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RISK AND RETURN: CONSUMPTION BETA VERSUS MARKET BETA

N. Gregory Mankiw and Matthew D. Shapiro*

Abstract—Much recent work emphasizes the joint nature of the consumption decision and the portfolio allocation decision. In this paper, we compare two formulations of the Capital Asset Pricing Model. The traditional CAPM suggests that the appropriate measure of an asset's risk is the covariance of the asset's return with the market return. The consumption CAPM implies that a better measure of risk is the covariance with aggregate consumption growth. We examine a cross-section of 464 stocks and find that average return is more closely related to the beta measured with respect to a stock market index than to the beta measured with respect to consumption growth.

I. Introduction

MUCH recent work examines the consumption decision and the portfolio allocation decision jointly using the consumption-based capital asset pricing model.¹ As most capital asset pricing models, the consumption CAPM relates the expected return on an asset to its systematic risk. While the covariance with the return on a stock market index may be the standard measure of systematic risk, the consumption CAPM suggests that a better measure is the covariance with aggregate consumption growth. The consumption beta appears preferable on theoretical grounds because it takes account of the intertemporal nature of the portfolio decision (Merton (1973), Breeden (1979)) and because it implicitly incorporates the many forms of wealth beyond stock market wealth that are in principle relevant for measuring systematic risk.

In this paper we examine whether the consumption CAPM provides an empirically more useful framework for understanding cross-sectional stock returns. We address two questions. First, do stocks with high consumption betas earn higher returns?

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¹ See Breeden (1979), Grossman and Shiller (1981, 1982), Hansen and Singleton (1983), Mankiw (1981, 1985), Mankiw, Rotemberg and Summers (1985), Shapiro (1984), Shiller (1982), and Summers (1982).

Second, is the consumption beta a better explainer of returns than the standard beta?

Our study of the consumption CAPM parallels previous studies of the traditional CAPM. We can therefore directly compare the two models. While some recent work reports rejections of the consumption CAPM, we believe the empirical usefulness of the model is not fully settled. Hansen and Singleton (1983), for example, report that the over-identifying restrictions implied by the consumption CAPM are overwhelmingly rejected. It is difficult, however, to judge the economic significance of this finding. In particular, it is possible that in economic terms the model is approximately true, but the strict tests of over-identification fail (Fisher (1961)). It is therefore essential to construct a test that nests an alternative hypothesis motivated by economic theory. Specifically, in our formulation, it is possible to tell from the results whether the consumption CAPM or the traditional CAPM is more consistent with the data.

Section II presents the theoretical framework for the tests. Section III describes the data, while section IV discusses some issues concerning estimation. Section V presents the empirical results. Section VI discusses the results and suggests some possible explanations.

II. Theory

In this section, we present the two formulations of the Capital Asset Pricing Model. We very briefly review the traditional CAPM. We then discuss the consumption CAPM.

A. The Traditional CAPM

The traditional CAPM is a static model of portfolio allocation under uncertainty and risk aversion. As Brealey and Myers (1981), Fama (1976), and other textbooks show, the model relates the return R_i on asset i to the risk-free return R_F and the market return R_M . The rela-

tion is

$$ER_i = R_F + (ER_M - R_F)\beta_{Mi} \quad (1)$$

where E denotes the expectation operator, and

$$\beta_{Mi} = \text{cov}(R_i, R_M) / \text{var}(R_M). \quad (2)$$

The term β_{Mi} is a measure of the systematic risk of asset i .

To test the model, we write equation (1) as

$$R_i = a_0 + a_1\beta_{Mi} + u_i \quad (3)$$

where

$$a_0 = R_F,$$

$$a_1 = ER_M - R_F,$$

R_i = the realized return on asset i over our sample, and

u_i = the expectational error $R_i - ER_i$.

The model thus relates the return on asset i to its systematic risk β_{Mi} .

If the β_{Mi} for each stock were directly observable, we could run the regression (3) on a cross-section of stocks. The β_{Mi} , however, are not observable. In practice, we use the sample estimates. That is, for each stock i , we use the time series of returns R_{it} and R_{Mt} to estimate β_{Mi} . We then use the estimated β_{Mi} as the variable in equation (3). We discuss the problem of sampling error in β_{Mi} below.

B. The Consumption CAPM

Consider the optimization problem facing the representative consumer. Each period he chooses a level of consumption and an allocation of his portfolio among various assets. His goal is to maximize the following utility function:²

$$E_t \sum_{s=0}^{\infty} (1 + \rho)^{-s} U(C_{t+s}) \quad (4)$$

² This utility function, which is standard in the consumption CAPM literature, entails several assumptions. In particular, consumption of the good measured by C is additively separable from other goods, including durables and leisure. The utility function is also additively separable through time. Another possible problem with the utility function is that it assumes aggregation across consumers is permissible. Breeden (1979) and Grossman and Shiller (1982) show conditions under which this aggregation can be rigorously justified. In contrast, see Mankiw (forthcoming) for a model in which this aggregation is misleading.

where

E_t = expectation conditional on information available at time t ,

ρ = rate of subjective time preference,

C_{t+s} = consumption in period $t + s$,

U = one-period, strictly concave utility function.

The standard first-order condition is

$$E_t \left[\left(\frac{1 + R_{it}}{1 + \rho} \right) \left(\frac{U'(C_{t+1})}{U'(C_t)} \right) \right] = 1, \quad (5)$$

or

$$E_t [(1 + R_{it})S_t] = 1, \quad (6)$$

where R_{it} is the return on asset i and $S_t = U'(C_{t+1}) / (U'(C_t)(1 + \rho))$ is the marginal rate of substitution.

From (6), we wish to derive a relation between an asset's expected return and its covariance with consumption. First note that equation (6) also holds in unconditional expectation by the law of iterated projections. Then rewrite (6) as

$$E[1 + R_{it}] = [ES_t]^{-1} (1 - \text{cov}(R_{it}, S_t)) \quad (7)$$

where E denotes the unconditional expectation and cov denotes the unconditional covariance.

We assume the consumer's one-period utility function $U(\cdot)$ has constant relative risk aversion. That is,

$$U(C) = C^{1-A} / 1 - A \quad (8)$$

where A is the Arrow-Pratt measure of relative risk aversion. With this utility function, we can approximate the covariance in (7) as³

$$\text{cov}(R_{it}, S_t) \cong \left[-A / (1 + \rho) \right] \times \text{cov}(R_{it}, C_{t+1} / C_t). \quad (9)$$

We can now derive the consumption-beta relation. We combine the relation (7) with the approximation (9) to obtain the following equation, which parallels equation (3) in the previous section:

$$R_i = a_0 + a_2\beta_{Ci} + u_i \quad (10)$$

³ This approximation is exact in continuous time if consumption and stock prices follow diffusion processes. This approximation is also accurate over quarterly intervals, since C_{t+1}/C_t is highly correlated with $(C_{t+1}/C_t)^{-A}$. For A as high as four, for example, this correlation exceeds 0.99.

where

R_i = the realized return on asset i over our sample,

$$a_0 = [ES_i]^{-1} - 1,$$

$$a_2 = A \text{cov}(R_{M_t}, C_{t+1}/C_t) / [(1 + \rho)ES_i],$$

and

$$\beta_{C_i} = \text{cov}(R_{i,t}, C_{t+1}/C_t) / \text{cov}(R_{M_t}, C_{t+1}/C_t). \quad (11)$$

As in the traditional CAPM, the model thus relates the return on asset i to its systematic risk β_{C_i} . The measure of an asset's systematic risk, however, is its covariance with consumption growth C_{t+1}/C_t . We have normalized the β_{C_i} 's so that the β_{C_i} for the stock market is one.

We can easily nest the traditional CAPM and the consumption CAPM in one equation. In particular, we can regress the return on asset i on its market beta and its consumption beta to see which measure of risk is a better explanator of return. That is, we estimate

$$R_i = a_0 + a_1\beta_{M_i} + a_2\beta_{C_i} + u_i. \quad (12)$$

This regression can shed light on the empirical usefulness of the consumption CAPM as compared to the traditional formulation.

In all of the possible regressions above—(3), (10), and (12)—the constant term a_0 has a natural interpretation. For an asset that earns a constant risk-free return, both betas are equal to zero. Therefore, each equation implies that this risk-free asset earns a return equal to the constant a_0 . (If there is no such asset, then a_0 is the unconditionally expected return on a zero-beta asset.) One way to judge the reasonableness of the results is to examine whether the estimated constant accords with other estimates of the risk-free return.

We can also easily interpret the coefficients on systematic risk (β_{M_i} and β_{C_i}). We have normalized these risk measures so the betas for the stock market index are one. Therefore, since the constant a_0 is the real risk-free return (R_F), each CAPM implies that the coefficient on the relevant beta is the spread between the market return and the risk-free return ($ER_M - R_F$). When we estimate equation (12), we can compare the coefficients a_1 and a_2 to gauge the relative success of the two CAPM formulations. The traditional CAPM implies $a_1 = ER_M - R_F$ and $a_2 = 0$, while

the consumption CAPM implies $a_1 = 0$ and $a_2 = ER_M - R_F$.

III. Data

The cross-section of stocks, which is from the CRSP tape, includes all those companies listed on the New York Stock Exchange continuously during our sample period; they number 464. We use quarterly data from 1959 to 1982 to calculate the return and covariances for each stock. The return is from the beginning of the quarter to the beginning of the following quarter.

The market return we use is the return (capital gain plus dividends) on the Standard and Poor composite. The consumption measure is real consumer expenditure per capita on non-durables and services during the first month of the quarter. We use the comparable consumer expenditure deflator to compute real returns for all the stocks and for the market index. The National Income Accounts data are seasonally adjusted.

The consumption CAPM strictly relates an asset's return between two points in time to consumption growth between the same two points in time. In practice, we observe average consumption over an interval. Thus, we are using measured consumption during the first month of the quarter to proxy consumption flow on the first day of the quarter. Since we examine quarterly returns, this approximation is probably accurate. That is, consumption growth between January (average) and April (average) is highly correlated with consumption growth between January 1 and April 1. The time-aggregation problem would, however, become more severe if we examined monthly returns.

Although data choices are always partly arbitrary, we can ensure that our results are somewhat robust by trying other comparable data. Although we do not report the results below, we have tried using annual rather than quarterly return data. The results were largely the same as those we report. We have also tried using alternative measures of consumption—in particular, expenditure on nondurables (i.e., not including services) and expenditure on food (an item that is most clearly nondurable). These alternative consumption measures produce results even less favorable to the consumption CAPM than those we report below.

IV. Estimation

There are at least two potential problems when estimating equations such as those we consider. The first issue concerns the assumption regarding the variance-covariance matrix of the residuals. The second issue involves the measurement of risk.

A. The Variance-Covariance Matrix

Previous studies that examine the relation between risk and return, such as Douglas (1969), Miller and Scholes (1972) Fama and MacBeth (1973), and Levy (1978), use ordinary least squares (OLS) to estimate equations such as (3). Although the coefficient estimates are consistent under very general assumptions, the estimates are efficient and the computed standard errors are correct only if the variance-covariance matrix of the residuals is spherical. That is, implicit in the OLS standard errors is the assumption that the returns of all stocks have the same own variance and do not covary together at all.

One simple improvement upon the use of ordinary least squares is to allow for heteroskedasticity across stocks. In particular, we can assume that the variance-covariance matrix is diagonal with elements proportional to γ_i , where γ_i is defined as $\text{var}(R_{it})/\text{var}(R_{Mt})$. This straightforward application of weighted least squares (WLS) is likely to produce more efficient estimates and more reliable standard errors than OLS.

This assumption regarding the variance-covariance matrix is not fully satisfactory because stock returns do covary. Finding a tractable alternative is difficult. We do not have enough data to estimate freely a 464 by 464 variance-covariance matrix.⁴ Some parameterization of the matrix is necessary if we are to estimate using generalized least squares (GLS). One simple parameterization is to assume a macroeconomic shock ν , which affects stock i with some factor k_i , and a stock-specific shock η_i , which is uncorrelated across stocks.⁵

⁴ This problem is inherent in many tests of the CAPM. Gibbons (1982), for example, freely estimates such a variance-covariance matrix by substantially restricting the number of assets he considers.

⁵ Our cross-section tests should not be confused with time-series, factor-analytic approaches to asset pricing. We are assuming here a one-factor model of returns. It is important to note, however, that neither the validity of the underlying

That is,

$$u_i = k_i \nu + \eta_i \tag{13}$$

where $\text{cov}(\eta_i, \eta_j) = 0$ if $i \neq j$ and $\text{cov}(\nu, \eta_i) = 0$. Under this assumption, we can show that $k_i = \beta_{Mi}$ and that $Eu_i u_j$ is proportional to γ_i if $i = j$ and to $\beta_{Mi} \beta_{Mj}$ if $i \neq j$.⁶ In section V below, we compare the results using ordinary least squares and weighted least squares to those using generalized least squares with this parameterization of the variance-covariance matrix.⁷

The estimates under alternative assumptions regarding the variance-covariance matrix provide a test of model specification. Under the null hypothesis that the model is correctly specified, OLS, WLS, and GLS produce consistent estimates. If the model is misspecified, however, then the estimates generally have different probability limits. Following the reasoning of Hausman (1978) and White (1980), if the estimates differ substantially, then we conclude the model is misspecified.⁸

B. Measurement of Risk

The second issue concerns the estimates of the risk measures β_{Mi} and β_{Ci} . The simplest approach is to use the sample estimates. Implicit in this approach is the assumption that the sample covariances are good measures of the covariances of the subjective distribution of the representative

theory nor the consistency of the estimates depends on this one-factor model. For purposes of statistical efficiency and inference, this parameterization appears better than the zero-factor model assumed by others.

⁶ This result is demonstrated by noting that, since the return on the market portfolio is a weighted average of individual stock returns, the (demeaned) market return is a weighted average of the u_i . Since each stock is a small part of the market portfolio, the η_i average to zero. Without loss of generality, we can now normalize the k_i so that the (demeaned) market return is ν .

⁷ Inversion of this 464 by 464 matrix may at first seem computationally difficult. This matrix, however, can be written as $D + VV'$, where D is a diagonal matrix and V is a vector. Its inverse is $D^{-1} - D^{-1}VV'D^{-1}/(1 + V'D^{-1}V)$. See Rao (1973, p.33).

⁸ The formal test statistic is

$$(a_{OLS} - a_{GLS})'(V(a_{OLS}) - V(a_{GLS}))^{-1}(a_{OLS} - a_{GLS}).$$

For this test, $V(a_{OLS})$ is calculated taking into account the structure on the variance-covariance matrix of the residuals given in (15). This test statistic is distributed as chi-squared with degrees of freedom equal to the dimension of a . Because our GLS transform probably does not lead to fully efficient estimates, this statistic is only suggestive.

investor. This assumption appears a useful starting point for exploring the consistency of the data with the two models.

One possible source of measurement error would seem to be the error in measuring aggregate consumption. Measurement error in consumption, however, need not lead to measurement error in the consumption betas. In particular, β_{Ci} in equation (11) is the ratio of covariances; if the error in measuring consumption growth is uncorrelated with the asset returns, the covariances are estimated consistently. Thus, the fact that the consumption data suffer from errors-in-variables does not preclude consistent estimation of the consumption betas.

Another potential errors-in-variables problem is that the estimates of both betas include sampling error. To examine whether our results are attributable to this sort of measurement error, we follow an instrumental variables (IV) procedure. We divide the sample of T observations per stock into the $T/2$ odd quarters and the $T/2$ even quarters. For each subsample, we compute the two betas. We then regress the odd quarter return on the odd quarter beta using the even quarter beta as an instrumental variable. Alternatively, we can reverse the procedure. The sampling error in the odd sample is uncorrelated with the sampling error in the even sample if stock returns and consumption changes are serially independent, an assumption approximately consistent with the data (Fama (1976), Hall (1978)). This procedure can thus produce consistent estimates despite sampling error in the betas. Below we compare the results using this instrumental variable procedure to those using the sample estimates of the betas without instrumenting.⁹

V. Results

For each of our 464 stocks, we compute its mean return over our sample and the two risk measures: its market beta (β_{Mi}) and its consumption beta (β_{Ci}). We also compute its normalized own variance of return (γ_i). Table 1 contains some sample statistics. Note that all the various risk

⁹ Consistency of the OLS, WLS, and GLS estimates requires the number of time observations to approach infinity. (This is the same condition that Hansen and Singleton (1983) require for consistency.) The IV procedure is asymptotically valid with fixed number of time observations as long as the number of cross-section observations approaches infinity.

TABLE 1.—SAMPLE STATISTICS

	R_i	β_{Mi}	β_{Ci}	γ_i
Mean	7.53	1.20	1.01	5.50
Median	7.12	1.14	0.91	4.34
Standard Deviation	4.78	0.38	0.70	3.91
Correlation with:				
R_i	1.00			
β_{Mi}	0.47	1.00		
β_{Ci}	0.27	0.58	1.00	
γ_i	0.55	0.74	0.42	1.00

Note:

R_i = Average return (percentage at annual rate)
 β_{Mi} = Market beta
 β_{Ci} = Consumption beta
 γ_i = Own variance (normalized by the variance of the return on the stock market index).

measures are positively correlated. That is, stocks that are risky according to one concept of risk tend to be risky according to the other concepts as well. The risk measures are not, however, very highly correlated. Thus, we expect to be able to discern the empirical usefulness of the alternative measures.

A. Do High Market Beta Stocks Earn Higher Returns?

A primary implication of any version of the CAPM is that assets with high systematic risk earn high average return. We therefore begin our exploration of the cross-section by examining whether this positive association holds true. The regressions in table 2 demonstrate that the traditional CAPM passes this first test.¹⁰ Under all estimation procedures, there is a positive relation between a stock's return and its market beta. The estimated constant, which should be the risk-free return, is always insignificantly different from one or from zero.¹¹ The slope coefficient, which should be the spread between the market return and the risk-free return, is always positive, significant, and of reasonable size. These results are thus broadly consistent with the theory.

¹⁰ All the coefficients and standard errors have been multiplied by 400 and can therefore be interpreted as annual percentages.

¹¹ Fama (1975) reports an annual risk-free real return of about 1% for the period between 1953 and 1971. Mehra and Prescott (1985) report a real risk-free return of 0.75% for the period between 1889 and 1978. These estimates are based upon examination of the returns on Treasury bills and other assets with little risk and are not based upon a particular asset pricing model.

TABLE 2.—DO HIGH MARKET BETA STOCKS EARN HIGHER RETURNS?
(DEPENDENT VARIABLE: R_t)

Estimation	(1a) OLS	(1b) WLS	(1c) GLS	(1e) GLS-IV	(1f) GLS-IV
Subsample of variable				ODD	EVEN
Subsample of instrument				EVEN	ODD
Constant	0.35 (0.66)	-0.38 (0.58)	-0.72 (0.56)	-0.01 (1.10)	0.94 (1.50)
Market beta	5.97 (0.52)	6.12 (0.53)	6.27 (2.19)	12.32 (1.38)	7.57 (2.16)
S.e.e.	4.23	3.47			
R^2	0.22	0.22			

Note: Standard errors are in parentheses.
OLS = Ordinary Least Squares
WLS = Weighted Least Squares
GLS = Generalized Least Squares
IV = Instrumental Variables Estimation.

B. Do High Consumption Beta Stocks Earn Higher Returns?

We next examine the empirical relation between return and consumption beta. In table 3, we report results analogous to those in table 2 for the consumption-based model. The results here are less supportive of the theory. When we estimate using GLS, the coefficient on the consumption beta is insignificant. When we use OLS or WLS, the constant term in the regressions in table 3 is higher than the theory suggests it would be. Remember that the constant a_0 is the implied risk-free return. Regression (2b) implies a high risk-free real return of 4%. When we estimate using our instrumental variables procedure, the consumption beta has a negative sign, although with a very large standard error.¹² Unlike the results for the traditional CAPM, the results here provide no support for the theory.

The formal specification test rejects both formulations of the CAPM at very high levels of significance (< 0.001). This finding means that the coefficient estimates change “too much” under the alternative assumptions regarding the variance-covariance matrix. The point estimates for the regressions in table 2, however, appear far more stable than those for the regressions in table 3. That is, the estimates using the market beta appear less sensitive to the variance-covariance ma-

¹² The wide variation in the IV estimates for the two subsamples may be due to the special character of stock returns in January. (See Tinic and West (1984).)

TABLE 3.—DO HIGH CONSUMPTION BETA STOCKS EARN HIGHER RETURNS?
(DEPENDENT VARIABLE: R_t)

Estimation	(2a) OLS	(2b) WLS	(2c) GLS	(2e) GLS-IV	(2f) GLS-IV
Subsample of variable				ODD	EVEN
Subsample of instrument				EVEN	ODD
Constant	5.66 (0.37)	4.43 (0.32)	-0.31 (0.55)	-7.77 (4.69)	-3.10 (7.08)
Consumption beta	1.85 (0.31)	1.87 (0.32)	0.36 (0.34)	-51.17 (44.07)	-19.80 (16.03)
S.e.e.	4.60	3.80			
R^2	0.07	0.07			

Note: Standard errors are in parentheses.

trix than do the estimates using the consumption beta. Although both models are formally rejected, this observation suggests that the traditional CAPM is more consistent with the data than is the consumption CAPM.

C. Which Beta Is More Related to Returns?

The regressions in table 4 include the consumption beta and the market beta together. The results do not at all support the consumption CAPM. The coefficient on the market beta is always far larger and far more significant than is the coefficient on the consumption beta. Many of our estimation strategies, in fact, produce a negative coefficient on the consumption beta. The market rewards systematic risk with higher return, but the relevant measure of systematic risk appears to be the market beta rather than the consumption beta.

TABLE 4.—WHICH BETA IS MORE RELATED TO RETURNS?
(DEPENDENT VARIABLE: R_t)

Estimation	(3a) OLS	(3b) WLS	(3c) GLS	(3e) GLS-IV	(3f) GLS-IV
Subsample of variable				ODD	EVEN
Subsample of instrument				EVEN	ODD
Constant	0.35 (0.66)	-0.37 (0.58)	-0.67 (0.57)	2.08 (5.39)	-9.44 (10.07)
Market beta	5.97 (0.64)	6.05 (0.63)	6.05 (2.22)	24.14 (11.78)	11.49 (8.35)
Consumption beta	-0.01 (0.34)	0.07 (0.34)	0.21 (0.34)	-56.09 (48.58)	-22.65 (18.83)
S.e.e.	4.23	3.47			
R^2	0.22	0.22			

Note: Standard errors are in parentheses.

VI. Conclusion

The data we examine in the paper provide no support for the consumption CAPM as compared to the traditional formulation. A stock's market beta contains much more information on its return than does its consumption beta. Since the consumption CAPM appears preferable on theoretical grounds, the empirical superiority of the traditional CAPM is a conundrum. As in all empirical research, however, we examine a joint hypothesis; the apparent rejection of the consumption CAPM is potentially attributable to failure of the one of the many auxiliary assumptions.

Our results are predicated on the existence of a stable utility function for the representative consumer. As Garber and King (1983) point out, this assumption is often critical for identification in Euler equation estimation. The same is true here. The consumption CAPM may perform poorly because shocks to preferences are an important determinant of consumer spending. Indeed, Hall (1984) argues that such taste shocks may be a central driving force of the business cycle.

Even if the utility function of the representative consumer is stable, our results may be attributable to a misspecification of that utility function. The utility function may not be additively separable among nondurables, durables and leisure, as we implicitly assume.¹³ Alternatively, adjustment costs in consumption may be important, or the goods called nondurable may be in fact largely durable.

It is possible that the consumption CAPM performs poorly because many consumers do not actively take part in the stock market. For whatever reason—transaction costs, ignorance, general distrust of corporations, or liquidity constraints—many individuals hold no stock at all.¹⁴ For these individuals, the first order condition relating consumption to stock returns is not likely to hold. Furthermore, if the consumption of these consumers constitutes a large fraction of total consumer expenditure, it is less reasonable to expect the first order condition to hold with aggregate data. In other words, it seems possible that the consumption CAPM holds for the minority of

consumers that hold stock and that our stock market index is a better proxy for the consumption of this minority than is aggregate consumption.

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¹¹ **Short-Term Interest Rates as Predictors of Inflation**

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