THE EMPIRICAL RELATIONSHIP BETWEEN AGGREGATE CONSUMPTION and SECURITY PRICES in AUSTRALIA

by

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March 1995

WORKING PAPER NO. 52

Not for quotation
Comments welcome.

ABSTRACT

Previous evidence on the consumption based CAPM (CCAPM) is predominantly US-based and no prior work in Australia has been published. This paper provides such an empirical examination using monthly and quarterly Australian equity return and consumption data. Multivariate tests of the CCAPM using actual quarterly consumption data indicate good support for the CCAPM. Positive and statistically significant (albeit small) estimates of the market price of consumption beta risk are found. In a second phase of tests, four versions of the maximum correlation portfolio (MCP) are used to proxy the consumption variable using monthly data. Generally, the results of these tests are very mixed, and their interpretation is further confused by the recognition of several joint test aspects of the analysis. Finally, for non-nested tests of the CCAPM versus the CAPM, the evidence favours the traditional CAPM using quarterly data, but is inconclusive using monthly data.

ACKNOWLEDGMENT

The author wishes to thank seminar participants at the University of Queensland, the University of Technology, Sydney and the Royal Melbourne Institute of Technology and participants at the Sixth Annual Northern Finance Association Conference and the first Annual Asia-Pacific Finance Association Conference. The author is also grateful for comments from Richard Heaney and for the financial assistance provided by a Monash University Research Fund Grant.

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1. Introduction

A fundamental concern in modern finance theory is how the equilibrium prices of capital assets are determined. Since the mid-1960s the capital asset pricing model (CAPM) has been the accepted paradigm. However, in recent years, for various reasons the CAPM has been placed under intense scrutiny, particularly in the US. This has led to the development and testing of various alternative asset pricing specifications, such as the arbitrage pricing theory (APT).[1] While the APT has received widespread examination with mixed results, little attention has been devoted to other promising models.

One such model which has had limited examination in the US, but has been ignored in Australia, is the Consumption-based CAPM (CCAPM). The CCAPM is closely linked to the intertemporal version of the CAPM in which the key assumption of a single-period model is relaxed. Instead a multi-period framework is assumed in which the representative investor/individual is concerned with maximising expected utility of life-time consumption.

Merton (1973) suggested that in an intertemporal setting investors would be concerned about uncertainties in the investment opportunity set. Hence, in equilibrium they require compensation in the form of expected return, for (1) systematic market risk and (2) risk of unfavourable shifts in investment opportunities. Only if the investment opportunities are constant through time, that is, there is no associated uncertainty, will the standard CAPM be valid. The identification of a sufficient set of state variables which represent the investment opportunity set is essentially an empirical concern. In addition to providing risk reduction from diversification, securities in this framework can be used to hedge against other sources of

[1] Tests of the APT using Australian data include Faff (1988), Faff (1992) and Faff (1993).

uncertainty. This leads to a multifactor intertemporal CAPM (ICAPM), the number of factors being equal to the number of sources of uncertainty that investors can hedge against and are prepared to pay for.[2]

A drawback with the ICAPM has been the lack of theoretical guidance as to the identity of the major sources of uncertainty which investors face. Fortunately, it has been shown that under certain conditions the ICAPM simplifies into a single factor model. The single factor is aggregate real consumption (see Breeden (1979)),[3] which produces the CCAPM. Like the standard CAPM, it postulates a positive linear relationship between expected return and systematic (beta) risk. Indeed, the only difference is that in the standard CAPM investors are concerned with *market* beta risk whereas in the CCAPM they are concerned with *consumption* beta risk.

The intuition underlying the CCAPM is elegantly explained by Schipper and Thompson (1981, p.309) as follows

> "Individuals select their optimum investment portfolios and consumption levels such that at each moment in time their marginal utilities of consumption are equal to their indirect marginal utilities of wealth. In the absence of state-of-the-world considerations, increases in wealth (i.e., returns on the market portfolio) translate into changes in the level of consumption through the optimality conditions. At any instant in time individuals adjust their rates of consumption in response to changes in the level of their wealth. They could express their demand preferences for a given security either in terms of the security's covariance with the changes in their wealth or in terms of the security's covariance with changes in their consumption. Given that the investor taste for wealth (i.e., marginal utility of wealth) is influenced by other elements in the state of the world, changes in these elements also induce changes in consumption through the optimality conditions. At any instant in time, the covariance of a security's return with the market and all relevant state variables is summarized by the covariance of a security's return with consumption, so that for purposes of security pricing, changes in consumption summarize the changes in both wealth and the state of the world."

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[2] For example, see Shanken (1990) for a recent test of an ICAPM in which changes in interest rates is the sole variable used to represent uncertainties in the investment opportunity set.

[3] See Cornell (1981) for criticism of this approach. Specifically, he argues that conditional consumption betas will be stochastic because they are functions of random state variables. Consumption beta instability will potentially weaken the interpretation of empirical tests of the CCAPM, to the extent that they are based on conditional co-moments of asset returns and consumption growth. As Breeden et al (1989, p.234) point out, since their approach tests restrictions on the unconditional co-moments, it avoids the Cornell (1981) criticism. See also Grossman and Shiller (1982, p.209) who make this point in a more general context.

Many studies have been conducted testing the CCAPM. These include Breeden, Gibbons and Litzenberger (1989), Ferson and Harvey (1992), Grossman, Melino and Shiller (1987), Mankiw and Shapiro (1986), Sauer and Murphy (1992) and Schipper and Thompson (1981). In general the results have been mixed. While the CCAPM is often rejected, in many cases it would not appear to be more strongly rejected than the traditional CAPM.[4] Indeed such comparisons have only been indirect and hence deserve cautious interpretation. The "good news" according to Fama (1991) is that, at least in univariate tests, the predictions of these single factor models are supported. That is, there is a positive linear relationship between consumption (or market) beta and expected return. Furthermore, Fama (1991, p. 1599) suggests it is also " . . . their powerful intuitive appeal, [that] keeps them alive and well."

Breeden, Gibbons and Litzenberger (1989) have tested the CCAPM by applying a multivariate testing approach to US data and they found some support for the model. Specifically, their results reveal an estimated market price for consumption risk which is significantly positive as predicted by the model. However, in an indirect comparison between the standard CAPM and the CCAPM the authors conclude that the models' performance is very similar.

The primary aim of this study is to examine the CCAPM using Australian equity data, employing and extending the framework used by Breeden et al (1989). The CCAPM remains untested in Australia. This study will therefore extend the accumulated international evidence on the CCAPM.[5]

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[4] For a useful summary of the prior research and evidence on the CCAPM see Fama (1991, p.1595-1598).

[5] For example, tests of the CCAPM have previously been conducted in Japan (Hamori (1992)) and Germany (Sauer and Murphy (1992)) and a test of the ICAPM in Spain (Rubio (1989)).

The Australian market provides an interesting environment for testing the CCAPM.[6] Despite the fact that the Australian economy is small with a relatively small capital market, it has traditionally been highly ranked according to many economic indicators in the world's developed economies. Moreover, in terms of real consumption per capita, it has traditionally held a prominent position in the OECD group of countries and also is one of the leading economies in the southern hemisphere.

The remainder of this paper is structured as follows. In the following section the basic empirical framework used in this paper is outlined, while section 3 describes the data. Section 4 presents and discusses the results and finally in section 5 a summary is provided and conclusions drawn.

2. Empirical Framework

A synthesis of the CCAPM theory is provided in Breeden et al (1989 pp.232), and hence is not repeated here. Instead its important elements will be selectively presented in a way which clarifies the key empirical issues.

The basic empirical framework used follows Breeden et al (1989). However, their approach is extended in two important directions. First, the analysis in Breeden et al (1989) considered only the zero-beta versions of the asset pricing models. In the current paper risk-free versions are also considered. Second, while Breeden et al (1989) tested both the CCAPM and the CAPM and made some general informal comparisons between them, a direct statistical test comparing the CCAPM and the CAPM was not performed. This was justified by the authors on the grounds that the models are non-nested alternatives, and hence formal statistical

[6] Several distinguishing features of the Australian market, relative to the US market are discussed in Brailsford and Faff (1993). These features include the small size of the market; the relative dominance of the largest stocks; the important role of resource sector stocks; the degree of regulation; and the dominance of institutional investors.

comparisons are difficult. However, while such tests might be difficult they are not impossible to perform. In this paper, the non-nested testing approach developed by Davidson and MacKinnon (1981) is utilised.

2.1 Tests Based on Consumption Data

Traditionally, most tests of the standard CAPM revolve around the market model equation. In the case of the CCAPM there is an analogous "consumption model" equation which is assumed to adequately describe how real returns (R_{it}) are generated in terms of the growth in per capita real aggregate consumption, C_t.[7] Specifically,

$$R_{it} = \alpha_{ci} + \beta_{ci} C_t + e_{it} \qquad \ldots (1)$$

where α_{ci} is a regression constant;

β_{ci} is the consumption beta for asset i; and

e_{it} is a mean zero error term.

The zero-beta CCAPM itself is given by:

$$E(R_i) = \gamma_0 + \gamma_1 \beta_{ci} \qquad \ldots (2)$$

where $E(R_i)$ is the expected real return for asset i, and

γ_0, γ_1 are pricing coefficients.

[7] It is important to recognise that in the context of the CCAPM we measure *real* growth in consumption *per capita*. Intuitively, investors ultimately are concerned with their ability to consume quantities of goods and services, which will be captured by a real measure. Furthermore, the model should be free of growth in population effects that might unnecessarily distort a consumption growth measure. Hence, the use of the per capita measure.

Following Breeden et al (1989, p.250), a test of the CCAPM is simplified if the consumption growth series are mean-adjusted. As a result taking expectations of the "consumption model" in (1) gives:

$$E(R_i) = \alpha_{ci} \qquad \ldots (3)$$

Consequently, by combining expressions (2) and (3), we find that the CCAPM implies the following theoretical restriction on (1), viz:

$$H_0 : \alpha_{ci} = \gamma_0 + \gamma_1 \beta_{ci} \qquad \ldots (4)$$

where γ_0 is the expected return on the zero-beta portfolio

γ_1 is the market price of consumption beta risk

This hypothesis represents a test of the CCAPM using consumption data. This can be performed using the multivariate testing approach developed by Gibbons (1982) based on a likelihood ratio test (LRT). A system of equations given by expression (1) is estimated in an unrestricted form and this is statistically compared to the restricted estimation with (4) imposed. Specifically, the statistic is given by:

$$LRT = (T - 1.5 - N/2)[\ln(\det(\hat{\Sigma}_r)) - \ln(\det(\hat{\Sigma}_u))] \qquad \ldots (5)$$

where T is the number of time-series observations.

N is the number of equations estimated in the system.

$\det(\hat{\Sigma}_r)$ is the determinant of the contemporaneous variance - covariance matrix estimated from the residuals of the restricted system.

$\det(\hat{\Sigma}_u)$ is the determinant of the contemporaneous variance - covariance matrix estimated from the residuals of the unrestricted system.

Under the null, the LRT statistic is distributed as a chi-square with (N - 2) degrees of freedom. Note that this statistic is a modified version of the original statistic suggested by Gibbons (1982). Specifically, it incorporates a small-sample correction factor (Bartlett (1938)), as suggested by Jobson and Korkie (1982).

2.2 Tests Based on the Maximum Correlation Portfolio (MCP)

A further multivariate test which can be performed is that suggested by Gibbons (1982) in the context of the zero-beta CAPM. Specifically, a test of mean-variance efficiency of the index chosen to proxy for the market gives rise to the imposition of a non-linear restriction on the market model viz:

$$R_{it} = \alpha_{pi} + \beta_{pi} R_{pt} + u_{it} \qquad \ldots (6)$$

If the zero-beta CAPM (or CCAPM) holds (that is, portfolio p is mean-variance efficient), then the following null hypothesis can be identified:

$$H_0 : \alpha_{pi} = \gamma(1 - \beta_{pi}) \qquad \ldots (7)$$

While this is readily testable in the standard CAPM, the absence of a market-based proxy for R_{pt} in the CCAPM context is a major difficulty.

Breeden, Gibbons and Litzenberger (1989) overcame this difficulty by suggesting that the CCAPM can be tested by using a market returns-based proxy for the consumption growth variable. Specifically, the consumption growth variable is proxied by the real returns on a portfolio of assets which has maximum correlation with the growth in real aggregate consumption. The portfolio is thus described as the maximum correlation portfolio (MCP). Following Breeden et al (1989, p.241), the beta of an asset measured relative to the MCP is proportional to its true consumption beta. Hence, the return on the MCP can be used to proxy for R_{pt} in a CCAPM version of expression (6). The non-linear restriction given by (7) can then be tested in the context of the CCAPM in the usual manner.

A major advantage of the concept of the MCP is that it provides a means of overcoming the empirical constraint imposed by the infrequent reporting of aggregate consumption information. In Australia, consumption data are reported only on a quarterly basis. This means that any empirical analysis based on consumption data will have to make strong stability assumptions in order to have sufficient data to provide meaningful statistical tests. However, the returns on the MCP proxy can be formed using the (monthly) measurement interval available for share market data. Consequently, tests of the CCAPM employing the MCP can be conducted with monthly data even though monthly consumption data do not exist.

In the case of both the CAPM and the CCAPM, the restrictions given by expression (7) can be tested using the LRT statistic. A system of equations given by expression (6) is estimated in unrestricted form. This is statistically compared to the estimation of its restricted counterpart, namely, the system of (6) with restriction (7) imposed.[8] The resulting LRT statistic is of the form given in expression (5) and is small-sample adjusted as before. Under the null, the LRT statistic is distributed as a chi-square with (N-1) degrees of freedom.

2.3 Testing the Risk-Free CCAPM and CAPM

The previous section outlined tests of mean-variance efficiency based on zero-beta versions of the CCAPM and the CAPM. Similar tests can be formulated in the context of their risk-free

[8] In contrast to Gibbons (1982), the non-linear restriction is tested directly rather than as a linearised approximation obtained from a Taylor-series expansion.

counterparts. These tests, while not conducted by Breeden et al, are pursued here. In this context, the empirical framework is specified in terms of an excess returns market model viz:

$$r_{it} = \alpha_{\rho i} + \beta_{\rho i} r_{\rho t} + \upsilon_{it} \qquad \ldots (8)$$

where r_{it} is the real return on asset i in excess of the real risk-free rate.

$r_{\rho t}$ is the real return on a chosen benchmark portfolio in excess of the real risk-free rate.

If the risk-free CAPM (or CCAPM) holds (that is, portfolio ρ is mean-variance efficient), then the following null hypothesis can be identified:

$$H_0 : \alpha_{\rho i} = 0 \qquad \ldots (9)$$

In order to perform this test for the CCAPM, the MCP approach is again utilised. Moreover, likelihood ratio tests, similar to those described in Section 2.2, are used to test the risk-free versions of the two models.

2.4 Testing the CCAPM Versus the CAPM

The situation of non-nested models is an increasingly common phenomenon in the asset pricing literature. A plethora of asset pricing models have been developed on the basis of widely varying assumptions and it is therefore not surprising to observe specifications which cannot be articulated by the imposition of some simple parametric restriction. An established econometric framework now exists to handle the difficulties created by non-nested hypotheses and these techniques have been successfully applied in other similar situations. [See for example, Chen (1983), Faff (1988), Faff (1992) and Faff (1993).]

Following the approach adopted in these papers, one such non-nested test, the "C test", is applied in this paper. [See Davidson and MacKinnon (1981).] The approach centres on an artificial regression which includes model predictions from the two non-nested alternatives of interest. For example, in the situation where the risk-free versions of the CAPM and CCAPM are being tested against each other, the artificial regression becomes:

$$r_{it} = \alpha_i \cdot \hat{r}_{it,\,CCAPM} + (1 - \alpha_i) \cdot \hat{r}_{it,\,CAPM} + \text{error} , \qquad \ldots (10)$$

where the independent variables are defined as:

$\hat{r}_{it,\,CCAPM}$ = the excess return for cross-section i in the period t, predicted by an excess returns MCP market model with the implied CCAPM restrictions imposed; and,

$\hat{r}_{it,\,CAPM}$ = the excess return for cross-section i in the period t, predicted by an excess returns market model with the implied CAPM restrictions imposed.

The null hypotheses which favour the CCAPM over the CAPM are:

$$H_0 : \alpha_i = 1, \; i = 1, 2, \ldots, 23. \qquad \ldots (11)$$

Alternatively, the null hypotheses which favour the CAPM over the CCAPM are:

$$H_0 : \alpha_i = 0, \; i = 1, 2, \ldots, 23. \qquad \ldots (12)$$

The tests are performed on the basis of individual t-statistics for each case.

3. Data

The data used in this study are of three basic types: (1) equity data sampled from transactions on the Australian Stock Exchange (ASX); (2) aggregate consumption data reported in the Australian National Accounts; and (3) Thirteen-Week Australian Treasury Note data which are used to proxy short-term, risk-free assets.

The equity data comprise discrete returns on twenty-three value-weighted industry portfolios supplied by the Centre for Research in Finance (CRIF) at the Australian Graduate School of Management. The time period examined covers the 19-year interval January 1974 to December 1992. Both monthly and quarterly sampling intervals are employed and various subperiods of the data are analysed. Furthermore, all equity data are adjusted by an inflation factor to produce a time-series of real percentage returns. Finally, the market index employed is the value-weighted index, supplied by CRIF.

The consumption data comprise discrete quarterly growth rates in real aggregate consumption per capita.[9] The consumption data, obtained from the Australian Bureau of Statistics, is total[10] private consumption expenditure measured on a seasonally adjusted basis.[11] The consumption growth rates are also mean-adjusted and scaled for the summation bias.[12]

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[9] Australian quarterly population estimates as reported by the Australian Bureau of Statistics are used to calculate the per capita numbers used in the analysis.

[10] In theory the CCAPM requires that expenditures on goods and services identified as consumption, are fully consumed in that period. Hence, the extent to which expenditures on non-durables affect the total expenditure on aggregate consumption is potentially a concern. Analysis using alternative measures of consumption did not materially affect the results and are not reported here.

[11] The choice between using seasonally adjusted and unadjusted consumption data is not obvious. The majority of papers testing the CCAPM have employed seasonally adjusted consumption numbers. As suggested by Breeden et al (1989) the smoothing effect of seasonal adjustment will be desirable to the extent to which this provides numbers closer to the underlying actual consumption. Furthermore, Ferson (1990, p.403) notes that seasonal adjustment may proxy for seasonal tastes or technology. Hence, the analysis is really a test of the joint hypothesis that the CCAPM holds and that the seasonal adjustment reflects the specification of investors' utility functions. (See Wheatley (1988, p.196))

[12] In theory the CCAPM requires a consumption growth figure based on observations of aggregate consumption at the beginning and at the end of a chosen measurement interval. Unfortunately, reported consumption numbers are for aggregate expenditures over a given period, and are not the required "spot" consumption figures. This gives rise to several problems, one of which is the "summation bias". Breeden et al (1989, pp.236-9, pp.250) show that consumption growth figures need to be scaled by a factor of 0.75 to counter the summation bias, and so achieve reasonable estimates of the desired "spot" CCAPM betas.

4. Results

Table 1 reports the time-series properties of the percentage changes in reported quarterly real per capita consumption. The mean consumption growth rate is relatively small over the nineteen-year period at approximately 0.38 percent per quarter. Over a similar time period (1968:1 to 1982:4) with US data, Breeden et al (1989, p.240) report a figure of approximately 0.51 percent per quarter. It is also apparent that consumption growth is quite smooth over time. Subperiod mean growth is not greatly divergent from the overall mean and the standard deviations of consumption are much lower than typically observed with share market data. Indeed, the standard deviation of quarterly Australian market index returns over the same nineteen-year period is 0.1129 compared to 0.0085 for consumption, reported in panel A of Table 1. This smoothness of consumption in part reflects measurement error and in part reflects consumers' gradual adjustment in consumption rates over time. Whatever the reason, smoothness in consumption presents a difficulty in any empirical work which tries to relate consumption information to much more responsive stock market data.[13]

A visual impression of the smoothness in the consumption data is displayed in Figure 1. This figure plots quarterly private final consumption expenditure in real $AUD billion over the sample period. A strong upward trend is readily apparent. As expected there are no signs of any undue volatility in consumption to coincide with known periods in which stock market volatility surged. For example, the crash of October 1987 does not seem to have had a great or immediate impact on the consumption levels experienced in the Australian economy around this period.

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[13] The issue of the smoothness of consumption has been investigated in related contexts by several other researchers. See, for example, Campbell and Deaton (1989), Christiano (1987), Flavin (1993) and West (1988).

TABLE 1: TIME SERIES PROPERTIES OF PERCENTAGE CHANGES IN QUARTERLY REAL PER CAPITA CONSUMPTION

Panel A

Time Period	T	$\bar{c}$[a]	$\widehat{SD}(c)$[b]
1974:1 to 1983:2	38	0.00368	0.00936
1983:3 to 1992:4	38	0.00385	0.00775
1974:1 to 1992:4	76	0.00377	0.00853

Panel B[c]

Time Period	$\hat{\rho}_1$	$\hat{\rho}_2$	$\hat{\rho}_3$	$\hat{\rho}_4$	$\hat{\rho}_8$	$\widehat{SD}$[d]	Q_{12}[e]	ρ - Value
1974:1 to 1983:2	-0.13	-0.26	-0.05	0.14	-0.14	0.16	13.98	0.302
1983:3 to 1992:4	0.01	-0.05	-0.02	-0.12	-0.12	0.16	6.12	0.910
1974:1 to 1992:4	-0.10	-0.17	-0.04	0.01	-0.12	0.11	10.50	0.573

[a] Sample mean of quarterly real per capita consumption.

[b] Sample standard deviation of quarterly real per capita consumption.

[c] This panel reports the sample autocorrelations for quarterly real per capita consumption.

[d] Sample standard errors for autocorrelations.

[e] Test statistic for the joint hypothesis that all correlations between lag 1 and lag 12 are zero.

In panel B of Table 1 the major autocorrelation characteristics of the quarterly consumption data are reported. For the overall period there is negative first order autocorrelation but it is statistically insignificant. Indeed there appears to be little statistical evidence of autocorrelation in the overall period or in either sub period.

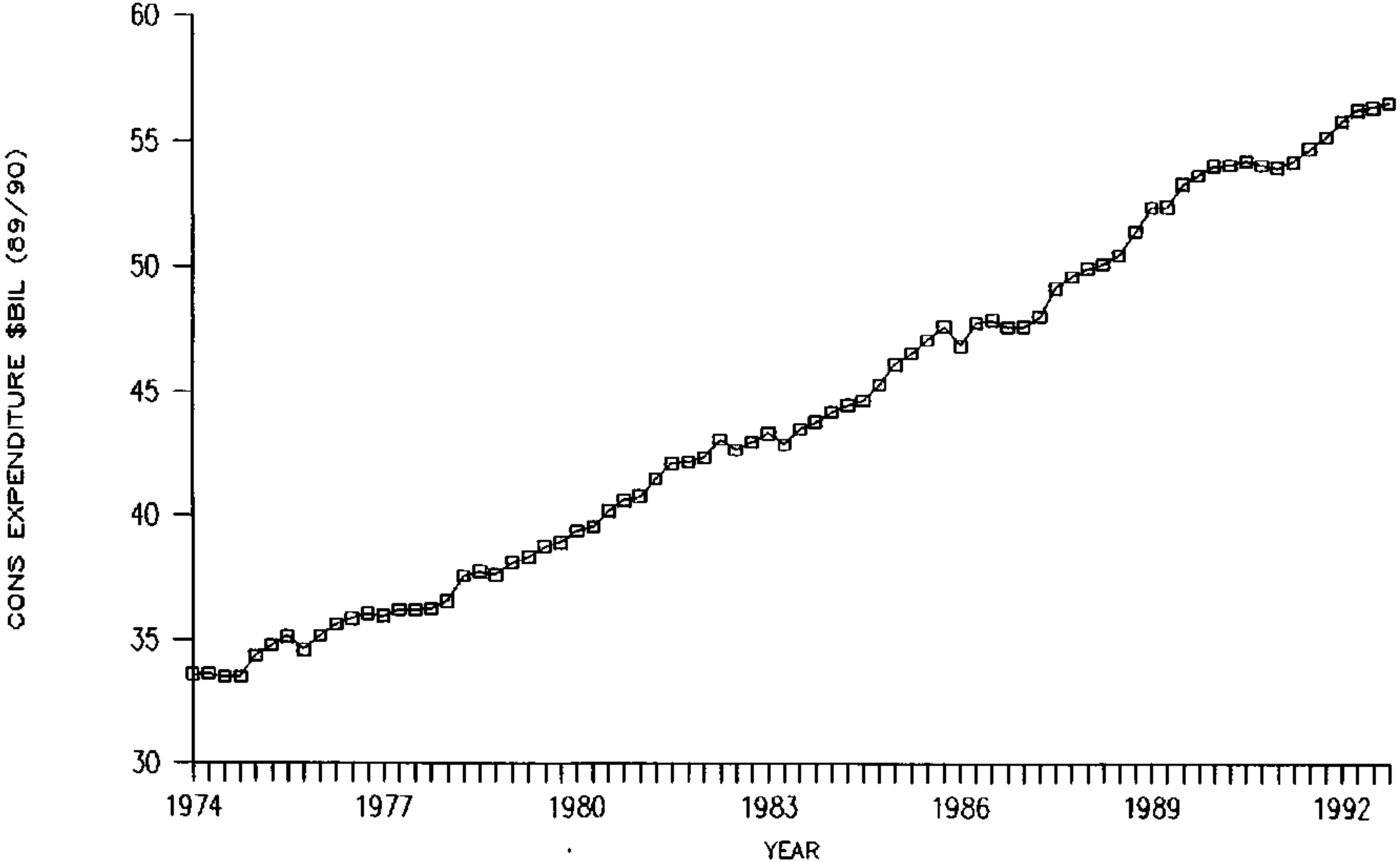

FIGURE 1: QUARTERLY PRIVATE FINAL CONSUMPTION EXPENDITURE: 1974 TO 1992

TABLE 2: MARKET VS CONSUMPTION BETAS 1974:2 TO 1992:4

Industry	Market Beta	Consumption Beta (Contemporaneous)	Consumption Beta (two-month lag)
1. Gold	1.316[a] (8.07)[b] $R^2 = 0.465$	0.423[a] (0.11)[b] $R^2 = 0.000$	5.019[a] (1.23)[b] $R^2 = 0.020$
2. Other Metals	1.081 (11.84) $R^2 = 0.652$	2.286 (0.84) $R^2 = 0.009$	4.511 (1.49) $R^2 = 0.029$
3. Solid Fuels	0.949 (7.87) $R^2 = 0.452$	2.657 (0.93) $R^2 = 0.010$	7.266* (2.64) $R^2 = 0.085$
4. Oil and Gas	1.449 (8.94) $R^2 = 0.516$	-2.684 (-0.65) $R^2 = 0.006$	4.556 (1.30) $R^2 = 0.022$
5. Diversified Resources	1.111 (12.91) $R^2 = 0.690$	5.222* (1.97) $R^2 = 0.049$	5.799* (2.34) $R^2 = 0.068$
6. Developers & Contractors	1.078 (13.50) $R^2 = 0.708$	1.763 (0.68) $R^2 = 0.006$	5.139* (2.34) $R^2 = 0.068$
7. Building Materials	0.983 (21.70) $R^2 = 0.863$	-0.105 (-0.05) $R^2 = 0.000$	3.653* (1.91) $R^2 = 0.046$
8. Alcohol & Tobacco	0.844 (8.78) $R^2 = 0.507$	0.508 (0.21) $R^2 = 0.001$	5.648* (2.38) $R^2 = 0.070$
9. Food & Household Goods	0.738 (10.65) $R^2 = 0.602$	0.374 (0.19) $R^2 = 0.001$	3.453* (1.91) $R^2 = 0.046$
10. Chemicals	0.819 (11.03) $R^2 = 0.619$	0.303 (0.14) $R^2 = 0.000$	3.503* (1.81) $R^2 = 0.042$
11. Engineering	0.816 (14.06) $R^2 = 0.725$	1.337 (0.69) $R^2 = 0.006$	3.269* (1.94) $R^2 = 0.048$
12. Paper & Packaging	0.728 (12.16) $R^2 = 0.664$	-0.041 (-0.02) $R^2 = 0.000$	2.047 (1.23) $R^2 = 0.020$
13. Retail	0.868 (12.43) $R^2 = 0.673$	2.205 (1.03) $R^2 = 0.014$	2.905 (1.52) $R^2 = 0.030$
14. Transport	1.038 (12.70) $R^2 = 0.683$	1.383 (0.54) $R^2 = 0.004$	5.303* (2.33) $R^2 = 0.067$
15. Media	1.012 (8.27) $R^2 = 0.477$	-1.489 (-0.50) $R^2 = 0.003$	2.903 (0.91) $R^2 = 0.011$
16. Banks	0.879 (10.20) $R^2 = 0.583$	2.302 (0.99) $R^2 = 0.013$	6.895* (3.54) $R^2 = 0.143$
17. Insurance	0.888 (7.85) $R^2 = 0.451$	0.848 (0.31) $R^2 = 0.001$	2.471 (0.92) $R^2 = 0.011$
18. Entrepreneurial Investors	1.412 (11.36) $R^2 = 0.632$	3.851 (1.07) $R^2 = 0.015$	5.382 (1.56) $R^2 = 0.032$
19. Investment & Financial Services	0.871 (15.86) $R^2 = 0.770$	2.962 (1.49) $R^2 = 0.029$	2.887 (1.62) $R^2 = 0.034$

20. Property Trusts	0.462 (7.83) $R^2 = 0.450$	0.129 (0.09) $R^2 = 0.000$	2.812* (2.25) $R^2 = 0.063$
21. Miscellaneous Services	0.780 (11.98) $R^2 = 0.657$	0.616 (0.31) $R^2 = 0.001$	3.709* (2.15) $R^2 = 0.058$
22. Miscellaneous Industrials	0.751 (12.35) $R^2 = 0.670$	1.794 (0.97) $R^2 = 0.012$	1.681 (0.97) $R^2 = 0.012$
23. Diversified Industrials	0.953 (16.92) $R^2 = 0.792$	1.147 (0.53) $R^2 = 0.004$	3.804* (1.93) $R^2 = 0.047$
Market Index	-- --	1.608 (0.79) $R^2 = 0.008$	4.340* (2.30) $R^2 = 0.066$

* Beta estimate is positively statistically significant at the (one-sided) 5 percent level. Note that all market betas are statistically significant.

a Beta estimate for a given industry portfolio.

b t-statistic for beta estimate.

Following Breeden et al (1989), all analysis was conducted using (ASX) industry-based portfolios, although the ASX classification does not coincide with the scheme they employed. Table 2 provides a comparison of industry beta estimates for the overall period. The expected pattern of market betas is revealed across industries. Generally, the resource-based industries produce market betas which are high (for example, $\beta_{Gold} = 1.316$) whereas, industrials produce market betas which are typically lower (for example, $\beta_{Retail} = 0.868$).

The middle column of beta estimates shown in Table 2 are the consumption betas measured on a contemporaneous basis. Looking through this list several notable (related) features emerge. First, there is a distinct lack of statistical significance in the estimates with only one industry (Diversified Resources) showing significance at the 5% level (critical value = 1.66 for one-sided test). Secondly, and not surprisingly, given the preceding observation, the R^2 of the contemporaneous "consumption model" regressions are very poor indeed. Finally, it is noted that for some industries negative (but insignificant) consumption betas are revealed. In sum, these results are very unflattering to the CCAPM.

Several researchers have previously recognised the difficulties in using macroeconomic data in combination with share market data.[14] One problem already noted is the smoothness of consumption data which is in stark contrast to the responsiveness of the share market data. Furthermore, there is the suggestion that given the inherent differences in the variables, (macroeconomic vs. capital market) it would be surprising to find any significant contemporaneous relationship between them. Indeed, given highly competitive capital markets in which information is rapidly impounded in prices, it would be expected that macro economic variables, such as aggregate consumption, are led by equity prices. For example, in a similar context, Poon and Taylor (1992) argued for the need to examine lead/lag relationships.[15] Consequently, a limited number of non-contemporaneous relationships have been examined in the current study, specifically, relationships between the consumption variable and lagged equity returns. Three possibilities were examined: a one-month lag, a two-month lag and a one-quarter (three-month) lag. The one-month case revealed stronger consumption beta estimates than the contemporaneous ones but still they were very weak. The two-month case revealed even stronger consumption beta estimates, while the one-quarter lag estimates were considerably less persuasive than the two-month case. The two-month lag estimates are reported in the last column of Table 2. There are several notable features of these "two-month lagged consumption beta" (hereafter, "adjusted consumption beta") estimates.

First, thirteen of the industries and the market index reveal statistically significant adjusted consumption beta estimates. However, this significance is still inferior to the market betas. Secondly, the R^2 are considerably higher than for the contemporaneous case, although they

[14] For example, see Chen, Roll and Ross (1986) and Poon and Taylor (1992).

[15] Poon and Taylor (1992) examined the relationship between various macroeconomic variables and market return data in the context of the APT. They detected no important relationships, although notably they examined "long term" lead and lag relationships.

are much lower than the case of market betas. Finally, while some of the adjusted consumption betas are statistically insignificant, none of the estimates are now negative.

Interestingly, US industry consumption betas estimated by Breeden et al ranged from 3.25 (Food and Tobacco) to 7.36 (Construction). This compares very favourably with the range of beta estimates reported for the Australian industries in Table 3, of 1.77 (Miscellaneous Industrials) through to 7.35 (Solid Fuels). However, in contrast, the US consumption betas have a far higher level of statistical significance as reflected by average t-statistics of about six across twelve industry groupings versus an average t-statistic of about two across 23 industries for the Australian data.

One very notable and highly influential feature of the sample period is the occurrence of the 1987 stock market crash in the fourth quarter of that year. Given the smoothness of the consumption series (ex ante and ex post) it would be expected that consumption beta estimates would be adversely affected by its inclusion. In contrast, given the uniformity of the (negative return) response across the stock market to the crash and given its magnitude, the exclusion of the crash would be expected to weaken market beta estimates.[16]

[16] There is also an issue here of beta instability which is beyond the scope of this paper.

TABLE 3: MARKET VS CONSUMPTION BETAS 1974:2 TO 1992:4 (1987:4 EXCLUDED)

Industry	Market Beta		Consumption Beta (two-month lag)	
1. Gold	1.316[a] (7.16)[b]	$R^2 = 0.409$	5.228[a] (1.30)[b]	$R^2 = 0.022$
2. Other Metals	1.125 (11.00)	$R^2 = 0.620$	4.635 (1.61)	$R^2 = 0.034$
3. Solid Fuels	1.009 (7.47)	$R^2 = 0.430$	7.348* (2.74)	$R^2 = 0.092$
4. Oil and Gas	1.513 (8.31)	$R^2 = 0.482$	4.674 (1.38)	$R^2 = 0.025$
5. Diversified Resources	1.177 (12.31)	$R^2 = 0.672$	5.888* (2.47)	$R^2 = 0.076$
6. Developers & Contractors	1.059 (11.77)	$R^2 = 0.652$	5.243* (2.57)	$R^2 = 0.082$
7. Building Materials	1.020 (20.34)	$R^2 = 0.848$	3.712* (1.99)	$R^2 = 0.051$
8. Alcohol & Tobacco	0.852 (7.86)	$R^2 = 0.455$	5.728* (2.49)	$R^2 = 0.077$
9. Food & Household Goods	0.697 (9.00)	$R^2 = 0.523$	3.529* (2.06)	$R^2 = 0.054$
10. Chemicals	0.862 (10.39)	$R^2 = 0.593$	3.571* (1.91)	$R^2 = 0.047$
11. Engineering	0.807 (12.33)	$R^2 = 0.673$	3.311* (2.00)	$R^2 = 0.051$
12. Paper & Packaging	0.759 (11.31)	$R^2 = 0.634$	2.117 (1.35)	$R^2 = 0.024$
13. Retail	0.840 (10.71)	$R^2 = 0.608$	2.979 (1.63)	$R^2 = 0.035$
14. Transport	1.061 (11.53)	$R^2 = 0.642$	5.410* (2.55)	$R^2 = 0.081$
15. Media	1.033 (7.49)	$R^2 = 0.431$	2.982 (0.95)	$R^2 = 0.012$
16. Banks	0.930 (9.70)	$R^2 = 0.560$	6.937* (3.60)	$R^2 = 0.149$
17. Insurance	0.884 (6.93)	$R^2 = 0.393$	2.517 (0.94)	$R^2 = 0.012$
18. Entrepreneurial Investors	1.336 (9.62)	$R^2 = 0.556$	5.544* (1.73)	$R^2 = 0.039$
19. Investment & Financial Services	0.798 (13.52)	$R^2 = 0.712$	2.967* (1.77)	$R^2 = 0.041$
20. Property Trusts	0.405 (6.24)	$R^2 = 0.345$	2.864* (2.42)	$R^2 = 0.073$

21. Miscellaneous Services	0.787 (10.73)	$R^2 = 0.609$	3.780* (2.29)	$R^2 = 0.066$
22. Miscellaneous Industrials	0.682 (10.30)	$R^2 = 0.589$	1.768 (1.11)	$R^2 = 0.016$
23. Diversified Industrials	0.928 (14.69)	$R^2 = 0.745$	3.903* (2.16)	$R^2 = 0.059$
Market Index	--	--	4.435* (2.56)	$R^2 = 0.081$

* Beta estimate is positively statistically significant at the (one-sided) 5 percent level. Note that all market betas are statistically significant.

[a] Beta estimate for a given industry portfolio.

[b] t-statistic for beta estimate.

Table 3 reveals the market and adjusted consumption beta estimates for the full period excluding the crash quarter of 1987 (1987:4). The predictions above are confirmed. In general the statistical significance of the market betas decline while the statistical significance of the adjusted consumption betas rise. Furthermore, now fifteen industry portfolios have statistically significant adjusted beta estimates. While these are still much less significant than their market beta counterparts, the gap has narrowed compared with Table 2. For example, the t-statistic for the market beta of Banks is 9.7 compared to a t-statistic of 3.6 for its adjusted consumption beta counterpart.

Two interesting questions arise from this analysis. First, what is the level of correlation between the alternative beta risk measures, across industries as revealed in Tables 2 and 3? Secondly, with regard to the consumption beta estimates, do the relative beta measures across industries accord with intuition in the context of the CCAPM?

TABLE 4: CORRELATION BETWEEN BETAS 1974:2 TO 1992:4

	Correlation				
Market Beta	1				
Market Beta (CRASH excl.)	0.984[a] (0.976)[b]	1			
Consumption Beta (Contemp.)	0.061 (0.219)	0.025 (0.157)	1		
Consumption Beta (2-month lag)	0.474 (0.588)	0.530 (0.659)	0.366 (0.393)	1	
Consumption Beta (2-month lag) (CRASH excl.)	0.486 (0.595)	0.541 (0.667)	0.367 (0.378)	0.999 (0.999)	1
	Market Beta	Market Beta (CRASH excl.)	Cons. Beta (Contemp.)	Cons. Beta (2-month lag)	Cons. Beta (2-month lag) (CRASH excl.)

[a] Standard correlation between different beta measures

[b] Spearman rank correlation between different beta measures are presented in parentheses

With regard to the former question, Table 4 reports the correlations between the different beta measures across the 23 industries. Not surprisingly the two market betas are very highly and positively correlated, as are the two adjusted consumption betas. However, it is quite clear that the contemporaneous consumption betas have very weak positive correlation with market betas. Finally, it is encouraging to find that the adjusted consumption betas are at least moderately positively correlated with the market betas. For example, the Spearman Rank correlation between the adjusted consumption and market betas (with the crash excluded for both) is 0.667. However, this contrasts with the extremely high correlation reported by Breeden et al (1989, p.246) of 0.96 between market and consumption betas.

Turning now to the second question, re-consider the consumption beta estimates revealed in Table 3. The three most risky industries are the Solid Fuels; Banks; Alcohol and Tobacco portfolios. In contrast, Breeden et al (1989) found that out of a twelve-industry classification scheme, the two most risky industries were Construction and Leisure. Breeden et al (1989, p.246) argued that goods with high (low) income elasticities of demand should have high (low) consumption betas, other things being equal. Perhaps, in the Australian case, only Banks would satisfy this condition. On the other hand, from Table 3 the three least risky industries in terms of consumption beta risk are Miscellaneous Industrials; Paper and Packaging; and Insurance. These rankings are more in accord with expectations as industries providing goods and services with low income elasticities for demand. They compare with the Food and Tobacco; and Utilities industries, found by Breeden et al (1989).

In summary, the empirical analysis based on contemporaneous data indicates very little evidence, for the relevance of consumption beta risk. However, the results using the two-month lagged equity data are somewhat stronger than the results using contemporaneous data. Moreover, the use of the lagged approach generally can be justified on the basis of the slow adjustment of macroeconomic variables relative to the information sensitive stock market data. Consequently, unless otherwise stated, all subsequent analysis and discussion involving actual quarterly consumption data focuses on the (two-month) lagged relationship. As such, the reported actual consumption based tests of the CCAPM are conditional on the validity of this lagged relationship.

TABLE 5: ESTIMATING AND TESTING THE CCAPM USING AGGREGATE CONSUMPTION DATA

Time Period	N	$\hat{\gamma}_0$[a]	$\hat{\gamma}_1$[b]	LRT
1974:2 to 1983:2	37	-0.010 (-1.84)	-0.000 (-0.25)	13.37[c] (0.895)[d]
1983:3 to 1992:4	38	0.010* (2.42)	0.002* (2.79)	16.08 (0.765)
1983:3 to 1992:4 (excl. 1987:4)	37	0.009* (2.88)	0.002* (2.63)	14.90 (0.828)
1974:2 to 1992:4	75	0.004 (0.67)	0.004* (3.47)	9.67 (0.983)
1974:2 to 1992:4 (excl. 1987:4)	74	0.004 (0.75)	0.005* (3.58)	10.17 (0.977)

* Parameter estimate is statistically significant at the (two-sided) 5 percent level.

a Estimated expected return for the zero-beta portfolio using CCAPM and quarterly consumption data.

b Estimated market price of consumption beta risk.

c The likelihood ratio test (LRT) statistic for the CCAPM restriction using quarterly consumption data. The LRT is a chi-square statistic with 21 degrees of freedom.

d The probability of exceeding the given level of the LRT statistic under the null hypothesis.

Presented in Table 5 are the parameter estimates for the restriction (4) imposed by the CCAPM using mean-adjusted aggregate consumption data in the consumption model (1). First, it can be seen that the estimate of the expected return on the zero-beta portfolio, $\hat{\gamma}_0$, is statistically significant in the latter sub period only. However, the estimates are much smaller than typically observed in asset pricing studies which is consistent with the results found by Breeden et al. This may be suggesting that a risk-free version of the CCAPM is more appropriate. In addition Table 5 reveals that the estimated market price of consumption beta risk, $\hat{\gamma}_1$, is significantly positive in all cases except the first sub period. However, the magnitude of this price is quite small with, for example, an annualised value of 1.6 percent for the total nineteen-year period.

TABLE 6: CONSUMPTION BETAS WHEN CCAPM RESTRICTION IMPOSED

Industry	Consumption Beta
1. Gold	5.607* (1.68)
2. Other Metals	4.722* (1.96)
3. Solid Fuels	7.31* (3.15)
4. Oil and Gas	4.90* (1.73)
5. Diversified Resources	5.958* (2.90)
6. Developers & Contractors	4.928* (2.79)
7. Building Materials	3.703* (2.30)
8. Alcohol & Tobacco	6.334* (3.17)
9. Food & Household Goods	4.44* (2.94)
10. Chemicals	4.09* (2.53)
11. Engineering	3.44* (2.38)
12. Paper & Packaging	2.68* (1.96)
13. Retail	3.499* (2.22)
14. Transport	6.266* (3.36)
15. Media	5.614* (2.10)
16. Banks	5.827* (3.40)
17. Insurance	2.870 (1.28)
18. Entrepreneurial Investors	6.503* (2.40)
19. Investment & Financial Services	2.907* (2.01)
20. Property Trusts	3.107* (2.87)
21. Miscellaneous Services	4.186* (2.88)
22. Miscellaneous Industrials	1.839 (1.38)
23. Diversified Industrials	4.571* (2.88)

* Beta estimate is positively statistically significant at the (one-sided) 5 percent level.

The final column of Table 5 reports the LRT statistics which test the null hypothesis that the CCAPM holds and thus imposing the restriction (4) is valid. The LRT values in all cases show strong support for the model with the lowest p-value of 0.763 occurring in the second subperiod. However, it could be that the test lacks power because the consumption betas are estimated with insufficient precision. Notwithstanding this possibility, given the significance of $\hat{\gamma}_0$ or $\hat{\gamma}_1$ or both in every case except the first sub period, Table 5 provides positive support for the CCAPM. Suggestive additional support is contained in Table 6, which reports the consumption betas when the CCAPM restriction of (4) is imposed for the total data period. In comparison to their unrestricted counterparts reported in the final column of Table 2, an increase in statistical significance is observed. Moreover, now twenty-one of the twenty-three industry portfolios have consumption betas statistically significant at the 5 percent level.

In comparison, the Breeden et al results based on actual consumption data, provide similarly strong evidence in favour of the CCAPM. Interestingly, Fama (1991, p.1597) conjectures that the Breeden et al finding of favourable support for the CCAPM is largely driven by the spread of betas/returns between bonds and stocks in that study. This suggestion is not supported in this paper since, notwithstanding the absence of bonds (and hence the concentration on equities only), support for the CCAPM is still evident.

The virtues of the maximum correlation portfolio (MCP) were previously identified to be (1) to permit testing of the CCAPM using monthly data when only quarterly consumption data are available and (2) to permit a test of the non-linear restriction imposed by a zero-beta CCAPM, analogous to that proposed by Gibbons (1982). One difficulty in estimating an MCP is the multicollinearity between the candidate market return explanatory variables. In the case of Breeden et al (1989) a twelve-industry classification was used whereas the twenty-three industries in the current study presents an even greater problem. Consequently, unlike

Breeden et al (1989) several variations of the MCP are examined but none of these include every possible industry. As it turns out the nature of the results are largely unaffected by this variation.

Four variants of the MCP were examined. Two of these exclude the effect of 1987:4, the "crash" quarter, while the other two exclude the market index return as an additional variable.

The selection of industries was guided by a balance between judgement and statistical significance of the consumption betas. Referring to Table 2 reveals that thirteen industries were significant (5 percent level), of which the eight most significant were selected. Similarly, referring to Table 3 reveals that fifteen industries were significant (5 percent level), of which the twelve most significant were selected.

Table 7 presents the regression results of the consumption growth variable against the various sets of market return variables just described, over the period 1974:2 to 1992:4. The weights have been rescaled so that their sum totals unity. In general the results across the various MCPs appear quite weak with only one variable, the Bank industry return, significant in all cases. The difficulty in estimating the weight of any industry with any precision reflects the multicollinearity problem and was similarly encountered by Breeden et al (1989).[17] This should be remembered when interpreting any of the results involving the MCP consumption proxies which follow.

[17] Breeden et al (1989) also included returns on Treasury Bills, long-term government bonds, long-term corporate bonds and junk bonds in their analysis. Reliable Australian data for these variables are unavailable for the period examined and are therefore not analysed.

TABLE 7: ESTIMATED WEIGHTS FOR THE MAXIMUM CORRELATION PORTFOLIO (MCP) FOR CONSUMPTION

Industry	MCP1 Weight	MCP2 Weight (excluding CRASH)	MCP3 Weight	MCP4 Weight (excluding CRASH)
3. Solid Fuels	0.194 (1.05)[a]	0.363 (1.37)[a]	0.236 (1.21)[a]	0.359 (1.35)[a]
5. Diversified Resources	0.182 (0.83)	0.343 (1.15)	0.538 (1.57)	0.479 (1.10)
6. Developers & Contractors	-0.460 (-1.11)	0.085 (0.13)	-0.226 (-0.48)	0.118 (0.18)
7. Building Materials	--	-0.976 (-1.49)	--	-0.861 (-1.24)
8. Alcohol & Tobacco	-0.035 (-0.13)	0.132 (0.38)	0.024 (0.09)	0.140 (0.40)
9. Food & Household Goods	--	0.024 (0.03)	--	0.008 (0.01)
11. Engineering	--	-0.098 (-0.14)	--	-0.075 (-0.11)
14. Transport	-0.036 (-0.12)	0.295 (0.71)	0.090 (0.28)	0.309 (0.75)
16. Banks	0.693* (2.17)	0.816* (1.96)	0.733* (2.21)	0.816* (1.96)
20. Property Trusts	0.523 (1.01)	0.243 (0.33)	0.477 (0.88)	0.260 (0.35)
21. Miscellaneous Services	-0.062 (-0.17)	0.301 (0.60)	0.252 (0.58)	0.394 (0.72)
23. Diversified Industrials	--	-0.528 (-0.74)	--	-0.455 (-0.63)
Market return	--	--	-1.123 (-1.36)	-0.493 (-0.44)
$\overline{R}^2$	0.0865	0.0867	0.0980	0.0745
F-statistic[b]	1.876 (0.079)	1.578 (0.122)	1.893 (0.068)	1.452 (0.163)
Wald-statistic[c]	15.007 (0.059)	18.934 (0.090)	17.038 (0.048)	18.879 (0.127)

* Parameter estimate is statistically significant at the (two-sided) 5 percent level.

[a] The t-statistic for the MCP weight given above.

[b] F-statistic which tests the joint significance of the MCP regression. The probability of exceeding the given level of the statistic under the null hypothesis is given in parentheses below.

[c] Wald-statistic which tests the joint significance of the MCP regression. The probability of exceeding the given level of the statistic under the null hypothesis is given in parentheses below.

TABLE 8: TESTING THE MEAN-VARIANCE EFFICIENCY OF THE MAXIMUM-CORRELATION PORTFOLIO (MCP) AND THE CRIF VALUE-WEIGHTED MARKET INDEX : THE ZERO-BETA CASE

Time Period	N	$\hat{\gamma}$[a]	LRT[b]
Panel A: Mean-Variance Efficiency Tests on the MCP1			
1974:1 to 1978:7	55	-0.001 (-0.21)	22.81 (0.412)
1978:8 to 1983:2	55	0.001 (0.55)	23.35 (0.382)
1983:3 to 1987:9	55	0.010* (3.95)	25.97 (0.253)
1988:1 to 1992:12	60	0.002 (0.88)	34.12 (0.048)
1974:1 to 1992:12	228	0.002 (1.11)	51.81 (0.000)
1974:1 to 1992:12 (excl. 1987:10 to 1987:12)	225	0.004* (2.05)	261.16 (0.000)
Panel B: Mean-Variance Efficiency Tests on the MCP3			
1974:1 to 1978:7	55	-0.004 (-1.04)	41.35 (0.007)
1978:8 to 1983:2	55	-0.002 (-0.64)	29.37 (0.135)
1983:3 to 1987:9	55	0.011* (4.22)	51.59 (0.000)
1988:1 to 1992:12	60	-0.006* (-2.59)	33.48 (0.055)
1974:1 to 1992:12	228	0.000 (0.00)	62.18 (0.000)
1974:1 to 1992:12 (excl. 1987:10 to 1987:12)	225	0.001 (0.32)	58.57 (0.000)
Panel C: Mean-Variance Efficiency Tests on the MCP4			
1974:1 to 1978:7	55	0.000 (0.03)	35.06 (0.038)
1978:8 to 1983:2	55	0.002 (0.66)	22.94 (0.405)
1983:3 to 1987:9	55	0.012* (4.86)	31.16 (0.093)
1988:1 to 1992:12	60	0.007* (3.11)	42.26 (0.006)
1974:1 to 1992:12	228	0.003 (1.18)	18.08 (0.701)
1974:1 to 1992:12 (excl. 1987:10 to 1987:12)	225	0.005* (2.37)	20.09 (0.577)

Panel D: Mean-Variance Efficiency Tests on the CRIF Market Index			
1974:1 to 1978:7	55	0.000 (0.03)	28.30 (0.166)
1978:8 to 1983:2	55	0.000 (0.09)	24.77 (0.308)
1983:3 to 1987:9	55	0.008* (2.85)	40.84 (0.009)
1988:1 to 1992:12	60	0.001 (0.43)	35.10 (0.038)
1974:1 to 1992:12	228	0.003 (1.38)	40.29 (0.010)
1974:1 to 1992:12 (excl. 1987:10 to 1987:12)	225	0.003 (1.58)	36.37 (0.028)

* Parameter estimate is statistically significant at the (two-sided) 5 percent level.

a Estimated expected return for the zero-beta portfolio using CCAPM and monthly maximum correlation portfolio (MCP) data.

b The LRT is the likelihood ratio test statistic for the zero-beta CCAPM (using monthly MCP based data) and CAPM restriction. The LRT is a chi-square statistic with 22 degrees of freedom. The probability of exceeding the given level of the LRT under the null hypothesis is given below the LRT in parentheses.

Presented in Table 8 are the parameter estimates for the restriction (7) imposed by the zero-beta CCAPM using MCP proxies for the aggregate consumption variable in the market model of (6). First, consider panels A, B and C which present the results for MCP1, MCP3 and MCP4, respectively.[18]

In all cases the estimated expected return on the zero-beta portfolio is positive and statistically significant for the third subperiod (1983:3 to 1987:9). It indicates an annualised expected return of about 4 percent in real terms. In the other periods analysed there is little consistent evidence of a significant estimate. However, in the full period excluding the crash for MCP1 and MCP4 it is significantly positive, implying an annualised rate of about 2 percent. With regard to the test of the hypothesis of mean-variance efficiency, there is a mixture of results. Only in the case of the second subperiod (1978:8 to 1983:12) can the hypothesis not be

[18] The results for MCP2 are not reported because of a problem in achieving convergence for the estimation of the restricted system of equations.

rejected across all MCPs. However, this may reflect a lack of power since the estimate of γ is insignificant for all MCPs in this subperiod. To shed further light on this issue consider the LRT statistics for the third subperiod in which the estimated value for γ was always statistically significant and positive, suggesting lack of power should not be an issue. In two out of three cases the hypothesis is supported. In summary, the evidence in Table 8 regarding the mean-variance efficiency of the MCP is somewhat mixed. Recall however, that this may also reflect the estimation problems related to the MCPs discussed earlier.

Secondly, consider panel D which contains the results for the market index. Similarly to the case of MCP the estimate of γ is positive and significant in the third subperiod, implying an annualised real expected return of 3.2 percent. However, the hypothesis of mean-variance efficiency is not supported in this subperiod. While according to the LRT statistics the hypothesis is supported in the first two subperiods, the insignificance of γ estimates, may indicate a lack of power in these test results.

Table 9 reports the results for the test of mean-variance efficiency of the value-weighted market index and of the MCP4 proxy[19] in the context of the risk-free versions of the CAPM and CCAPM, respectively. With regard to the tests of the CAPM restriction, it is found that the null hypothesis cannot be rejected in the first two subperiods, but is rejected in the last three subperiods, at standard significance levels. These results coincide with those for the comparable zero-beta CAPM tests reported in Table 8. Tests of the risk-free CCAPM restriction, reveal that the null hypothesis cannot be rejected in three of the five subperiods, at standard significance levels. Again comparing these results with the zero-beta CCAPM test results reported in Table 8, the same conclusions are reached for each of the five subperiods.

[19] The results for the MCP4 case are in general terms representative of the other MCP proxies discussed earlier in the paper. In order to conserve space these results are not reported.

Generally, the results in Tables 8 and 9 indicate that moving between the zero-beta and risk-free versions of either model makes very little difference empirically, using the current data set.

TABLE 9: TESTING THE MEAN-VARIANCE EFFICIENCY OF THE MAXIMUM-CORRELATION PORTFOLIO (MCP) AND THE CRIF VALUE-WEIGHTED MARKET INDEX: THE RISK-FREE CASE

Time Period	N	LRT[a]	
		CAPM	CCAPM[b]
1974:1 to 1978:7	55	29.09 (0.177)	35.87 (0.043)
1978:8 to 1983:2	55	30.40 (0.138)	25.76 (0.312)
1983:3 to 1987:9	55	40.67 (0.013)	31.36 (0.114)
1988:1 to 1992:12	60	38.97 (0.020)	42.58 (0.008)
1974:1 to 1992:12	228	44.71 (0.004)	25.61 (0.319)
1974:1 to 1992:12 (excl. 1987:10 to 1987:12)	225	42.00 (0.009)	24.03 (0.402)

a The LRT is the likelihood ratio test statistic for the risk-free CCAPM and CAPM restriction. The LRT is a chi-square statistic with 23 degrees of freedom. The probability of exceeding the given level of the LRT under the null hypothesis is given below the LRT in parentheses.

b Results are reported for the case of MCP4, as presented in Table 7.

In Table 10 the final set of empirical results are presented. Specifically, this table reports the results for the non-nested tests of the CCAPM versus the CAPM, (as described in Section 2.4) using both monthly and quarterly data.[20] In the case of monthly analysis the results are very similar for both the zero-beta and risk-free versions. Moreover, the results do not strongly favour either model since in the vast majority of cases the "weighting" coefficient is significantly

20 Reported results are for the case where the CCAPM is based on the MCP4 portfolio only. Since these results are representative, the other cases are not reported to conserve space.

TABLE 10: A NON-NESTED COMPARISON OF THE CCAPM VERSUS THE CAPM: C TEST RESULTS[a]

$\hat{\alpha}_i$	Monthly[b] 1988:1 to 1992:12		Quarterly[c] 1974:2 to 1992:4 (excl. 1987:4)
	Zero-Beta	Risk-Free	
1. Gold	-1.589 (0.186)[d]	-1.399 (0.168)	-0.109[e] (0.123)
2. Other Metals	-0.162 (0.083)	-0.133[e] (0.084)	-0.115[e] (0.084)
3. Solid Fuels	1.621 (0.156)	1.381 (0.164)	0.133[e] (0.142)
4. Oil and Gas	-1.039 (0.172)	-1.228 (0.168)	-0.046[e] (0.107)
5. Diversified Resources	-0.389 (0.086)	-0.211 (0.106)	-0.014[e] (0.081)
6. Developers & Contractors	-0.101[e] (0.132)	-0.169[e] (0.127)	0.103[e] (0.083)
7. Building Materials	0.924[f] (0.073)	0.937[f] (0.075)	0.025[e] (0.065)
8. Alcohol & Tobacco	1.726 (0.189)	1.815 (0.196)	0.235[e] (0.140)
9. Food & Household Goods	0.454 (0.137)	0.410 (0.139)	0.167[e] (0.111)
10. Chemicals	1.038[f] (0.166)	1.076[f] (0.166)	0.091[e] (0.106)
11. Engineering	0.834[f] (0.162)	0.799[f] (0.159)	0.094[e] (0.100)
12. Paper & Packaging	0.046[e] (0.136)	-0.080[e] (0.135)	0.052[e] (0.092)
13. Retail	0.305 (0.147)	0.175[e] (0.147)	0.116[e] (0.119)
14. Transport	0.586 (0.111)	0.608 (0.112)	0.101[e] (0.093)
15. Media	-0.661 (0.160)	-0.799 (0.166)	0.075[e] (0.135)
16. Banks	1.595 (0.073)	1.702 (0.075)	0.215[e] (0.123)
17. Insurance	-1.362 (0.215)	-1.078 (0.191)	0.067[e] (0.170)
18. Entrepreneurial Investors	0.353 (0.201)	0.200[e] (0.188)	0.065[e] (0.127)
19. Investment & Financial Services	0.033[e] (0.156)	-0.086[e] (0.150)	0.050[e] (0.093)
20. Property Trusts	0.883[f] (0.164)	-0.413[e] (0.285)	0.228[e] (0.153)
21. Miscellaneous Services	0.025[e] (0.137)	-0.116[e] (0.146)	0.072[e] (0.087)

22. Miscellaneous Industrials	0.132[e] (0.242)	0.165[e] (0.230)	0.051[e] (0.116)
23. Diversified Industrials	0.708 (0.087)	0.723 (0.088)	0.070[e] (0.071)

[a] The non-nested comparison is based on the C-test framework of Davidson and MacKinnon (1981).

[b] Results are reported for the case of MCP4, as presented in Table 7.

[c] Results are reported for direct tests of the zero-beta CCAPM using adjusted consumption data versus the zero-beta CAPM.

[d] Standard errors in parentheses.

[e] The null hypothesis $H_0 : \alpha_i = 0$ (i.e. CAPM) cannot be rejected at the 5 percent level.

[f] The null hypothesis $H_0 : \alpha_i = 1$ (i.e. CCAPM) cannot be rejected at the 5 percent level.

different from both zero and unity. For only four of the 23 industries, is the evidence in favour of the CCAPM, while for only five industries is the evidence in favour of the CAPM. In contrast, the results of the non-nested tests using quarterly data provide very strong evidence in favour of the CAPM relative to the CCAPM. Indeed, for every industry portfolio, the non-nested weighting coefficient is significantly different from unity (rejecting the CCAPM) and simultaneously is not significantly different from zero, thereby providing evidence in favour of the CAPM. Note however that these results may be more a reflection of the empirical difficulties of measuring quarterly consumption as previously discussed, than a rejection of the CCAPM (per se) in favour of the CAPM.

5. Summary and Conclusions

The consumption-based CAPM (CCAPM) had its genesis in work by Merton (1973a, b) and others on the intertemporal CAPM (ICAPM). Merton (1973) suggested that in an intertemporal setting investors would be concerned about uncertainties in the investment opportunity set. This leads to a multifactor ICAPM, where the number of priced factors is equal to the number of sources of uncertainty that investors can and wish to hedge against. The drawback with the ICAPM is the lack of theoretical guidance as to the identity of the sources of uncertainty which investors face and hence the identity of the factors to be included in the ICAPM. The CCAPM is a convenient way to simplify and operationalise the ICAPM into a single factor model, where an aggregate real consumption variable is the overall factor, postulated to capture all dimensions of uncertainty.

Previous evidence on the CCAPM is predominantly US-based and no prior work has been published in Australia. This paper has presented an empirical examination of the CCAPM using monthly and quarterly Australian equity return and consumption data. The empirical framework extended the work of Breeden et al (1989) in employing the multivariate approach pioneered by Gibbons (1982). Preliminary analysis in the paper indicated that an approach using two-month lagged equity return data is preferable to contemporaneous data.

Tests of the CCAPM using quarterly consumption data generally revealed an insignificant estimate of the expected zero-beta return but a positive and statistically significant estimate of the market price of consumption beta risk. Multivariate tests indicated good support for the CCAPM.

In a second phase of the multivariate tests, four versions of the maximum correlation portfolio (MCP) were used as a proxy for the consumption variable, using monthly data. Generally, the results of these tests were very mixed, in some cases revealing support for the mean-variance efficiency of the MCP but in other cases showing strong rejection of this hypothesis.

In a final phase of the analysis, non-nested tests of the CAPM versus the CCAPM were conducted. While the evidence favoured the traditional CAPM over the CCAPM using quarterly data, the tests using monthly data provided inconclusive results.

In general, the results in this paper indicated a relatively poor performance for the CCAPM. However, this should be viewed in the context of the various empirical problems discussed previously. Notably, these problems which mostly relate to the joint test issue and the smoothness of consumption data, all seem to reinforce a bias toward rejecting the CCAPM. Specifically, in the context of these poor results we should ask a series of questions. To what extent do the results reflect unstable consumption betas? To what extent do the results reflect an inadequate MCP proxy due to high measurement error and/or multicollinearity? To what extent are the results driven by measurement errors and/or excessive smoothness in aggregate consumption data? Finally, to what extent are the results explained by the observation made by Mankiw and Shapiro (1986, p.458) that consumers do not take an active role in the stock market? Future research may hopefully shed some light on the relative importance of these competing explanations, and hence lead to more reliable conclusions regarding the CCAPM.

References

Bartlett, M., "Further Aspects of the Theory of Multiple Regression", *Proceedings of the Cambridge Philosophical Society*, Vol. 34, 1938, pp. 33-47.

Bergman, Y. "Time Preference and Capital Asset Pricing Models", *Journal of Financial Economics*, Vol. 14, 1985, pp. 145-159.

Brailsford, T. and R. Faff, "Modelling Australian Stock Market Volatility", *Australian Journal of Management*, 1993, Vol.18, No.2, December, pp.109-132.

Breeden, D.T., M.R. Gibbons and R. H. Litzenberger, "Empirical Tests Of The Consumption-Oriented CAPM", *Journal of Finance*, 1989, v44(2), pp. 231-262.

Breeden, D.T., "An Intertemporal Asset Pricing Model With Stochastic Consumption And Investment Opportunities", *Journal of Financial Economics*, 1979, v7(3), pp. 265-296.

Breeden, D.T. "Consumption, Production, Inflation And Interest Rates: A Synthesis", *Journal of Financial Economics*, 1986, v16(1), pp. 3-40.

Brown, D.P. "The Implications Of Nonmarketable Income For Consumption-Based Models Of Asset Pricing", *Journal of Finance*, 1988, v43(4), pp. 867-880.

Campbell, J. and A. Deaton, "Why is Consumption So Smooth?", *Review of Economic Studies*, 1989, v.56, pp.357-373.

Cecchetti, S., P. Lam and N. Mark, "The Equity Premium and the Risk-free Rate: Matching the Moments", *Journal of Monetary Economics*, Vol. 31, 1993, pp. 21-45.

Chen, N-F, "Some Empirical Tests of the Theory of Arbitrage Pricing", *Journal of Finance*, Vol. 38, pp.1393-1414.

Chen, N., R. Roll and S. Ross, "Economic Forces and the Stock Market", *Journal of Business*, Vol. 59, 1986, pp. 383-404.

Christiano, L., "Is Consumption Insufficiently Sensitive to Income", *American Economic Review*, 1987, v77, pp. 337-341.

Connor, G. and R. Korajczyk, "An Intertemporal Equilibrium Beta Pricing Model", *The Review of Financial Studies*, Vol. 2, 1989, pp. 373-392.

Cornel, B., "The Consumption Based Asset Pricing Model: A Note On Potential Tests And Application", *Journal of Financial Economics*, 1981, v9(1), pp. 103-108.

Davidson, R. and J. MacKinnon, "Several Tests of Model Specification in the Presence of Alternative Hypotheses", *Econometrica*, 1981, Vol.49, pp.781-793.

Faff, R., "An Empirical Test of the Arbitrage Pricing Theory on Australian Stock Returns 1974-85", *Accounting and Finance*, Vol. 28, November, 1988, pp. 23-43.

Faff, R., "A Multivariate Test of an Equilibrium APT with Time-Varying Risk Premia in the Australian Equity Market", *Australian Journal of Management*, Vol. 17, December, 1992, pp. 233-258.

Faff, R., "An Empirical Test of Arbitrage Equilibrium with Skewed Asset Returns: Australian Evidence", *Asia Pacific Journal of Management*, Vol. 10, 1993, pp. 195-211.

Fama, E. and J. MacBeth, "Tests of the Multiperiod Two-Parameter Model", *Journal of Financial Economics*, Vol. 1, 1974, pp. 43-66.

Fama, E., "Efficient Capital Markets: II", *Journal of Finance*, Vol. 46, 1991, pp. 1575- 1617.

Ferson, W.E. "Are The Latent Variables In Time-Varying Expected Returns Compensation For Consumption Risk?," *Journal of Finance*, 1990, v45(2), pp. 397-430.

Ferson, W.E. and J.J. Merrick, Jr. "Non-Stationarity And Stage-Of-The-Business-Cycle Effects In Consumption-Based Asset Pricing Relations", *Journal of Financial Economics*, 1987, v18(1), pp. 127-146.

Ferson, W., "Expectations of Real Interest Rates and Aggregate Consumption: Empirical Tests", *Journal of Financial and Quantitative Analysis*, Vol. 18, December 1983, pp. 477-497.

Ferson, W. and C. Harvey, "Seasonality and Consumption-Based Asset Pricing", *Journal of Finance*, Vol. 47, June, 1992, pp. 511-552.

Flavin, M., "The Excess Smoothness of Consumption: Identification and Interpretation", *Review of Economic Studies*, 1993, v60, pp. 651-666.

Ghysels, E. and A. Hall, "Are Consumption-Based Intertemporal Capital Asset Pricing Models Structural?", *Journal of Econometrics*, Vol. 45, 1990, pp. 121-139.

Gibbons, M., "Multivariate Tests of Financial Models: A New Approach", *Journal of Financial Economics*, Vol. 10, 1982, pp. 3-27.

Grossman, S. and R. Shiller, "Consumption Correlatedness and Risk Measurement in Economies with Non-Traded Assets and Heterogenous Information", *Journal of Financial Economics*, Vol.10, 1982, pp.195-210.

Grossman, S., A. Melino and R. Shiller, "Estimating the Continuous-Time Consumption-Based Asset-Pricing Model", *Journal of Business and Economic Statistics*, Vol. 5, July 1987, pp. 315-327.

Hamori, S. "Test of C-CAPM for Japan: 1980-1988", *Economic Letters*, Vol. 38, 1992, pp. 67-72.

Hansen, L. and K. Singleton, "Stochastic Consumption, Risk Aversion, and the Temporal Behaviour of Asset Returns", *Journal of Political Economy*, Vol. 91, 1983, pp. 249-265.

Hansen, L. and K. Singleton, "Generalised Instrumental Variables Estimation of Nonlinear Rational Expectations Models", *Econometrica*, Vol. 50, September 1982, pp. 1269-1286.

Hazuka, T.B., "Consumption Betas And Backwardation In Commodity Markets", *Journal of Finance*, 1984, v39(3), pp. 647-655.

Jobson, J. and B. Korkie, "Potential Performance and Tests of Portfolio Efficiency", *Journal of Financial Economics*, Vol. 10, 1982, pp. 433-466.

Kandel, S. and R. Stambaugh, "A Mean-Variance Framework for Tests of Asset Pricing Models", *The Review of Financial Studies*, Vol. 2, 1989, pp. 125-156.

Kandel, H. and Robert F. Stambaugh, "Expectations And Volatility Of Consumption And Asset Returns", *Review of Financial Studies*, 1990, v3(2), pp. 207-232.

Kazemi, B., "An Alternative Testable Form Of Consumption CAPM", *Journal of Finance*, 1988, v43(1), pp. 61-70.

Kazemi, B., "A Multiperiod Asset-Pricing Model With Unobservable Market Portfolio: A Note", *Journal of Finance*, 1988, v43(4), pp. 1015-1024.

Lewis, K., "Should the Holding Period Matter for the Intertemporal Consumption-Based CAPM?", *Journal of Monetary Economics*, Vol. 28, 1991, pp. 365-389.

Longstaff, F., "Temporal Aggregation and the Continuous-Time Capital Asset Pricing Model", *Journal of Finance*, Vol. 44, September 1989, pp. 871-887.

Mankiw, N. and M. Shapiro, "Risk and Return: Consumption Beta Versus Market Beta", The *Review of Economics and Statistics*, 1986, pp. 452-459.

Mehra, R. and E. Prescott, "The Equity Premium: A Puzzle", *Journal of Monetary Economics*, Vol.15, 1985, pp.145-161.

Merton, R., "A Reexamination of the Capital Asset Pricing Model" in I. Friend and J. Bicksler (eds.) Risk and Return in Finance, Ballinger, Mass. 1973b, pp. 141-159.

Merton, R. "An Intertemporal Capital Asset Pricing Model", *Econometrica*, Vol. 41, 1973a, pp. 867-887.

Poon, S. and S. Taylor, "Macroeconomic Factors and the UK Stock Market", *Journal of Business Finance and Accounting*, Vol. 18, 1991, pp. 619-636.

Richardson, M. and T. Smith, "Tests of Financial Models in the Presence of Overlapping Observations", *The Review of Financial Studies*, Vol. 4, 1991, pp. 227-254.

Rubio, G. "An Empirical Evaluation of the Intertemporal Capital Asset Pricing Model: The Stock Market in Spain", *Journal of Business Finance and Accounting*, Vol. 16, Winter 1989, pp. 729-743.

Sauer, A. and A. Murphy, "An Empirical Comparison of Capital Asset Pricing in Germany", *Journal of Banking and Finance*, Vol. 16, 1992, pp. 183-196.

Schipper, K. and R. Thompson, "Common Stocks As Hedges Against Shifts In The Consumption Or Investment Opportunity Set", *Journal of Business*, 1981, v54(2), pp. 305-328.

Shanken, J., "Intertemporal Asset Pricing: An Empirical Investigation", *Journal of Econometrics*, Vol. 45, 1990, pp. 99-120.

Shanken, J., "On the Estimation of Beta-Pricing Models", *The Review of Financial Studies*, Vol. 5, 1992, pp. 1-33.

Sinclair, N., "Multifactor Asset Pricing Models", *Accounting and Finance*, Vol. 27, May, 1987, pp. 17-36.

West, K., "The Insensitivity of Consumption to News about Income", *Journal of Monetary Economics*, v21, pp. 17-33.

Wheatley, S. "Some Tests of the Consumption-Based Asset Pricing Model", *Journal of Monetary Economics*, Vol.22, 1988, pp. 193-215.

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