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CONSUMPTION RISK AND THE COST OF EQUITY CAPITAL

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ABSTRACT

We demonstrate, using data for the period 1954-2003, that differences in exposure to consumption risk explains cross sectional differences in average excess returns (cost of equity capital) across the 25 benchmark equity portfolios constructed by Fama and French (1993). We use yearly returns on stocks to take into account well documented within year deterministic seasonal patterns in returns, measurement errors in the consumption data, and possible slow adjustment of consumption to changes in wealth due to habit and prior commitments. Consumption during the fourth quarter is likely to have a larger discretionary component. Further, given the availability of more leisure time during the holiday season and the ending of the tax year in December, investors are more likely to review their asset holdings and make trading decisions during the fourth quarter. We therefore match the growth rate in the fourth quarter consumption from one year to the next with the corresponding calendar year return when computing the latter's exposure to consumption risk. We find strong support for our consumption risk model specification in the data.

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1 Introduction

There is general agreement in the literature that the cost of equity capital, i.e., the expected return on stocks, varies across different types of firms in a systematic way. For example, investors appear to require a lower return on average for investing in growth firms when compared to value firms, and a higher return for investing in smaller firms when compared to larger firms. A substantial part of the research effort in finance is directed toward understanding why we would observe such heterogeneity in expected returns. In an ideal world with *perfect capital markets* where there are no arbitrage opportunities, investors would require a higher return on an asset only if it has a larger exposure to systematic economy wide pervasive risk. According to *standard* economic *theory*[1], in such a world with rational investors, the covariance of the return on an asset with aggregate consumption growth, hereafter referred to as exposure to *consumption risk*, determines the asset's systematic risk. Hence, to the extent that the perfect market assumption is not unreasonable, we should find growth firms to be engaged in activities that have less exposure to consumption risk than value firms; and smaller firms to be exposed to higher consumption risk when compared to larger firms. In this paper we empirically demonstrate that it is indeed the case. We find that a substantial part of the variation in the historical average returns across different firm types can be explained by differences in their historical exposure to consumption risk.

There are a priori reasons to believe that the support for the standard theory would be stronger at longer horizons. Brainard, Nelson and Shapiro (1991) recommend the use of longer horizon returns when examining the relation between consumption risk and expected returns in order to minimize the effect of measurement errors in consumption data. Bansal, Ditmar and Lundblat (2004) find that the long run covariance between consumption and dividends account for a large fraction of the variation in average returns across commonly studied equity portfolios[2]. Parker and Juliard (2004) examine the data in an ingenious way to minimize the influence of measurement errors in consumption and possible lagged response of consumption to

[1] Developed by Rubinstein (1976), Breeden (1979), Lucas (1978), Grossman and Shiller (1981), Hansen and Singleton (1982, 1983).

[2] Hansen, Heaton and Li (2004) explore the statistical challenges involved in empiricially examining the relation between riskiness of cash flows far into the future and expected returns, and provide a general framework such analysis. Lettau and Ludvigson (2001) find empirical support for a conditional version of the standard model.

changes in wealth, and conclude that the difference in returns across assets are due to differences in their covariance with consumption growth during the quarter of the return measurement and several quarters that follow.

We contribute to this literature by showing that exposure to consumption risk over a one year horizon can also explain the cross section of stock returns. We obtain results that are different from those reported elsewhere in the literature because we measure an asset's exposure to consumption risk over a time interval chosen in such way as to (a) minimize the effect of transactions costs on an investor's savings, consumption and investment decisions, and (b) integrate over calendar month seasonal patterns in stock returns.

The empirical literature in finance and macro economics document pronounced calendar month and calendar quarter seasonal effects in stock returns and macro economic aggregates. For example, Keim (1983) documents that smaller stocks earn most of their risk adjusted return during the first week of January. Roll (1983) and Reinganum (1983) find support for the view this may be due to investors selling stocks to realize losses for tax purposes. Bouman and Jacobsen (2002) find that stocks earn a higher return during the November through April than other months. Miron and Beaulieu (1996) find that the seasonal behavior of GDP is dominated by fourth quarter increases and first quarter declines. They argue that the Christmas demand shift is an important factor in producing seasonal fluctuations. Braun and Evans (1995) provide evidence supporting the view that the observed seasonal shifts in aggregate consumption is more due to seasonal shifts in preferences and not technology. Ait-Sahalia, Parker and Yogo (2004) point out that consumers have more discretion over their consumption of luxury goods than essential goods, and consumption of the former covaries more strongly with stock returns.

We therefore match calendar year returns with growth rates in fourth quarter consumption of nondurables and services from one year to another in order to generate the most support from the data for standard theory. The use of calendar year returns would avoid the need to explain the January effect, and the sell in May and go away effects documented in stock returns. Working with longer horizon attenuates the errors that may arise due to ignoring the effect of habit formation on preferences[3]. Further, fourth quarter consumption may be less subject to habit-like

[3]Sundaresan (1989), Constantinides (1990), Abel (1990) and Campbell and Cochrane (1999) take the stand that there are important time variations in effective risk aversion due to habit formation.

behavior induced by the need to commit consumption in advance[4], and more subject to discretion since investors have more leisure time to review their consumption and portfolio choice decisions during the holiday season.

According to the standard theory[5], $E(R_i) \propto Cov(R_i, g_c^{-\gamma})$, where $Cov(.)$ denotes the covariance operator, $E(.)$ denotes the expectation operator, R_i is the excess return over the risk free return on an arbitrarily chosen financial asset, i, g_c is the growth in contemporaneous consumption, and γ is the coefficient of relative risk aversion of the economy's representative investor. When deviations in the realized values of the consumption growth, g_c, from its mean $\bar{g}_c$,are not large, $Cov(R_i, g_c^{-\gamma}) \simeq -\gamma Cov(R_i, g_c)$. In that case $E(R_i) \simeq \lambda Cov(R_i, g_c)$ where λ denotes the risk premium for bearing consumption risk. When consumption is measured with error, or when systematic stochastic variations induce variations in the relative risk aversion coefficient of the representative agent due to habit, $|E(R_i) - \lambda Cov(R_i, g_c)|$ is likely to be smaller than $|E(R_i) - Cov(R_i, g_c^{-\gamma})|$, since in the latter, errors in g_c are likely to be accentuated since they are raised to the $(-\gamma)'th$ power. We therefore follow Breeden (1979) and Breeden, Gibbons, and Litzenberger (1989), and examine whether $Cov(R_i, g_c)$ can explain cross sectional variation in $E(R_i)$ across different assets.

Related Literature

Several measures of systematic risk have been proposed in the literature for explaining cross sectional differences in average returns on financial assets. They can be grouped into two broad categories. In models belonging to the first category, commonly referred to as consumption-based asset pricing models, systematic risk is represented by the sensitivity of the return on an asset to changes in the intertemporal marginal rates of substitution (IMRS) of a representative investor. Models within this class differ from one another based on the specification for IMRS as a function of observable and latent variables[6]. The primary appeal of consumption-based models comes from their simplicity, and their ability to value not only primitive securities like stocks, but also derivative securities like stock options. The disadvantage is that the models in this class make use of macro economic factors that are measured with substantial errors. In the standard consumption-based model, the IMRS of the

[4]See Chetty and Seidel (2004) who show that consumption commitment will induce habit like features in the indirect utility function.

[5]The standard model assumes that there is a representative agent who maximizes expected utility for lifetime consumption subject to budget constraints; the agent's intertemporal preferences can be represented by time separable utility function where the utility for consumption in any period exhibits constant relative risk aversion.

[6]See Cochrane (2000) for an excellent review of this extensive literature.

representative investor is a function of only the growth rate in aggregate per capita consumption. This model has the advantage that its validity can be evaluated using sample analogues of means, variances and covariances of returns and per capita consumption growth rates without the need for specifying how these moments change over time in some systematic stochastic fashion. In this paper we will examine a particular specification of the consumption-based CAPM that assumes that investors revise their consumption plans infrequently.

Models in the second category are commonly referred to as portfolio-return-based models. In these models systematic risk is represented by the sensitivity of the return on an asset to returns on a small collection of benchmark factor portfolios[7]. These models have the advantage that they make use of factors can be constructed from market prices of financial assets that are measured relatively more accurately, if only they are available. In the case of the CAPM and the ICAPM belonging to this category, the shortcoming is that the aggregate wealth portfolio of all assets in the economy is not observable and a proxy must be used. The common practice is to use the return on all exchange traded stocks as a proxy for the market portfolio; but as Jagannathan and Wang (1996) point out that the stock market forms only a small part of the total wealth in the economy while human capital forms a much larger part and the return on that part is not observed. The return on aggregate human capital has to be inferred from national income and product account numbers, and they are subject to substantial measurement errors. In contrast, the linear beta pricing models in this category, need only find a method for identifying *factor* portfolios that capture economy wide pervasive risk. Chamberlain and Rothschild (1983) show that factor constructed through principal component analysis of returns on primitive assets would serve as valid factors. Connor and Korajczyk (1986) develop a fast algorithm for constructing factors based on principal component analysis of returns on a large collection of assets. Fama and French (1993) construct factors by taking long and short positions in two asset classes that earn vastly different returns on average. Zhi

[7] In the standard Sharpe-Lintner CAPM, the benchmark portfolio is the return on the aggregate wealth portfolio in the economy; in empirical studies of the CAPM the return on a portfolio of all exchange traded stocks are used as its proxy. Merton (1973) derived an intertemporal version of the CAPM (ICAPM) showing that the expected return on an asset would in general be a linear function of its several factor betas, with the return on the market portfolio being one of the factors. Campbell (1993) identified the other factors in Merton's ICAPM as those variables that help forecast the future return on the market portfolio of all assets in the economy. Ross (1976) showed that Merton's ICAPM like beta pricing model would obtain even when markets are incomplete provided returns have a factor structure, and the law of one price was satisfied. Connor (1984) provided sufficient conditions for Ross' results to obtain in equilibrium.

Da (2004) shows that the Fama and French three factor beta pricing model would obtain when cash flows of firms have a conditional two factor structure, with the first factor being the return on a well diversified portfolio and the other two factors being excess returns on well diversified long-short portfolios.

The Fama and French (1993) three factor model has become the premier model within this class. We will therefore use the Fama and French three factor model as the benchmark for comparing the standard consumption-based model.

2 A consumption-based asset pricing model

We assume that there is a representative investor in the economy with time and state separable Von Neumann – Morgenstern utility function for lifetime time consumption from the vantage point of time t given by:

$$E\left[\left(\sum_{s=t}^{\infty}\delta^{s}u(c_{s})\right) \mid F_{t}\right] \tag{1}$$

where, c_s denotes consumption expenditure over several types of goods during period s, $u(.)$ denotes a strictly concave period utility function, δ denotes the time discount factor, and F_t denotes the information set available to the representative agent at time t. We assume that the representative investor reviews her consumption policy and portfolio holdings at periodic intervals in time, for some exogenously given reasons[8]. Such reviews take place once every k periods, and at the same point in time for every investor.

Consider an arbitrary point in time, t, where the representative investor reviews her consumption-investment decisions. Such points will occur at times $t = 0, k, 2k, 3k, ...$ i.e., t will be an integral multiple of the decision interval, k. The investor will choose consumption and investment policies at t, $t = 0, k, 2k, 3k, ...$ so as to maximize expected life time utility, that gives rise to the following relation that

[8] Lynch (1996) and Gabaix and Laibson (2001) examine economies where investors make consumption-investment decisions at different but infrequent points in time. They show that in such economies aggregate consumption will be much smoother relative to consumption of any one investor. Marshall and Parekh (1999) examine an economy where infrequent adjustment of consumption arises endogenously due to transactions costs. They show that the aggregation property fails; aggregate consumption does not resemble the optimal consumption path of a hypothetical representative agent with preferences belonging to the same class as the investors in the economy. In our economy all agents review their consumption-savings decisions infrequently, but at the same predetermined points in time. Hence there is a representative investor in our example economy.

must be satisfied by all financial assets:

$$E_t\left[R_{i,t+j}\left(\frac{\delta^j u'(c_{t+j})}{u'(c_t)}\right)\right] = 0,\ t = 0, k, 2k, ...;\ j = 1, 2, ... \tag{2}$$

In equation (2) given above $R_{i,t+j}$ denotes the excess return on an arbitrary asset, i, from date t to $t + j$; c_{t+j} denotes consumption flow during $t + j$, $u(.)$ denotes the period utility function and $u'(.)$ denotes its first derivative, δ denotes the time discount factor, and $E_t[.]$ denotes the expectation operator based on information available to the investor at date t. For notational convenience define the stochastic discount factor (SDF) as $m_{t,t+j} \equiv \frac{\delta^j u'(c_{t+j})}{u'(c_t)}$. Substituting this into equation (2) gives:

$$E_t\left[R_{i,t+j} m_{t,t+j}\right] = 0 \tag{3}$$

In our empirical study we will work with expected returns that can be estimated using historical averages. Therefore work with the unconditional version of equation (3), after rewriting it in the more common covariance form given below:

$$E[R_{i,t+j}] = -\frac{Cov[R_{i,t+j}, m_{t,t+j}]}{E[m_{t,t+j}]} = -\frac{Var[m_{t,t+j}]}{E[m_{t,t+j}]}\frac{[Cov[R_{i,t+j}, m_{t,t+j}]}{Var[m_{t,t+j}]} \equiv \lambda_m \beta_{im,j} \tag{4}$$

where $\beta_{im,j}$, the sensitivity of excess return, $R_{i,t+j}$, on asset i to changes in the stochastic discount factor, $m_{t,t+j}$, will in general be negative, and the market price for SDF risk, λ_m should be strictly negative. When the period utility function exhibits constant relative risk aversion with the coefficient of relative risk aversion γ, the stochastic discount factor is given by:

$$m_{t,t+j} = \delta^j \left(\frac{c_{t+j}}{c_t}\right)^{-\gamma} \equiv \delta^j g_{c,t+j}^{-\gamma} \tag{5}$$

where, $g_{c,t+j}$ is the j period growth in per capita consumption from t to $t + j$. Substituting the expression for $m_{t,t+j}$ given by equation (5) into equation (4) and simplifying gives:

$$\begin{aligned} E[R_{i,t+j}] &= \lambda_{g\gamma j}\beta_{ig\gamma,j}, \\ \text{where, } \beta_{ig\gamma,j} &= \frac{Cov(R_{i,t+j}, g_{c,t+j}^{-\gamma})}{Var(g_{c,t+j}^{-\gamma})}, \end{aligned} \tag{6}$$

and $\lambda_{g\gamma j}$ is a strictly negative constant representing the risk premium for bearing the risk in $g_{c,t+j}^{-\gamma}$. For most assets, i, $\beta_{ig\gamma}$ will be strictly negative.

Typically consumption growth, $g_{c,t+j}$, is observed with measurement error, i.e., we observe $\hat{g}_{c,t+j} = g_{c,t+j} + \varepsilon_{g,t+j}$, where $\varepsilon_{g,t+j}$ denotes the measurement error in the growth in consumption from t to $t+j$. When γ is large, say in the 10 to 20 range, the percentage error in $g_{c,t+j}^{-\gamma}$ will be larger when compared to the percentage error in $g_{c,t+j}$. For example, with $\gamma = 20$, $g_{c,t+j} = 1.04$, and $\varepsilon_{g,t+j} = 0.005$, $\hat{g}_{c,t+j} = 1.0045$, $g_{c,t+j}^{-\gamma} = 0.4564$, and $\hat{g}_{c,t+j}^{-\gamma} = 0.4146$, i.e., a 0.48% measurement error in $g_{c,t+j}$ translates into a 9.15% measurement error in $g_{c,t+j}^{-\gamma}$. Since the approximation error is likely to have a smaller effect than the measurement error, there may be an advantage to working with a first order Taylor approximation of the function, $g_{c,t+j}^{-j}$. We therefore consider the following linear version of equation (6), generally referred to as the consumption capital asset pricing model (CCAPM):

$$
\begin{aligned}
E[R_{i,t+j}] &= \lambda_{gj}\beta_{igj}, \\
\text{where, } \beta_{igj} &= \frac{Cov(R_{i,t+j}, g_{c,t+j})}{Var(g_{c,t+j})},
\end{aligned}
\tag{7}
$$

and $\lambda_{gj} \simeq \gamma\frac{Var(g_{c,t+j})}{1-\gamma E(g_{c,t+j}-1)}$ is the market price for consumption risk; note that the consumption beta for most assets, as well as the market price of consumption risk will be strictly positive.

In general, the ratio of the first and second moments of the measurement error, $\varepsilon_{g,t+j}$, to the corresponding moments of $g_{c,t+j}$ will be decreasing in j. Hence measurement errors in consumption will have less influence on the conclusions when the return horizon, j, is increased, provided $E[R_{i,t+j}]$, and β_{igj} are known constants. When $E[R_{i,t+j}]$, and β_{igj} are not known and have to be estimated using data, increasing the return horizon, j, decreases the precision of those estimates. Ideally we would like to choose j so as to minimize the effect of measurement errors as well sampling errors on our conclusions. Given insufficient information to assess how measurement error and sampling error depend on j, we decided to set the return horizon, j, to equal the review period, k. We assume that k is a calendar year, i.e., investors review their consumption and investment decisions in the fourth quarter of every calendar year. While these choices are somewhat arbitrary, measuring returns over the calendar year enables us to overcome the need to model and explain well documented within year deterministic seasonal effects in stock returns.

We examine the specification in equation (7) using the two stage cross sectional regression (CSR) method of Black, Jensen and Scholes (1972) and Fama and MacBeth (1973). Following Berk (1995) and Jagannathan and Wang (1998), we examine possible model misspecification by checking whether the coefficient for firm characteristics like book to market ratio and relative market capitalization are significant in the cross sectional regressions.

3 Data and Empirical Analysis

We assume that time period is measured in quarters. We use annual and quarterly seasonally adjusted[9] aggregate nominal expenditure on consumer nondurables and services for the period 1954-2003 from National Income and Product Accounts (NIPA) table 2.3.5, and monthly nominal consumption expenditures from NIPA table 2.8.5. We use population numbers taken from NIPA tables 2.1 and 2.6 and price deflator series taken from NIPA table 2.3.4 and 2.8.4 to construct the time series of per capita real consumption figures for use in our empirical work. The returns on the 25 size and book/market sorted portfolios, the risk free return, and the values for the three Fama and French (1993) factors for the period 1954-2003 are taken from Kenneth French's website. We construct the excess return series on the 25 portfolios from this data. To check the robustness of our conclusions, we also examine the performance of the model specifications when time period is measured in months.

In what follows we will first discuss the results obtained using calendar year excess returns and growth rate in per capita real consumption in the fourth quarter of a calendar year from one year to another. Table I gives the summary statistics for the consumption data we use in the study. Note that the means and the standard deviation of the four quarter consumption growth rates do not depend much on which quarter of the year we start with. However, the Max minus the Min is larger for Q4-Q4 when compared to other quarters, providing support for our conjecture that Q4 consumption bundle is less subject to rigidity due to prior commitments.

Table II, panel A shows substantial variation in the average excess returns across the 25 portfolios. For example, small growth firms had an average excess return of 6.19% per year whereas small value firms earned 17.19% per year over the riskless

[9]We used seasonally adjusted data since we were unable to obtain seasonally unadjusted data on consumption deflator. The seasonal adjustment process can be viewed as another source for measurement error.

rate. The value-growth effect is more pronounced among small firms and the size effect is more pronounced among value firms. Firms that earn a lower return on average tend to have smaller consumption betas. Small growth firms which earn the lowest return on average have a consumption beta of 3.46 whereas small value firms have a consumption beta of 5.94, i.e., 1.72 times as large. Further, the estimated consumption betas are statistically significantly different from zero. Figure 1 provides a scatter plot of the mean excess return on the 25 portfolios against their estimated consumption betas. We find a reasonably linear relation.

Table III provides the results for the CSR method. When the model is correctly specified the intercept term should be zero, i.e., assets with zero consumption beta should earn zero risk premium. The intercept is 0.14% per year, which is not statistically significantly different from zero after taking sampling errors into account. The slope coefficient is significantly positive consistent with the view that consumption risk carries a positive risk premium. There is some evidence that the model is misspecified; when log book to market ratio is introduced as an additional variable in the cross sectional regression, its slope coefficient is significantly different from zero. Notice however that a similar phenomenon occurs with the Fama and French three factor model as well. When log size and log book to market ratio are added as additional explanatory variables in the Fama and French three factor model, they take away the statistical significance of the slope coefficients for the three risk factors[10]. The point estimate of the intercept term for the Fama and French 3 factor model is 10.43% per year, which is a rather large value for the expected return on a zero beta asset when compared to the risk premium of 5.83% per year for the HML factor risk. Figure 2 gives plots of the realized average excess returns against what they should be according to each of the three fitted models. Notice that while the points are about evenly distributed around the 45 degree line for the CCAPM specification, there is a U-shaped pattern for the Fama and French three factor model; assets with both high and low expected returns according to the model tend to earn more on average.

In order to compare the two models further, we also estimated them after imposing the restriction that the intercept term in the cross sectional regression equation, λ_0, is zero. The results are given in Table IV. The estimated value of the consumption risk premium for the restricted model is 2.59, not much different from the estimate of 2.56 obtained using the unrestricted model. The cross sectional R-Squares for

[10] In contrast, Jagannathan, Kubota and Takehara (1998) find that the book to market ratio is not significant when added as an additional variable in the Fama and French three factor model.

the consumption risk model and the Fama and French three factor model for the restricted model are the same, 73%. The estimated risk premiums for the HML and the SMB factors do not change much when the restriction that the intercept term in the cross sectional regression equation is zero. However, the estimated risk premium for the stock market factor changes substantially; it increases to 9.71% per year from -3.26% per year, which is consistent with a flat relation between market factor beta and average return in the sample.

Let $\alpha_i = E(R_i) - \lambda_0 - \lambda' \beta_i$ denote the model pricing error, i.e., the difference between the expected return on asset i and the expected return assigned to it by the asset pricing model. Let $\hat{\lambda}_0$ and $\hat{\lambda}$ denote estimates obtained using the unrestricted models and $\tilde{\lambda}$ denote the estimates obtained with the restriction that $\lambda_0 = 0$. Define the corresponding estimated values for the alphas as $\hat{\alpha}_i \equiv E(R_i) - \hat{\lambda}_0 - \hat{\lambda}' \hat{\beta}_i$, and $\tilde{\alpha}_i \equiv E(R_i) - \tilde{\lambda}' \hat{\beta}_i$. Table V gives the pricing errors for the constrained and unconstrained models. For the CCAPM the average value of $|\hat{\alpha}_i|$ is 1.41% per year and the maximum value of $|\hat{\alpha}_i|$ is 3.45% per year. These values do not change when the intercept term in the cross sectional regressions are restricted to be zero. The average value of $|\hat{\alpha}_i|$ is 1.09% per year, and the maximum value of $\hat{\alpha}_i$, however, is 2.73% for the Fama and French three factor model, a substantial improvement over the CCAPM.

When the intercept term is constrained to be zero, however, the maximum value of $\tilde{\alpha}_i$ for Fama and French three factor model increases to 3.30% per year, not much different from the corresponding value for the CCAPM model. While the Fama and French model does better on average, for the most mispriced asset, both models are about equally good or bad. The average value of alpha does not comedown when the two models are combined, suggesting that both models may be capturing the same types of economy wide pervasive risks, to a large extent. Table VI gives the model misspecification measure, pricing error for the most mispriced portfolio, suggested by Hansen and Jagannathan (1997). That measure is smaller for the CCAPM than for the Fama and French three factor model. On balance, it therefore appears that there is fairly strong empirical support for the consumption risk model.

Implied Coefficient of Relative Risk Aversion

Consider the slope coefficient, λ_1, in the cross sectional regression equation given by:

$$R_{i,t+4} = \lambda_0 + \lambda_1 \beta_{i,g_c} + \varepsilon_{i,t+4}$$

If the standard consumption-based asset pricing model holds, the intercept, $\lambda_0 = 0$

and the slope coefficient, $\lambda_1 = \frac{\gamma Var(g_{c,t+4})}{1-\gamma[E(g_{c,t+4})-1]}$,where, γ denotes the coefficient of relative risk aversion. The estimated slope coefficient, $\widehat{\lambda}_1 = 2.56$, therefore corresponds to an implied coefficient of relative risk aversion of 31 when the model is correctly specified. The large estimate for the risk aversion parameter of the representative investor on the one hand and the ability of the CCAPM to explain the cross section of stock returns well on the other hand is consistent with the explanation given by Constantinides and Duffie (1996) and Heaton and Lucas (2000). It is also consistent with the specification suggested by Campbell and Cochrane (1999). For example, suppose the period utility function is given by Abel's external habit model, i.e., the period utility function is given by, $u(C_t - X_t)$, C_t denotes the date t consumption as before, and X_t represents external habit level that the consumer uses as reference point. In that case, as Campbell and Cochrane (1999) show, the stochastic discount factor that assigns zero value to an excess return is given by:

$$m_{t,t+k} = \left(\frac{S_{t+k}}{S_t}\frac{C_{t+k}}{C_t}\right)^{-\gamma} \quad (8)$$

where and $S_t = \frac{C_t - X_t}{C_t}$, denotes the surplus consumption ratio. We can approximate $m_{t,t+k}$ given above around $S_t = S_{t+k}$ and $C_t = C_{t+k}$ using Taylor series to get:

$$\begin{aligned} m_{t,t+k} &\simeq \left(1 - \gamma\left[\frac{S_{t+k} - S_t}{S_t} + \frac{C_{t+k} - C_t}{C_t}\right]\right) \\ &= (1 - \gamma\left[(g_{s,t+k} - 1) + (g_{c,t+k} - 1)\right]) \end{aligned} \quad (9)$$

where $g_{s,t+k}$ and $g_{c,t+k}$ are the growth in surplus consumption ratio and consumption respectively, from date t to date $t + k$. Substituting the above expression for $m_{t,t+1}$ into equation (3) and simplifying gives:

$$\begin{aligned} E[R_{i,t+k}] &= \lambda_c \beta_{ic} + \lambda_s \beta_{is} \\ \text{where, } \beta_{ic} &= \frac{Cov(R_{i,t+k}, g_{c,t+k})}{Var(g_{c,t+k})}; \beta_{is} = \frac{Cov(R_{i,t+k}, g_{s,t+k})}{Var(g_{s,t+k})}, \end{aligned} \quad (10)$$

with λ_s and λ_c being the risk premium for bearing the risk associated with surplus consumption ratio growth and consumption growth respectively. In general S_t will be a stationary random variable, whereas C_t will be growing. This can be seen from the fact that $S_t = \frac{C_t - X_t}{C_t}$, and X_t will be some average of past consumptions, and extreme case of which will be, $X_t = C_{t-1}$. Hence $\frac{Var(g_{s,t+k})}{Var(g_{c,t+k})}$ will become small as k becomes large. The rather large implied value for the coefficient of relative risk aversion indicates that setting k to 4 quarters may be due to ignoring the effect due to $\frac{S_{t+k}-S_t}{S_t}$. The high cross sectional R-Square, on the other hand, indicates that the effect due to possible omission of $\frac{S_{t+k}-S_t}{S_t}$ is likely to be the same for all the portfolios.

Alternative model specifications

Table VII gives the results when we use the monthly consumption data and measure the annual growth rate in consumption from December of one year to December of the following year. To the extent monthly consumption is measured less precisely, we should expect the performance to worsen when compared to our earlier specification. That is what we find. The cross sectional R-Square drops from 71% to 38%; and the intercept term becomes larger in absolute value, though still not statistically different from zero.

We take the stand that all investors review their consumption investment decisions during the last quarter of the calendar year. They may also review at other points in time, but such reviews may not occur during the same period for all individuals. Given this view, we would expect to find most support for the CCAPM when matching consumption growth from the fourth quarter of one calendar year to the next with asset returns for the corresponding period. We would expect less support when we examine consumption growth from one month to another, or from one quarter to another, or from one year to another. We would also expect less support for the CCAPM when we examine the growth in consumption from the last month of a calendar quarter to the last month in the calendar quarter that follows. As can be seen from the figures reported in Table VIII, that is exactly what we find.

Table IX gives the results when we measure annual consumption growth starting from other than the 4th quarter in a year. Notice that the consumption betas of small growth and small value firms are closer to each other when consumption growth is measured from Q1-Q1, or Q2-Q2, or Q3-Q3. The cross sectional R-Squares drop substantially, to as low as 14% when consumption growth is measured from Q2 on one year to Q2 of the next year. The estimated intercepts are large and significantly different from zero. Given the sequence, Q1, Q2, Q3, Q4, Q1, Q2,..., in which calendar quarters occur over time, Q2 is the farthest from quarter Q4. Hence, we should expect the empirical support for the CCAPM to be weakest when we match consumption growth in quarter 2 in one year to another with asset returns for the corresponding period. Our findings are consistent with this view.

In deriving our consumption based asset pricing model specification we assumed that all investors revise their consumption decision at the same time. As Lynch (1996) and Gabaix and Laibson (2001) show, when investors review their consumption-investment plans infrequently, but at different points in time, aggregate consumption will exhibit substantially less variability than individual consumption. In that case, while the linear relation between expected return and consumption covariance will hold approximately, the implied risk aversion coefficient will be much larger.

Other portfolios

We also examined the robustness of our findings using the six size and book to market sorted portfolios constructed by Fama and French. The asymptotic theory we rely on for statistical inference may be more justified in this smaller cross section of assets. The results are given in Table X. The slope coefficient for consumption growth is 2.81, not much different from the 2.56 for the cross section of 25 assets we examined earlier. The cross sectional R-squares for the CCAPM and the Fama and French three factor model specifications, again, are comparable.

Table XI gives the results for several other set of assets: 18 portfolios sorted on size, 18 portfolios sorted on B/M, 19 portfolios sorted on E/P, and 19 portfolios sorted on CF/P, taken from Kenneth French's website. The consumption model performs almost as well as the Fama and French three factor model for the Size and B/M portfolios, but not for the E/P and CF/P sorted portfolios. However, the estimated slope coefficients for consumption growth in the cross sectional regressions are not much different across the different set of assets.

To check whether our conclusions critically depend on the use of seasonally adjusted data on expenditures of nondurables and services, we evaluated the model using nonseasonally adjusted consumption data. Since the price deflator for personal consumption expenditures are only available in seasonally adjusted form, we followed Ferson and Harvey (1992), and used nonseasonally adjusted CPI to deflate nominal consumption expenditures. As can be seen from the results reported in Table XII, the use of seasonally unadjusted consumption data does not change the results in any significant way.

4 Conclusion

In this paper we examine the ability of the consumption based asset pricing model to explain the cross section of average returns on the 25 benchmark equity portfolios constructed by Fama and French. We find surprisingly strong support for the model. The single consumption factor model performs almost as well as the widely used Fama and French (1993) three factor model. Most of the variation in average returns can be explained by corresponding variation in exposure to consumption risk. The model performs well in other test assets as well.

In deriving the econometric specifications for the consumption based asset pricing model we assumed that all investors review their consumption-investment plans once a year at the same time during the fourth quarter of every calendar year. We find more support for this assumption than the standard specification that follows from the assumption that investors review their consumption-investment plans every month.

While the consumption-based model is able to explain the cross section of average return on stocks, there is evidence indicating that the model specifications used in our empirical study misses some important aspects of reality. While the model can explain the cross section of returns on stocks, it has difficulty explaining the equity premium. The implied market risk premium for bearing consumption risk is rather high. When book to market ratio is introduced as an additional variable in the cross sectional regressions, its slope coefficient is significantly different zero, indicating that it would be possible to construct a set of interesting test assets that pose a challenge to the consumption based model by following Daniel and Titman (1997). That would help future research in identifying what is missing in consumption based models.

References

[1] Abel, Andrew, 1990, Asset prices under habit formation and catching up with the Jonses, *American Economic Review*, 80, 38-42.

[2] Ait-Sahalia, Yacine, Jonathan A. Parker, and Motohiro Yogo, 2004, Luxury goods and the equity premium, *Journal of Finance* 59, 2959-3004.

[3] Bansal, Ravi, Robert Dittmar, and Christian Lundblad, 2004, Consumption, dividends, and the cross-section of equity returns, *Journal of Finance*, forthcoming.

[4] Berk, Jonathan, 1995, A critique of size related anomalies, *Review of Financial Studies* 8, 275-286.

[5] Black, Fischer, Michael Jensen, and Myron Scholes, 1972, The capital asset pricing model: some empirical tests , in M.C. Jensen (ed.), *Studies in the Theory of Capital Markets* (New York: Praeger): pp 79-121.

[6] Bouman, Sven. and Ben Jacobsen, 2002, The Halloween indicator, 'sell in May and go away': another puzzle, *American Economic Review* 92, 1618-1635.

[7] Brainard, William, Richard Nelson,and Matthew Shapiro, 1991, The consumption beta explains expected returns at long horizons, Working paper, Yale University.

[8] Braun, Anton, and Charles Evans, 1995, Seasonality and equilibrium business cycle theories, *Journal of Economic Dynamics and Control* 19, 503-531.

[9] Breeden, Douglas, 1979, An intertemporal asset pricing model with stochastic consumption and investment opportunities, *Journal of Financial Economics* 7, 265-296.

[10] Breeden, Douglas, Michael Gibbons, and Robert Litzenberger, 1989, Empirical tests of the consumption-oriented CAPM, *Journal of Finance* 44, 231-262.

[11] Campbell, John, 1993, Intertemporal asset pricing without consumption data, *American Economic Review* 83, 487-512.

[12] Campbell, John, and John Cochrane, 1999, By force of habit: a consumption-based explanation of aggregate stock market behavior, *Journal of Political Economy* 107, 205-251.

[13] Chamberlain, Gary, and Michael Rothschild, 1983, Arbitrage, factor structure, and mean-variance analysis on large asset markets, *Econometrica* 51, 1281-304.

[14] Chetty, Raj, and Adam Szeidl, 2004, Consumption commitments and asset prices, Working paper.

[15] Connor, Gregory, 1984, A unified beta pricing theory, *Journal of Economic Theory* 34, 13-31.

[16] Connor, Gregory, and Robert A. Korajczyk, 1986, Performance measurement with the arbitrage pricing theory: A new framework for analysis, *Journal of Financial Economics* 15, 373-394.

[17] Constantinides, George, 1990, Habit formation: A resolution of the equity premium puzzle, *Journal of Political Economy* 98, 519-543.

[18] Da, Zhi, 2004, Firm characteristic, excess return factor and expected return, Working paper, Northwestern University.

[19] Daniel, Kent, and Sheridan Titman, 1997, Evidence on the characteristics of cross sectional variation in stock returns, *Journal of Finance* 52, 1-34.

[20] Daniel, Kent, and Sheridan Titman, 2004, Testing factor-model explanations of market anomalies, working paper.

[21] Fama, Eugene, and Kenneth French, 1992, The cross-section of expected stock returns, *Journal of Finance* 47, 427-466.

[22] Fama, Eugene, and Kenneth French, 1993, Common risk factors in the return on bonds and stocks, *Journal of Financial Economics* 33, 3-56.

[23] Fama, Eugene, and James MacBeth, 1973, Risk, return, and equilibrium: empirical tests, *Journal of Political Economy* 71, 607-636.

[24] Ferson, Wayne, and Campbell Harvey, 1992, Seasonality and consumption-based asset pricing, *Journal of Finance* 47, 511-552.

[25] Gabaix, Xavier and David Laibson, 2001, The 6D Bias and the Equity-Premium Puzzle, *The NBER Macroeconomics Annual*.

[26] Gibbons, Michael, Stephen Ross, and Jay Shanken, 1989, A test of the efficiency of a given portfolio, *Econometrica* 57, 1121-1152.

[27] Grossman, Sanford, and Robert Shiller, 1981, The determinants of the variability of stock market prices, *American Economic Review* 71, 222-227.

[28] Hansen, Lars, John Heaton, and Nan Li, 2004, Consumption strikes back? Working paper, University of Chicago.

[29] Hansen, Lars, and Ravi Jagannathan, 1997, Assessing specification errors in stochastic discount factor models, *Journal of Finance* 52, 557-590.

[30] Hansen, Lars, and Kenneth Singleton, 1982, Generalized instrumental variables estimation of nonlinear rational expectations models, *Econometrica* 55, 1269-1286

[31] Hansen, Lars, and Kenneth Singleton, 1983, Stochastic consumption, risk aversion, and the temporal behavior of asset returns, *Journal of Political Economy* 91, 249-268.

[32] Heaton, John and Deborah Lucas, 2000, Portfolio choice and asset prices: The importance of entrepreneurial risk, *Journal of Finance* 55, 1163-1198.

[33] Jagannathan, Ravi, Keiichi Kubota and Hitoshi Takehara, 1998, Relationship between labor-income risk and average return: Empirical evidence from the Japanese stock market, *Journal of Business* 71, 319-347.

[34] Jagannathan, Ravi, and Zhenyu Wang, 1996, The conditional CAPM and the cross-section of expected returns, *Journal of Finance* 51, 3-53.

[35] Jagannathan, Ravi, and Zhenyu Wang, 1998, An asymptotic theory for estimating beta-pricing models using cross-sectional regression, *Journal of Finance*, 57, 1285-1309.

[36] Keim, Donald, 1983, Size related anomalies and stock market seasonality, *Journal of Financial Economics* 12, 12-32.

[37] Lettau, Martin, and Sydney Ludvigson, 2001, Resurrecting the (C)CAPM: A crosssectional test when risk premia are time-varying, *Journal of Political Economy* 109, 1238-1287.

[38] Lucas, Robert, 1978, Assets prices in an exchange economy, *Econometrica* 46, 1429-1445.

[39] Lynch, Anthony W., 1996, Decision frequency and synchronization across agents: Implications for aggregate consumption and equity return, *The Journal of Finance* 51, 1479-1497.

[40] Marshall, David A. and Nayan G. Parekh, 1999, Can costs of consumption adjustment explain asset pricing puzzles?, *The Journal of Finance* 54, 623-654.

[41] Merton, Robert,.1973, An intertemporal capital asset pricing model, *Econometrica* 41, 867-887.

[42] Miron, Jeffrey, and Joseph, Beaulieu, 1996, What have macroeconomists learned about business cycles from the study of seasonal cycles?, *Review of Economics and Statistics* 78, 54-66.

[43] Parker, Jonathan, and Christian Julliard, 2004, Consumption risk and the cross-section of expected returns, *Journal of Political Economy,* forthcoming.

[44] Reinganum, Marc, 1983, The anomalous stock market behavior of small firms in January : Empirical tests for tax-loss selling effects, *Journal of Financial Economics* 12, 89-104.

[45] Roll, Richard, 1983, Vas ist Das? The turn of the year effect and the return premia of small firms, *Journal of Portfolio Management* 9, 18-28.

[46] Ross, Stephen, 1976, The arbitrage theory of capital pricing, *Journal of Economic Theory* 13, 341-360.

[47] Rubinstein, Mark, 1976, The valuation of uncertain income streams and the pricing of options, *Bell Journal of Economics and Management Science* 7, 407-425.

[48] Sundaresan, Suresh, 1989, Intertemporal dependent preferences and the volatility of consumption and wealth, *Review of Financial Studies* 2, 73-88.

Table I: Consumption Growth Summary

This table reports summary statistics of consumption growth. Consumption is measured by real consumer expenditure per capita on nondurables and services. For notational convenience, let Δc denote the growth rate in consumption, $(g_c - 1)$. Then, the consumption growth rate is given by

$$\Delta c = (\frac{C_{t+4}}{C_t} - 1) \times 100\%.$$

Q1-Q1 consumption growth is calculated using Quarter 1 consumption data. Q2-Q2, Q3-Q3, and Q4-Q4 consumption growth are calculated in the similar way. Q4-Q4 consumption growth is calculated using 4th quarter consumption data. Annual consumption growth is calculated using annual consumption data. Dec-Dec consumption growth is calculated from December consumption data. Sample period of quarterly and annual data is 1954-2003. Sample period of monthly data is 1960-2003.

	Q1-Q1	Q2-Q2	Q3-Q3	Q4-Q4	Annual	Dec-Dec
mean	2.38	2.38	2.41	2.44	2.40	2.49
std	1.38	1.31	1.29	1.38	1.21	1.43
min	-0.36	-0.27	-0.49	-0.78	-0.07	-0.79
max	5.72	5.40	4.83	5.70	4.52	5.17

Table II: Annual Excess Returns and Consumption Betas

Panel A reports average annual excess returns on Fama-French 25 portfolios from 1954-2003. Annual excess return is calculated from January to December in real term. Panel B reports these portfolios' consumption betas estimated by time series regression:

$$R_{i,t} = \alpha_i + \beta_{i,c}\Delta c_t + \varepsilon_{i,t}$$

where Δc is Q4-Q4 consumption growth calculated using 4th quarter consumption data. Panel C reports t-value associated with consumption betas.

Panel A: Average Annual Excess Returns

	Low	book-to-market			High
Small	6.19	12.47	12.24	15.75	17.19
	5.99	9.76	12.62	13.65	15.07
size	6.93	10.14	10.43	13.23	13.94
	7.65	7.91	11.18	12.00	12.35
Big	7.08	7.19	8.52	8.75	9.50

Panel B: Consumption Betas

	Low	book-to-market			High
Small	3.46	5.51	4.26	4.75	5.94
	2.89	3.03	4.79	4.33	5.21
size	2.88	4.10	4.35	4.79	5.71
	2.57	3.35	3.90	4.77	5.63
Big	3.39	2.34	2.83	4.07	4.41

Panel C: t-value

	Low	book-to-market			High
Small	0.93	1.71	1.59	1.83	2.08
	0.98	1.27	2.02	1.83	2.10
size	1.15	1.93	2.17	2.07	2.39
	1.14	1.75	1.90	2.26	2.39
Big	1.71	1.32	1.67	2.15	2.00

Figure 1: Annual Excess Returns and Consumption Betas

Plot figure of average annual excess returns on Fama-French 25 portfolios and their consumption betas. Each two digit number represents one portfolio. The first digit refers to the size quintiles (1 smallest, 5 largest), and the second digit refers to the book-to-market quintiles (1 lowest, 5 highest). Annual excess returns and consumption betas are reported in previous table.

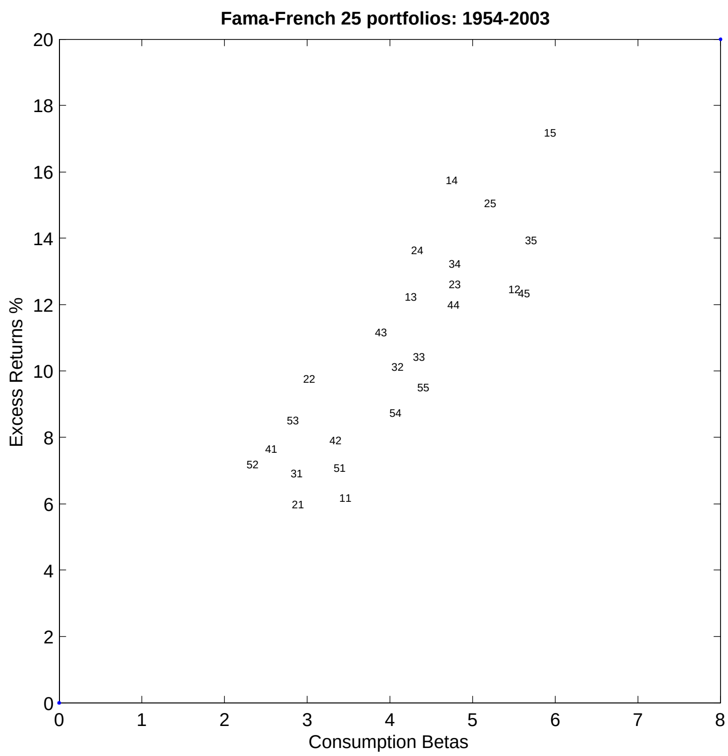

Table III: Cross Sectional Regression

This Table reports Fama-MacBeth cross sectional regression (CSR) estimation results for asset pricing model :

$$E[R_{i,t}] = \lambda_0 + \lambda'\beta$$

Betas are estimated by the time-series regression of excess returns on the factors. Test portfolios are Fama-French 25 portfolios, annual return from 1954-2003. The estimation method is Fama-MacBeth cross-sectional regression procedure. The first row reports the coefficient estimates ($\widehat{\lambda}$). Fama-MacBeth t-statistic are reported in the second row, and Shanken corrected t-statistic are in the third row. The last column gives the R^2 and adjusted R^2 just below it.

	$const$	Δc	R_m	SMB	HML	$log(ME)$	$log(B/M)$	R^2(adj-R^2)
estimate	0.14	2.56						0.73
t-value	(0.05)	(3.89)						0.71
Shanken-t	(0.02)	(1.98)						
estimate	11.31		-0.56					0.00
t-value	(2.05)		(-0.09)					-0.04
Shanken-t	(2.05)		(-0.08)					
estimate	10.43		-3.26	3.12	5.83			0.80
t-value	(2.66)		(-0.70)	(1.62)	(3.11)			0.77
Shanken-t	(2.37)		(-0.57)	(1.03)	(2.12)			
estimate	11.75	1.58	-3.76	3.00	5.75			0.87
t-value	(2.98)	(3.64)	(-0.81)	(1.56)	(3.07)			0.84
Shanken-t	(1.95)	(2.26)	(-0.50)	(0.83)	(1.71)			
estimate	16.20					-0.87	3.46	0.84
t-value	(2.95)					(-1.43)	(3.00)	0.83
estimate	12.19	0.71				-0.71	2.66	0.86
t-value	(2.41)	(1.62)				(-1.23)	(2.12)	0.84
estimate	22.22		-3.80	-0.67	0.96	-1.07	3.04	0.87
t-value	(3.50)		(-0.88)	(-0.23)	(0.37)	(-1.51)	(2.87)	0.84

Figure 2: Realized vs. Fitted Excess Returns: FF25 Portfolios

This figure compares realized returns and fitted returns of Fama-French 25 portfolios 1954-2003. Each two digit number represents one portfolio. The first digit refers to the size quintiles (1 smallest, 5 largest), and the second digit refers to the book-to-market quintiles (1 lowest, 5 highest). Three models are compared: CCAPM, CAPM and Fama-French 3 factor model. Models are estimated by using Fama-MacBeth cross-sectional regression procedure Estimation results are reported in previous table.

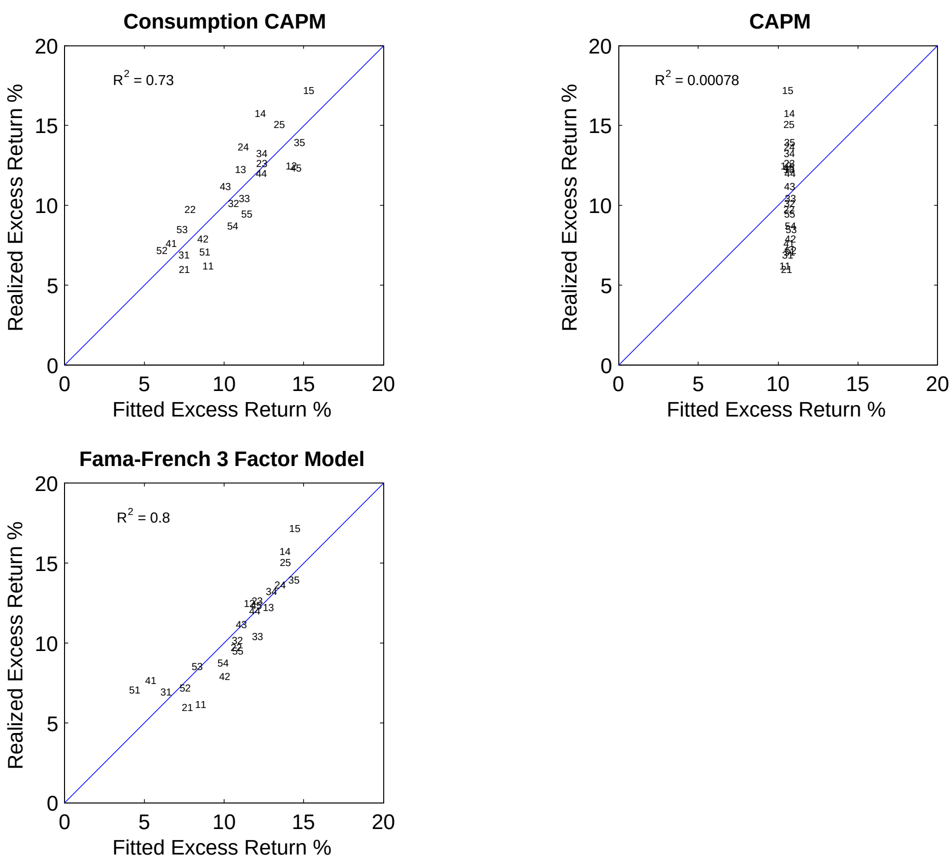

Table IV: Cross Sectional Regression without intercept

This table reports Fama-MacBeth cross sectional regression (CSR) estimation results with restrictions :

$$E[R_{i,t}] = \lambda'\beta$$

Betas are estimated by the time-series regression of excess returns on the factors. Test portfolios are Fama-French 25 portfolios, annual return from 1954-2003. The estimation method is Fama-MacBeth cross-sectional regression procedure. The first row reports the coefficient estimates ($\widetilde{\lambda}$). Fama-MacBeth t-statistic are reported in the second row, and Shanken corrected t-statistic are in the third row. The last column gives the R^2 and adjusted R^2 just below it.

	Δc	R_m	SMB	HML	$log(ME)$	$log(B/M)$	R^2(adj-R^2)
estimate	2.59						0.73
t-value	(3.72)						0.73
Shanken-t	(1.88)						
estimate		9.71					-0.26
t-value		(3.49)					-0.26
Shanken-t		(2.42)					
estimate		7.09	3.03	6.24			0.73
t-value		(2.79)	(1.58)	(3.31)			0.71
Shanken-t		(1.79)	(0.95)	(2.13)			
estimate	1.67	7.78	2.92	6.21			0.79
t-value	(3.84)	(3.06)	(1.52)	(3.30)			0.76
Shanken-t	(2.39)	(1.70)	(0.81)	(1.84)			
estimate					1.88	3.20	0.81
t-value					(9.67)	(2.03)	0.76
estimate	2.75				0.01	0.29	0.74
t-value	(3.09)				0.03	(0.18)	0.72
estimate		-1.13	7.27	3.04	1.29	2.39	0.77
t-value		(-0.29)	(3.26)	(1.17)	(3.28)	(2.06)	0.72

Table V: Pricing Errors

This table compares pricing errors of Fama-French 25 portfolios generated by CCAPM, Fama-French three factor model, and the nesting four factor model (FF 3 factor $+\Delta c$). When the model is estimated without restrictions, then pricing errors are calculated by $\widehat{\alpha}_i = \overline{R_i} - \widehat{\lambda}_0 - \widehat{\lambda}'\widehat{\beta}_i$; when the model is estimated with restrictions, then pricing errors are calculated by $\widetilde{\alpha}_i = \overline{R_i} - \widetilde{\lambda}'\widehat{\beta}_i$.

CCAPM: $\widehat{\alpha}$

-2.82	-1.77	1.20	3.45	1.85
-1.55	1.87	0.23	2.41	1.59
-0.58	-0.48	-0.85	0.85	-0.81
0.95	-0.79	1.07	-0.35	-2.18
-1.74	1.06	1.14	-1.81	-1.93

CCAPM: $\widetilde{\alpha}$

-2.78	-1.80	1.21	3.44	1.80
-1.50	1.91	0.22	2.42	1.57
-0.53	-0.47	-0.85	0.83	-0.86
1.01	-0.76	1.08	-0.37	-2.23
-1.71	1.12	1.20	-1.80	-1.93

3 Factor model: $\widehat{\alpha}$

-2.36	0.87	-0.55	1.92	2.73
-1.74	-1.03	0.52	0.13	1.20
0.52	-0.71	-1.68	0.25	-0.49
2.23	-2.14	0.08	0.06	0.32
2.65	-0.40	0.20	-1.22	-1.37

3 Factor model: $\widetilde{\alpha}$

-3.30	-0.45	0.55	2.90	2.29
-2.18	-0.42	1.27	0.46	0.72
0.33	0.11	-0.70	-0.01	-0.27
2.85	-1.32	-0.03	0.11	-1.03
2.54	0.13	1.34	-1.56	-2.88

4 Factor model: $\widehat{\alpha}$

-1.64	-0.01	-0.54	1.73	1.94
-0.82	0.48	-0.46	1.07	1.45
0.58	-1.20	-2.06	0.60	-1.38
1.66	-1.72	0.86	-0.37	-0.42
0.73	0.71	0.36	-1.13	-0.44

4 Factor model: $\widetilde{\alpha}$

-2.77	-1.36	0.68	2.84	1.57
-1.43	0.95	0.50	1.31	0.88
0.36	-0.22	-0.92	0.26	-1.02
2.42	-0.86	0.64	-0.26	-1.82
0.86	1.15	1.60	-1.52	-2.24

Table VI: HJ-GMM Estimation

This table reports HJ-GMM estimation results for asset pricing model :

$$E[(1 - b'f)R_{i,t}] = 0$$

Asset returns are value-weighted annual returns on Fama-French 25 portfolios. Sample period is 1954 – 2003. The model is estimated by HJ-GMM, in which the inverse of the second moments of asset returns is used as weighting matrix. The coefficient estimates are reported in first row. Second row reports t-statistic. The last two columns give the J-statistic and corresponding p-value.

CCAPM

	Δc	$HJ - dist$	p-value.
estimate	33.01	0.29	0.69
t-value	(25.45)		

CAPM

	R_m	$HJ - dist$	p-value.
estimate	2.10	0.74	0.08
t-value	(6.44)		

Fama-French 3 Factor Model

	R_m	SMB	HML	$HJ - dist$	p-value.
estimate	1.90	0.56	2.61	0.63	0.10
t-value	(4.12)	(0.85)	(5.02)		

Table VII: Consumption Betas Using Monthly Data

Panel A reports FF25 portfolios' consumption betas estimated by time series regression:

$$R_{i,t} = \alpha_i + \beta_{i,c}\Delta c_t + \varepsilon_{i,t}$$

where Δc is Dec-Dec consumption growth calculated using December consumption data. Portfolio returns are calendar year excess returns on Fama-French 25 portfolios from 1960-2003. Panel B reports Fama-MacBeth cross sectional regression estimation results for CCAPM:

$$E[R_{i,t}] = \lambda_0 + \lambda_1\beta_{i,c}$$

Panel A: Consumption Betas

	Low	book-to-market			High
Small	6.82	7.31	5.81	5.84	7.16
	5.33	4.83	6.07	5.37	6.63
size	4.63	5.18	5.14	5.59	6.43
	4.47	4.29	4.91	5.67	6.82
Big	4.70	3.71	3.72	4.49	4.81

Panel B: CSR Results

	const	Δc	R^2(adj-R^2)
estimate	-1.83	2.01	0.41
t-value	(-0.51)	(2.33)	0.38

Table VIII: CCAPM with Different Frequency Data

We use different frequency returns data and consumption data to test CCAPM. Panel A describes how the consumption growth is calculated. For example, with monthly consumption data, annual consumption growth is measured using December consumption of one year and December consumption of the following year. Panel B reports cross sectional regression estimation results for CCAPM:

$$E[R_{i,t}] = \lambda_0 + \lambda_1 \beta_{i,c}$$

Test portfolio returns are annualized excess returns on Fama-French 25 portfolios from 1960-2003 (monthly consumption data are available from 1959).

Panel A: Consumption Growth

	Monthly Consumption Data	Quarterly Consumption Data	Annual Consumption Data
Monthly Growth	Month-Month		
Quarterly Growth	Dec-Mar,Mar-Jun Jun-Sep,Sep-Dec	Quarter-Quarter	
Annual Growth	Dec-Dec	Q4-Q4	Annual-Annual

Panel B: CSR Results

	Monthly Consumption Data			Quarterly Consumption Data			Annual Consumption Data		
	λ_0	λ_1	$R^2(\overline{R^2})$	λ_0	λ_1	$R^2(\overline{R^2})$	λ_0	λ_1	$R^2(\overline{R^2})$
Monthly	7.70	0.02	0.00						
Return	(2.61)	(0.17)	-0.04						
Quarterly	8.34	0.03	0.00	4.52	0.33	0.22			
Return	(2.80)	(0.15)	-0.04	(1.83)	(1.59)	0.18			
Annual	-1.83	2.01	0.41	-1.19	2.68	0.69	10.12	1.32	0.21
Return	(-0.51)	(2.33)	0.38	(-0.37)	(3.49)	0.68	(3.70)	(1.61)	0.18

Table IX: Consumption Betas Using Other Quarterly Data

Panel A reports FF25 portfolios' annual returns and their consumption betas estimated by time series regression:

$$R_{i,t} = \alpha_i + \beta_{i,c}\Delta c_t + \varepsilon_{i,t}$$

where Δc is annual consumption growth calculated using quarterly consumption data. Portfolio returns are annual excess returns on Fama-French 25 portfolios from 1954-2003. For Q1-Q1 consumption growth, portfolio annual returns are calculated from April to next March. For Q2-Q2 consumption growth, portfolio annual returns are calculated from July to next June. For Q3-Q3 consumption growth, portfolio annual returns are calculated from October to next September. Panel B reports Fama-MacBeth cross sectional regression estimation results for CCAPM:

$$E[R_{i,t}] = \lambda_0 + \lambda_1\beta_{i,c}$$

Panel A: Annual Excess Returns and Consumption Betas

	Excess Returns						Consumption Betas				
	Low	book-to-market			High		Low	book-to-market			High
						Q1-Q1					
Small	3.88	9.80	10.75	13.93	14.69		5.10	6.02	4.30	4.83	5.80
	4.34	8.62	11.29	12.21	13.14		2.64	3.02	3.99	3.23	4.60
size	5.90	9.04	9.55	11.64	12.22		2.03	2.52	3.17	3.74	4.25
	7.12	6.93	10.24	10.51	10.78		2.39	1.68	2.44	3.77	5.23
Big	6.63	6.59	7.83	8.01	8.29		3.11	1.84	2.15	3.60	4.55
						Q2-Q2					
Small	4.61	10.95	11.54	14.83	15.67		5.31	4.81	4.28	4.38	5.14
	5.58	9.55	12.08	12.78	13.90		2.03	2.46	3.23	2.64	3.60
size	6.85	10.06	10.32	12.23	12.82		1.93	1.70	2.83	2.51	2.95
	7.66	7.91	10.94	11.16	11.38		1.90	0.60	1.24	2.81	3.10
Big	7.18	7.00	8.44	8.60	8.79		3.03	0.15	0.89	1.88	2.73
						Q3-Q3					
Small	5.52	11.81	12.05	15.51	16.56		3.30	2.76	2.62	2.98	3.63
	6.01	9.64	12.62	13.25	14.44		-0.02	0.54	1.84	1.11	2.52
size	7.35	10.64	10.45	13.03	13.33		0.01	0.34	1.41	0.66	2.80
	8.51	8.26	11.37	11.99	11.81		0.19	0.11	0.10	1.95	2.09
Big	7.64	7.47	8.67	8.75	9.10		1.41	-0.13	1.04	1.34	1.55

Panel B: CSR Results

	$const$	Δc	R^2(adj-R^2)
		Q1-Q1	
estimate	5.10	1.18	0.27
t-value	(2.00)	(2.39)	0.24
		Q2-Q2	
estimate	7.70	0.88	0.18
t-value	(3.05)	(1.68)	0.14
		Q3-Q3	
estimate	8.64	1.38	0.30
t-value	(2.98)	(2.71)	0.27

Table X: Fama-French 2×3 Portfolios

This table reports cross sectional regression results of CCAPM and Fama-French 3 factor models on Fama-French 2×3 portfolios (Small Value, Small Neutral, Small Growth, Big Value, Big Neutral, Big Growth). Samples are 1954-2003 annual data.

	$const$	Δc	R_m	SMB	HML	R^2(adj-R^2)
estimate	-1.10	2.81				0.89
t-value	(-0.33)	(3.86)				0.86
Shanken-t	(-0.16)	(1.84)				
estimate	9.07		-1.46	2.64	5.76	0.87
t-value	(1.94)		(-0.27)	(1.39)	(3.11)	0.68
Shanken-t	(1.75)		(-0.23)	(0.88)	(2.12)	

Table XI: CSR Results: Other Portfolios

Test portfolios are sorted on size, book-to-market, earning/price, and cashflow/price. 19 portfolios are constructed for each sorting variable: Negative (not used for size and B/M), 30%, 40%, 30%, 5 Quintiles, 10 Deciles. Value-weighted annual returns are from January 1 to December 31. Consumption betas are estimated using Q4-Q4 consumption growth. Sample period is 1954-2003.

	CCAPM			Fama-French 3 Factor Model				
	const	Δc	$R^2(\overline{R^2})$	*const*	R_m	SMB	HML	$R^2(\overline{R^2})$
18 Size Portfolios								
estimate	-0.44	2.60	0.81	9.09	-1.01	3.36	-0.05	0.99
t-value	(-0.09)	(1.68)	0.80	(0.78)	(-0.09)	(1.43)	(-0.01)	0.99
Shanken-t	(-0.04)	(0.85)		(0.75)	(-0.08)	(1.05)	(-0.01)	
18 B/M Portfolios								
estimate	2.62	1.79	0.80	-0.58	8.53	0.27	4.62	0.95
t-value	(0.97)	(2.94)	0.79	(-0.10)	(1.37)	(0.05)	(1.80)	0.94
Shanken-t	(0.63)	(1.87)		(-0.09)	(1.08)	(0.04)	(1.29)	
19 E/P Portfolios								
estimate	1.94	2.09	0.53	-1.96	10.05	-0.02	6.44	0.96
t-value	(0.93)	(3.85)	0.50	(-0.36)	(1.67)	(0.00)	(2.75)	0.95
Shanken-t	(0.55)	(2.22)		(-0.27)	(1.21)	(0.00)	(1.81)	
19 CF/P Portfolios								
estimate	2.81	1.72	0.59	-1.33	9.41	1.64	6.09	0.90
t-value	(1.19)	(3.46)	0.56	(-0.27)	(1.69)	(0.40)	(2.61)	0.88
Shanken-t	(0.79)	(2.22)		(-0.21)	(1.25)	(0.29)	(1.75)	

Table XII: CCAPM based on Not Seasonally Adjusted Data

This table reports results of CCAPM test using not seasonally adjusted consumption data. Nominal seasonally unadjusted consumer expenditure data on nondurables and services are from NIPA table 8.2. We use not seasonally adjusted CPI to deflate the nominal expenditure. Q4-Q4 consumption growth is calculated using 4th quarter real consumption data. Sample period is 1954-2003. Panel A reports statistics summary of $C4_{nsa}$ (Q4-Q4 consumption growth calculated using Not Seasonally Adjusted consumption data). The correlation coefficient between $C4_{nsa}$ and $C4_{sa}$ (Q4-Q4 consumption growth calculated using seasonally adjusted consumption data) is also reported. Panel B reports cross sectional regression estimation results for asset pricing model :

$$E[R_{i,t}] = \lambda_0 + \lambda_1 \beta_{i,C4nsa}$$

Betas are estimated by the time-series regression of excess returns on $C4_{nsa}$. Test portfolios are Fama-French 25 portfolios, annual return from 1954-2003.

Panel A: Not Seasonally Adjusted Consumption Growth

Mean($C4_{nsa}$)	Std($C4_{nsa}$)	Corrcoef($C4_{nsa}, C4_{sa}$)
1.96	1.71	0.92

Panel B: Cross Sectional Regression Estimation

	$\widehat{\lambda_0}$	$\widehat{\lambda_1}$	R^2(adj-R^2)
estimate	0.88	2.82	0.76
t-value	(0.25)	(3.91)	0.75
Shanken-t	(0.15)	(2.19)	