081 |
| Std | 0.0638 | 0.0508 | 0.0473 | 0.0446 | 0.0440 | 0.0428 | 0.0442 | 0.0443 | 0.0480 | 0.0599 |

# Table 2: Results of Two-Pass Regression Using 10 Testing Portfolios

This table reports the regression results from the two-pass regressions for various decile testing portfolios. The $\alpha$s and $\beta$s from the first pass are reported in the left panel. Risk premia, conventional t-values, and Shanken's (1992) t-values from the second pass are reported in the right panel. Testing portfolios are 10 BM portfolios formed on book-to-market ratios in Panel A, 10 portfolios formed on short-term past returns in Panel B, and 10 portfolios formed on long-term past returns in Panel C respectively.

| Panel A 10 Portfolios Formed on B/M Ratio | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Growth | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Value |
| Mean | 0.0076 | 0.0088 | 0.0091 | 0.0090 | 0.0093 | 0.0098 | 0.0101 | 0.0111 | 0.0117 | 0.0130 |
| alpha | -0.0018 | 0.0000 | 0.0004 | 0.0006 | 0.0012 | 0.0016 | 0.0014 | 0.0030 | 0.0035 | 0.0044 |
| $R_w$ | 1.0763 | 1.0119 | 0.9783 | 0.9863 | 0.9051 | 0.9256 | 0.8577 | 0.8936 | 0.9257 | 1.0498 |
| $\Delta c$ | 2.0476 | 1.6000 | 1.5558 | 1.7476 | 1.4518 | 1.6441 | 1.8546 | 1.6932 | 1.4456 | 1.7890 |
| $\Delta h$ | 0.5476 | 0.6854 | 0.6766 | 0.1948 | 0.3634 | 0.1596 | 0.3808 | 0.0861 | 0.4429 | 0.2615 |
| t(alpha) | -2.1167 | 0.0638 | 0.5673 | 0.7585 | 1.4834 | 2.1019 | 1.5317 | 3.0008 | 3.3407 | 3.0257 |
| t($R_w$) | 60.187 | 78.547 | 70.581 | 62.003 | 52.961 | 57.005 | 44.506 | 43.214 | 42.091 | 34.554 |
| t($\Delta c$) | 10.3119 | 11.1851 | 10.1086 | 9.8940 | 7.6509 | 9.1189 | 8.6670 | 7.3741 | 5.9194 | 5.3032 |
| t($\Delta h$) | 3.2094 | 5.5758 | 5.1158 | 1.2837 | 2.2285 | 1.0302 | 2.0708 | 0.4364 | 2.1104 | 0.9021 |

| | Constant | $R_w$ | $\Delta c$ | $\Delta h$ |
|---|---|---|---|---|
| Coefficient | 0.009 | 0.003 | -0.003 | -0.004 |
| t-value | 1.844 | 0.718 | -1.935 | -2.277 |
| Shanken-t | 1.344 | 0.486 | -1.433 | -1.403 |
| | OLS R2 | GLS R2 | GRS | p-value |
| | 0.278 | 0.095 | 1.557 | 0.116 |

| Panel B 10 Portfolios Formed on Short-Term Past Returns | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | loser | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | winner |
| Mean | 0.0101 | 0.0089 | 0.0101 | 0.0112 | 0.0118 | 0.0122 | 0.0130 | 0.0137 | 0.0147 | 0.0161 |
| alpha | -0.0015 | -0.0018 | -0.0001 | 0.0013 | 0.0022 | 0.0027 | 0.0036 | 0.0041 | 0.0047 | 0.0054 |
| $R_w$ | 1.4777 | 1.2580 | 1.1348 | 1.0521 | 1.0037 | 0.9768 | 0.9767 | 1.0110 | 1.0908 | 1.2668 |
| $\Delta c$ | 2.7790 | 2.5772 | 2.3713 | 2.2371 | 2.1201 | 2.1182 | 2.0480 | 2.1541 | 2.3467 | 2.8172 |
| $\Delta h$ | 0.9725 | 0.6937 | 0.6748 | 0.6363 | 0.6308 | 0.6269 | 0.6031 | 0.5745 | 0.5245 | 0.4600 |
| t(alpha) | -0.4749 | -0.8609 | -0.0850 | 1.0022 | 1.9302 | 2.5148 | 3.5019 | 3.7803 | 3.7438 | 3.0871 |
| t($R_w$) | 22.001 | 28.893 | 33.737 | 37.609 | 41.585 | 43.970 | 45.010 | 44.807 | 41.098 | 34.528 |
| t($\Delta c$) | 3.7262 | 5.3304 | 6.3489 | 7.2020 | 7.9103 | 8.5869 | 8.4995 | 8.5971 | 7.9627 | 6.9150 |
| t($\Delta h$) | 1.5174 | 1.6695 | 2.1024 | 2.3838 | 2.7386 | 2.9575 | 2.9128 | 2.6681 | 2.0712 | 1.3139 |

| | Constant | $R_w$ | $\Delta c$ | $\Delta h$ |
|---|---|---|---|---|
| Coefficient | 0.023 | 0.034 | -0.015 | -0.028 |
| t-value | 4.117 | 3.296 | -3.474 | -3.531 |
| Shanken-t | 0.604 | 0.465 | -0.444 | -0.515 |
| | OLS R2 | GLS R2 | GRS | p-value |
| | 0.652 | 0.104 | 5.535 | 0.000 |

| Panel C 10 Portfolios Formed on Long-Term Past Returns | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Low | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | High |
| Mean | 0.0124 | 0.0114 | 0.0109 | 0.0099 | 0.0101 | 0.0100 | 0.0096 | 0.0090 | 0.0080 | 0.0081 |
| alpha | 0.0026 | 0.0024 | 0.0025 | 0.0015 | 0.0019 | 0.0024 | 0.0017 | 0.0008 | -0.0010 | -0.0018 |
| $R_w$ | 1.1525 | 0.9958 | 0.9364 | 0.9094 | 0.8990 | 0.8813 | 0.9191 | 0.9171 | 0.9997 | 1.2513 |
| $\Delta c$ | 2.5782 | 2.2034 | 1.7374 | 1.4206 | 1.5316 | 1.1776 | 1.0407 | 1.4697 | 1.6833 | 2.3447 |
| $\Delta h$ | 0.1469 | 0.1112 | 0.2181 | 0.5996 | 0.3984 | 0.2904 | 0.6928 | 0.4601 | 0.7609 | 0.4631 |
| t(alpha) | 1.5708 | 2.2186 | 2.5533 | 1.8571 | 2.2941 | 3.0848 | 2.2527 | 1.1125 | -1.2529 | -1.8847 |
| t($R_w$) | 32.997 | 44.025 | 45.094 | 52.609 | 52.495 | 53.582 | 57.788 | 57.115 | 60.735 | 61.480 |
| t($\Delta c$) | 6.6479 | 8.7725 | 7.5348 | 7.4007 | 8.0542 | 6.4481 | 5.8931 | 8.2427 | 9.2095 | 10.375 |
| t($\Delta h$) | 0.4408 | 0.5151 | 1.1007 | 3.6350 | 2.4380 | 1.8503 | 4.5653 | 3.0025 | 4.8447 | 2.3844 |

| | Constant | $R_w$ | $\Delta c$ | $\Delta h$ |
|---|---|---|---|---|
| Coefficient | 0.011 | -0.007 | 0.001 | -0.004 |
| t-value | 2.812 | -1.110 | 0.990 | -2.363 |
| Shanken-t | 1.992 | -0.782 | 0.681 | -1.665 |
| | OLS R2 | GLS R2 | GRS | p-value |
| | 0.686 | 0.400 | 2.048 | 0.027 |

## Table 3: Preference Parameters Estimates in the Euler Equation

This table estimates preference parameters for the model with money, consumption and the market return using one stage Generalized Method of Moments. The test assets are 30 portfolios formed on book-to-market ratio, short-term past returns and long-term past returns, and the risk-free rate. The p-value for the J-test (test of over-identifying restrictions) and for t-test is in parenthesis. Panel A is the estimation without instruments. Panel B is the estimation using default premium, term premium and dividend price ratio as instruments.

| Parameter | Estimate | Standard Error |
|---|---|---|
| Panel A Without Instruments | | |
| $\sigma$ | 0.4767 | 0.0441 |
| $\gamma$ | 276.857 | 83.498 |
| $\rho$ | 0.0658 | 0.0116 |
| $\alpha$ | 0.2674 | 0.0056 |
| $\beta$ | 0.7892 | 0.0007 |
| J-test | 67.889 | (0) |
| Test for $\sigma > \rho$ | 7.5676 | (0.0418) |
| Panel B With Instruments | | |
| $\sigma$ | 0.7 | 0.0628 |
| $\gamma$ | 121.383 | 25.500 |
| $\rho$ | 0.08 | 0.0232 |
| $\alpha$ | 0.8 | 0.0701 |
| $\beta$ | 0.719 | 0.0009 |
| J-test | 67.887 | (1) |
| Test for $\sigma > \rho$ | 7.4203 | (0.0426) |

## Table 4: Factor Loadings of Alternative Model Specifications

This table reports the beta estimates from monthly regressions of five models. Model 1 is CAPM and the factor is market excess return; model 2 is the CCAPM, and the factor $\Delta c$ is the growth rate of nondurable goods consumption and service; model 3 is a one-factor model with only $\Delta h$, the real money growth, as the factor; model 4 has two-factors, $\Delta c$ and $\Delta h$, real money growth and consumption growth; model 5 has three factors, $\Delta h$, $\Delta c$ and the orthoganized market return, which equals the sum of the constant and residuals from a regression of market excess return on real money growth rate and consumption growth. Testing portfolios are 10 BM portfolios formed on past book-to-market ratios in Panel A, 10 portfolios formed on short-term past returns in Panel B, and 10 portfolios formed on long-term past returns in Panel C, respectively.

| Panel A 10 Portfolios Formed on B/M Ratio | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Model | | Growth | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Value |
| 1 | $R_w$ Loading | 1.08 | 1.01 | 0.98 | 0.99 | 0.90 | 0.92 | 0.86 | 0.89 | 0.92 | 1.05 |
| | t-value | 61.39 | 79.55 | 71.55 | 62.96 | 53.78 | 57.87 | 45.50 | 43.91 | 42.74 | 35.10 |
| 2 | $\Delta c$ Loading | 2.23 | 1.83 | 1.78 | 1.81 | 1.57 | 1.70 | 1.98 | 1.72 | 1.60 | 1.88 |
| | t-value | 4.45 | 4.00 | 3.99 | 3.97 | 3.66 | 3.91 | 4.70 | 3.89 | 3.45 | 3.38 |
| 3 | $\Delta h$ Loading | 1.06 | 1.09 | 1.07 | 0.63 | 0.73 | 0.57 | 0.84 | 0.51 | 0.80 | 0.71 |
| | t-value | 2.43 | 2.74 | 2.75 | 1.59 | 1.95 | 1.51 | 2.29 | 1.32 | 2.01 | 1.47 |
| 4 | $\Delta h$ Loading | 0.55 | 0.69 | 0.68 | 0.19 | 0.36 | 0.16 | 0.38 | 0.09 | 0.44 | 0.26 |
| | t-value | 1.22 | 1.67 | 1.69 | 0.47 | 0.94 | 0.41 | 1.00 | 0.22 | 1.07 | 0.52 |
| 5 | $\Delta h$ Loading | 0.55 | 0.69 | 0.68 | 0.19 | 0.36 | 0.16 | 0.38 | 0.09 | 0.44 | 0.26 |
| | t-value | 3.21 | 5.58 | 5.12 | 1.28 | 2.23 | 1.03 | 2.07 | 0.44 | 2.11 | 0.90 |
| Panel B 10 Portfolios Formed on Short-Term Past Returns | | | | | | | | | | | |
| Model | | Loser | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Winner |
| 1 | $R_w$ Loading | 1.48 | 1.27 | 1.14 | 1.06 | 1.01 | 0.99 | 0.98 | 1.02 | 1.10 | 1.28 |
| | t-value | 22.49 | 29.57 | 34.53 | 38.49 | 42.53 | 44.95 | 46.00 | 45.81 | 42.04 | 35.34 |
| 2 | $\Delta c$ Loading | 3.11 | 2.81 | 2.60 | 2.45 | 2.33 | 2.33 | 2.25 | 2.35 | 2.52 | 2.97 |
| | t-value | 3.25 | 3.95 | 4.29 | 4.52 | 4.64 | 4.83 | 4.69 | 4.72 | 4.61 | 4.44 |
| 3 | $\Delta h$ Loading | 1.67 | 1.34 | 1.27 | 1.20 | 1.16 | 1.16 | 1.11 | 1.11 | 1.11 | 1.16 |
| | t-value | 2.02 | 2.17 | 2.41 | 2.54 | 2.65 | 2.75 | 2.67 | 2.57 | 2.33 | 2.00 |
| 4 | $\Delta h$ Loading | 0.97 | 0.69 | 0.67 | 0.64 | 0.63 | 0.63 | 0.60 | 0.57 | 0.52 | 0.46 |
| | t-value | 1.13 | 1.08 | 1.24 | 1.31 | 1.40 | 1.45 | 1.40 | 1.29 | 1.07 | 0.76 |
| 5 | $\Delta h$ Loading | 0.97 | 0.69 | 0.67 | 0.64 | 0.63 | 0.63 | 0.60 | 0.57 | 0.52 | 0.46 |
| | t-value | 1.52 | 1.67 | 2.10 | 2.38 | 2.74 | 2.96 | 2.91 | 2.67 | 2.07 | 1.31 |
| Panel C 10 Portfolios Formed on Long-Term Past Returns | | | | | | | | | | | |
| Model | | Low | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | High |
| 1 | $R_w$ Loading | 1.16 | 1.00 | 0.94 | 0.91 | 0.90 | 0.88 | 0.91 | 0.92 | 1.00 | 1.25 |
| | t-value | 33.71 | 44.89 | 45.90 | 53.42 | 53.42 | 53.96 | 57.89 | 58.03 | 61.67 | 62.67 |
| 2 | $\Delta c$ Loading | 2.63 | 2.24 | 1.81 | 1.62 | 1.67 | 1.28 | 1.28 | 1.63 | 1.94 | 2.50 |
| | t-value | 4.24 | 4.56 | 3.94 | 3.75 | 3.89 | 3.05 | 2.96 | 3.78 | 4.17 | 4.31 |
| 3 | $\Delta h$ Loading | 0.79 | 0.66 | 0.65 | 0.95 | 0.78 | 0.58 | 0.95 | 0.83 | 1.18 | 1.05 |
| | t-value | 1.47 | 1.54 | 1.63 | 2.55 | 2.11 | 1.62 | 2.57 | 2.22 | 2.93 | 2.08 |
| 4 | $\Delta h$ Loading | 0.15 | 0.11 | 0.22 | 0.60 | 0.40 | 0.29 | 0.69 | 0.46 | 0.76 | 0.46 |
| | t-value | 0.26 | 0.25 | 0.53 | 1.54 | 1.04 | 0.77 | 1.79 | 1.19 | 1.82 | 0.89 |
| 5 | $\Delta h$ Loading | 0.15 | 0.11 | 0.22 | 0.60 | 0.40 | 0.29 | 0.69 | 0.46 | 0.76 | 0.46 |
| | t-value | 0.44 | 0.52 | 1.10 | 3.64 | 2.44 | 1.85 | 4.57 | 3.00 | 4.84 | 2.38 |

## Table 5: Risk Premia for Alternative Model Specifications

This table reports the risk premia estimates for five models. Model 1 is CAPM and the factor is market excess return; model 2 is the CCAPM, and the factor $\Delta c$ is the growth rate of nondurable goods consumption and service; model 3 is a one-factor model with only $\Delta h$, the real money growth, as the factor; model 4 has two-factors, $\Delta c$ and $\Delta h$, real money growth and consumption growth; model 5 has three factors, $\Delta h$, $\Delta c$ and the orthoganized market return, which equals the sum of the constant and residuals from a regression of market excess return on real money growth rate and consumption growth. Testing portfolios are 10 BM portfolios formed on past book-to-market ratios in Panel A, 10 portfolios formed on short-term past returns in Panel B, and 10 portfolios formed on long-term past returns in Panel C, respectively. Both the conventional t-value and Shanken's (1992) t-value are reported.

| Model | | Alpha | $\Delta h$ | $\Delta c$ | $R_w$ | OLS R2 | GLS R2 | GRS-test | GRS p-value |
|---|---|---|---|---|---|---|---|---|---|
| Panel A 10 Portfolios Formed on B/M Ratio | | | | | | | | | |
| 1 | Risk Premium | 0.0100 | | | -0.0046 | 0.0430 | 0.0018 | 1.6605 | 0.0865 |
| | t-Value | 2.0417 | | | -0.8885 | | | | |
| | Shanken t-Value | 2.0263 | | | -0.8818 | | | | |
| 2 | Risk Premium | 0.0112 | | -0.0031 | | 0.1455 | 0.0920 | 1.5099 | 0.1317 |
| | t-Value | 3.1899 | | -1.7872 | | | | | |
| | Shanken t-Value | 2.5941 | | -1.4596 | | | | | |
| 3 | Risk Premium | 0.0085 | -0.0036 | | | 0.2349 | 0.0059 | 1.6820 | 0.0813 |
| | t-Value | 3.7070 | -2.0027 | | | | | | |
| | Shanken t-Value | 2.3375 | -1.5152 | | | | | | |
| 4 | Risk Premium | 0.0108 | -0.0034 | -0.0023 | | 0.2630 | 0.0926 | 1.4547 | 0.1527 |
| | t-Value | 3.1712 | -1.9737 | -1.4922 | | | | | |
| | Shanken t-Value | 2.5443 | -1.4647 | -1.1952 | | | | | |
| 5 | Risk Premium | 0.0087 | -0.0039 | -0.0029 | 0.0034 | 0.2784 | 0.0950 | 1.5570 | 0.1157 |
| | t-Value | 1.8435 | -2.2769 | -1.9351 | 0.7176 | | | | |
| | Shanken t-Value | 1.3436 | -1.4032 | -1.4329 | 0.4859 | | | | |
| Panel B 10 Portfolios Formed on Short-Term Past Returns | | | | | | | | | |
| 1 | Risk Premium | 0.0121 | | | -0.0037 | 0.0735 | 0.0030 | 7.2474 | 0.0000 |
| | t-Value | 2.9573 | | | -0.8022 | | | | |
| | Shanken t-Value | 2.8959 | | | -0.7809 | | | | |
| 2 | Risk Premium | 0.0108 | | -0.0011 | | 0.0226 | 0.0169 | 5.3525 | 0.0000 |
| | t-Value | 2.3073 | | -0.4900 | | | | | |
| | Shanken t-Value | 2.2067 | | -0.4733 | | | | | |
| 3 | Risk Premium | 0.0178 | -0.0081 | | | 0.3774 | 0.0464 | 5.7106 | 0.0000 |
| | t-Value | 3.4756 | -1.6253 | | | | | | |
| | Shanken t-Value | 1.5258 | -0.6748 | | | | | | |
| 4 | Risk Premium | 0.0125 | -0.0134 | 0.0016 | | 0.6020 | 0.0950 | 4.8883 | 0.0000 |
| | t-Value | 2.4487 | -2.4970 | 0.8904 | | | | | |
| | Shanken t-Value | 0.6006 | -0.6123 | 0.2313 | | | | | |
| 5 | Risk Premium | 0.0225 | -0.0277 | -0.0149 | 0.0340 | 0.6518 | 0.1035 | 5.5349 | 0.0000 |
| | t-Value | 4.1167 | -3.5313 | -3.4742 | 3.2956 | | | | |
| | Shanken t-Value | 0.6043 | -0.5146 | -0.4444 | 0.4651 | | | | |

| Model | | Alpha | $\Delta h$ | $\Delta c$ | $R_w$ | OLS R2 | GLS R2 | GRS-test | GRS p-value |
|---|---|---|---|---|---|---|---|---|---|
| Panel C 10 Portfolios Formed on Long-Term Past Returns | | | | | | | | | |
| 1 | Risk Premium | 0.0058 | | | -0.0002 | 0.0002 | 0.0164 | 1.8661 | 0.0471 |
| | t-Value | 1.9168 | | | -0.0480 | | | | |
| | Shanken t-Value | 1.9181 | | | -0.0481 | | | | |
| 2 | Risk Premium | 0.0042 | | 0.0008 | | 0.0708 | 0.0047 | 1.5852 | 0.1070 |
| | t-Value | 2.1978 | | 0.7943 | | | | | |
| | Shanken t-Value | 2.1473 | | 0.7910 | | | | | |
| 3 | Risk Premium | 0.0098 | -0.0050 | | | 0.4774 | 0.3917 | 1.9394 | 0.0376 |
| | t-Value | 4.1823 | -2.4693 | | | | | | |
| | Shanken t-Value | 2.7472 | -1.7731 | | | | | | |
| 4 | Risk Premium | 0.0081 | -0.0051 | -0.0002 | | 0.6284 | 0.3998 | 1.6654 | 0.0853 |
| | t-Value | 3.9033 | -2.4888 | -0.2305 | | | | | |
| | Shanken t-Value | 2.7284 | -1.7011 | -0.1422 | | | | | |
| 5 | Risk Premium | 0.0111 | -0.0037 | 0.0014 | -0.0065 | 0.6864 | 0.4002 | 2.0478 | 0.0268 |
| | t-Value | 2.8122 | -2.3633 | 0.9897 | -1.1101 | | | | |
| | Shanken t-Value | 1.9921 | -1.6646 | 0.6805 | -0.7820 | | | | |

**Figure 1. Money-to-Consumption Ratio: 1959 to 2009**
This figure plots the deviation of money-to-consumption ratio (M/C) from its average in the upper part and plots the difference of real money growth and consumption growth in the bottom part for January 1959 to December 2009. Shaded areas are recessions measured by the NBER.