BETA AND THE CROSS-SECTION OF STOCK RETURNS

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ABSTRACT

One of the central predictions of the CAPM is that beta alone is sufficient to explain cross-sectional differences in returns. Fama and French (1992) find that, having purged beta of size effects, it is unable to explain the cross-section of returns. This paper re-examines the usefulness of beta using UK data. We find that beta does not explain the cross-section of returns in the UK except for the months of January and April. However, a stock's beta provides a good indication of the likely extent of its rise or fall in extreme bull and bear markets respectively.

INTRODUCTION

Since its development, the Sharpe (1964), Lintner (1965) and Black (1972) Capital Asset Pricing Model (CAPM) has come under attack from a number of empirical papers. While these studies have been undertaken in the shadow of Roll (1977), they have whittled away the empirical validity of the model's prediction that expected returns are significantly linearly related to ß. Thus far, the most damaging empirical evidence for the CAPM has come from Fama and French (1992). The latter authors find that, having purged beta of the influence of size, it is not significantly related to return, even when it is the only explanatory variable in the model. This finding has led to increased interest in testing the CAPM and examining the usefulness of beta.

This paper examines the relationship of beta with return for a sample of UK companies. Like Chan and Lakonishok (1993), we do not restrict ourselves to strict tests of the CAPM. Instead, we focus on the broader question of whether beta provides useful information about expected return. Our methodology differs from that of Fama and French in a number of respects. First, we use a variety of ß-estimate adjustors to overcome data problems such as thin trading and to improve the accuracy of ß-estimates. Secondly, following evidence from Tinic and West (1986) and Bhardwaj and Brooks (1992), we investigate the possibility that the expected returns and ß relation could be seasonal, with particular attention paid to the month of January. Finally, in order to test the usefulness of ß for investors, we repeat Chan and Lakonishok's approach to analysing the 10 largest positive and negative months on the market in order to assess ß's ability to reflect upside and downside risk.

The next section examines previous literature relevant to the current study. The following two sections contain the details of the data and the empirical analysis/results, respectively. We conclude with a summary and interpretation of our findings together with some thoughts for future research.

PREVIOUS STUDIES

One of the central predictions of CAPM is that beta is sufficient to explain the cross-section of returns. The earliest tests of CAPM used alternative explanatory variables to represent unsystematic risk. Lintner (1965) and Miller and Scholes (1972) found that unsystematic risk was significant in explaining the cross-section of average returns. However, beta was significant in their regression models, regardless of whether some proxy for unsystematic risk was included. Black, Jensen and Scholes (1972) and Fama and MacBeth (1973) found that beta alone can explain the cross-section of returns at a portfolio level.

During the late 1970s and 1980s, a plethora of anomalous evidence regarding the relationship of return with variables such as size (Banz, 1981), P/E (Basu, 1977) and book equity to market equity (Stattman, 1980) emerged. This motivated Fama and French to re-evaluate the CAPM tests using additional variables such as size, E/P and book to market equity (BE/ME) instead of the measures of unsystematic risk used heretofore. Fama and French maintain that there is only a weak positive relation between average returns and ß in the years 1941-1990 and there is no relation between them for the period 1963-1990. Where ß fails, Fama and French find that firm size and BE/ME do explain the cross-sectional variance in average returns. The Fama and French paper has itself received a number of rebuttals, most of which have focused on the data used.

Chan and Lakonishok (1993) state that phenomena, such as a noisy and constantly changing environment and factors like indexation of particular shares, may render the empirical tests of CAPM less than conclusive. For example, they show that, using a sample of 20 years of US data, even if one estimated the coefficient on beta in the standard second-pass regression of a CAPM test to be exactly equal to R_m - R_F for each month, the time-series variability of the latter would be such as to cause the standard t-test to fail to reject the null hypothesis that the coefficient on beta equals zero. The Chan and Lakonishok paper also recognises the fact that usefulness of ß is not dependent on the validity of the CAPM and demonstrates how ß is an important measure of both upside and downside risk for investors.

Kothari, Shanken and Sloan (1995a) find a statistically significant positive relation between ß and the cross-section of expected returns, when annual returns (as opposed to monthly returns) are used in the tests. In addition, they propose that the significant relation between expected returns and book to market value of equity found in Fama and French may be *partly* attributable to a selection bias in the COMPUSTAT databases used by Fama and French.

Finally, Hillion and Rau (1995) cast doubt on the negative relation between firm size and expected returns evident in Fama and French by drawing attention to another selection bias. They point out that most tests of the CAPM have tended to omit stocks with less than 24 observations, so as to ensure good estimates of "pre-betas". This selection procedure results in the exclusion of initial public offerings (IPOs) and firms switching between exchanges. These firms tend to be small and poor-performing. Consequently, their exclusion may bias the coefficients for the firm size variable downwards in tests such as those of Fama and French (1992).

DATA

The sample used in this study comprised the constituents of the FT All-Share index for which LSPD continuously-compounded monthly returns were available. In common with previous studies, we omitted financial firms from the analysis. We also required that details of size (the market value of equity) were available from Datastream over the period of the study. This provided us with a sample of 245 companies with data spanning the period 1975-1992. The FT All-Share Index was used for the estimation of beta.

There are a number of potential biases induced by the sample selection procedure. The major potential sample bias arises from the fact that the sample companies were chosen using a 1975 base date on the Datastream service. This will possibly result in a survivorship bias as firms that have been distressed/failed or merged are not included. This bias may be mitigated if the sample comprises of mainly large companies (Kothari et al., 1995b). A comparison of the size distribution of the sample companies with that of a randomly-selected sample from the FT All-Share Index, which comprises relatively large companies anyway, reveals no major differences (see **Table 1**). If non-survivors, which are likely to be small firms, are excluded by the sample selection process, this will cause poor-performing small firms to be omitted from the sample. Thus, the smaller firms in our sample will *appear* to perform better relative to large firms than really is the case. Accordingly, we would expect a survivorship bias to manifest itself in a negative relation between size and return. Despite our fears in this regard, the results do not exhibit such a relation. A possible interpretation is that our sample, being drawn from the FT All-Share Index, comprises of large firms and, as such, is not susceptible to survivorship bias. An alternative explanation for the absence of a size effect comes from the findings of Hillion and Rau (1995). They demonstrate that using no exclusion period, or exclusion periods of 12 months or 5 years, will cause the Fama and French size effect to disappear. Since we use an exclusion period of more than 5 years, it is likely that the bias documented by Hillion and Rau is not present in our sample.

Table 1: Comparison of the Size of Sample Companies used in the Study with that of a Randomly-selected Sample

	SAMPLE	RANDOM SAMPLE
Mean	5.32	5.40
Standard Deviation	1.6	1.31
Maximum	9.66	9.83
Q3	6.6	6.3
Median	5.07	5.18
Q1	4.15	4.39
Minimum	2.03	3.13

Size is measured here as the natural log of market value (millions of pounds) at 31/12/89.
Both samples are drawn from the FT All-Share Index, which comprises relatively large firms.

Chan and Lakonishok provide evidence that US companies that are part of an index (for example, S&P 500) have higher returns (2.19% on average) than non-indexed firms. This could skew the size effect and the CAPM relationship itself. It is possible that indexation may produce a positive size effect where indexed stocks are concerned. This should not be a major problem here since the sample is drawn from the FT All-Share Index, which may itself be tracked. However, some stocks will be in the FT-100 and FTSE-350 indices. The former is the index that is most likely to be tracked so there may be some differential demand due to inclusion or exclusion from this index.

EMPIRICAL ANALYSIS AND RESULTS

The procedure used to estimate betas was based on Fama and French (1992). It involves two sortings of security returns into 25 portfolios. Companies are ranked and allocated to portfolios based on size. These size-ranked portfolios are subsequently subdivided into additional portfolios based on pre-formation beta. This procedure is used to separate any size effect from the ß/returns relationship, because prior research suggested that there is a high correlation between firm size and security ßs.

Taking 1980 as year t_0, we sort the 12 months (January-December) of returns for each security into five portfolios based on each firm's total market capitalization, (ln (ME)), at the end of June of that year (each portfolio has 49 companies). The next step was to subdivide each of these five portfolios into five smaller portfolios of 9, 10, 10, 10 and 10 securities, sorted by pre-ranking ßs. The pre-ranking ßs were obtained by regressing the monthly returns for the five years previous to t_0 (1975-1979) against the corresponding market index returns. The returns of securities in portfolios were averaged to give post-ranking portfolio returns. This procedure was repeated for each of the 13 years 1980-1992 so that each portfolio had 156 monthly post-ranking returns. These were regressed against the corresponding monthly returns on the market index to provide ordinary post-ranking portfolio ßs.

Initially, we examine the relation between returns and beta using size- and beta-formed portfolios. **Table 2** outlines matrices of average monthly returns over the period 1980-1992 for portfolios formed on size and beta. The matrices differ only in the manner in which beta was estimated. For Matrix A, portfolios were formed using ordinary OLS betas. There is no apparent relation between size and return here but beta displays a weak negative relation. We then examined the robustness of our results to the choice of proxy for the market portfolio. The portfolios that comprise Matrix B use the FT-500 index in the estimation of pre- and post-ranking betas. Again, there is no clear pattern between size and average return but beta appears to be negatively related to the latter. In addition, we made adjustments to the ordinary beta described above. Specifically, we employ three different ß-estimate adjustors to take account of problems such as trading friction, non-synchronous data and thin trading – the Dimson, Scholes-Williams and the Vasicek-Bayesian adjustors. These methods have been supported in various articles (Dimson and Marsh (1983), Cohen et al. (1983), Fowler and Rorke (1983) and Ushman (1987)). Matrix C shows the portfolio returns when Dimson betas are used. The negative relation between beta and return is again apparent.

Table 2: Fama and French Portfolio Returns

Matrix A: Beta Estimated using the FT All-Share Index as a Proxy for the Market Portfolio

${}_{lo}$Firm size${}_{hi}$

.0181003	.0140748	.0189538	.0159093	.0161042	${}^{lo}\beta$
.0160306	.0166432	.0129250	.0165820	.0147331	
.0121772	.0145301	.0117216	.0118692	.0179561	
.0130722	.0110374	.0161303	.0151689	.0135755	
.0134800	.0134532	.0159905	.0142660	.0159073	${}_{hi}\beta$

Matrix B: Beta Estimated Using the FT-500 Index as a Proxy for the Market Portfolio

${}_{lo}$Firm size${}_{hi}$

.0181007	.0146918	.0216607	.0170959	.0150388	${}^{lo}\beta$
.0147483	.0153587	.0147719	.0157385	.0163344	
.0124100	.0129359	.0125505	.0103744	.0155101	
.0127944	.012990	.0138950	.0158466	.0146526	
.0148339	.0138311	.0131526	.0148007	.0166483	${}_{hi}\beta$

Matrix C: Dimson-adjusted Pre-ranking Betas

${}_{lo}$Firm size${}_{hi}$

.0190107	.0145906	.0199142	.0187100	.0171803	${}^{lo}\beta$
.0135787	.0159645	.0134204	.0166416	.0148503	
.0125118	.0110728	.0145159	.0123516	.0152686	
.0142591	.0170026	.0108212	.0122435	.0155174	
.0136696	.0111558	.0171962	.0140085	.0156116	${}_{hi}\beta$

In summary, the matrices that comprise **Table 2** consistently fail to identify a size effect but an anomalous negative relation between beta and average return is evident. **Table 3** is constructed in exactly the same manner as **Table 2** except that it contains the beta estimates instead of average returns. It would appear that beta is positively related to firm size[1]. Regardless of the way in which they are computed, the post and pre-ranking betas are consistent.

Table 3: Fama and French Post-ranking Betas

Matrix A: Beta Estimated Using the FT All-Share Index

$_{lo}$Firm size$_{hi}$

0.67310	0.58696	0.69381	0.69989	0.65756	^{lo}ß
0.65921	0.81842	0.86741	1.00845	0.93032	
0.82205	0.89425	0.98932	1.04254	1.05308	
0.94747	0.98791	1.02829	1.05716	1.06722	
1.04719	1.00803	1.14250	1.23056	1.11972	$_{hi}$ß

Matrix B: Beta Estimated Using the FT-500 Index

$_{lo}$Firm size$_{hi}$

0.610447	0.581000	0.620196	0.651926	0.521522	^{lo}ß
0.529916	0.647177	0.691403	0.785066	0.713943	
0.615569	0.740415	0.791952	0.899264	0.913971	
0.775048	0.807118	0.836480	0.977014	0.872964	
0.913058	0.912917	0.975728	0.997294	0.965865	$_{hi}$ß

Matrix C: Dimson Post-ranking Betas

$_{lo}$Firm size$_{hi}$

0.63452	0.64787	0.69398	0.79611	0.73107	^{lo}ß
0.69734	0.79139	0.91704	0.98087	0.93335	
0.84790	0.78802	0.98526	1.04015	1.01348	
0.94240	1.02144	0.98331	1.06330	1.09658	
1.02364	1.05294	1.14061	1.16930	1.06098	$_{hi}$ß

Previous studies (for example, Bhardwaj and Brooks, 1992) have noted that January is an exceptional month. Tinic and West (1984) demonstrate that the relationship between return and systematic risk is consistently positive only for the month of January in the US. Accordingly, we examine the relation between post-formation betas and average returns for the month of January. The higher returns in Matrix A of **Table 4** compared with those in **Table 2** are a manifestation of the well-known turn-of-the-year effect. Unlike **Table 2**, the former table reveals a distinct positive relation between beta and returns. It is worth noting that the positive *ex-post* returns in January are more likely to correspond to the *ex-ante* expected returns which beta is hypothesised to explain. This may be a factor in rationalising why beta works better in January. Curiously, there is a positive relation between size and return. Matrix B of **Table 4** demonstrates that the pre-ranking betas are preserved in the test period. However, there is no easily discernible relation between post-ranking betas and size in January.

Table 4: January Post-ranking Returns

Matrix A: January Returns for Size- and Beta-formed Portfolios

$_{lo}$Firm size$_{hi}$

.0429692	.0320598	.0314000	.0311838	.0392769	^{lo}ß
.0341685	.0455869	.0449777	.0529221	.0564517	
.0357723	.0441269	.0523485	.0590754	.0545985	
.0394931	.0513369	.0591331	.0559962	.0485300	
.0447600	.0519885	.0603885	.0549346	.0647523	$_{hi}$ß

Matrix B: January Betas for Size- and Beta-formed Portfolios

$_{lo}$Firm size$_{hi}$

0.78939	0.36809	0.68142	0.88590	0.81154	^{lo}ß
0.05818	0.93512	0.73755	1.17660	0.98345	
0.73869	0.82041	1.05994	0.97392	0.99602	
0.83577	1.00799	0.96283	1.13219	0.96676	
1.35155	0.94429	0.96005	1.09012	1.29867	$_{hi}$ß

The above results indicate that neither beta nor size are good explanatory variables for average returns. However, the former in particular seems to work reasonably well in January.

Table 5: Company Level Second-Pass Regressions

$R_{it} = \gamma_0 + \gamma_1 Size_{it-1} + \gamma_2 \beta_t$		
Intercept	**Size**	**ß**
Panel A: Ordinary Beta		
.017 (5.03)		-.003 (-0.51)
0.016 (3.35)	-.0003 (-0.68)	
0.018 (4.23)	-.0003 (-0.66)	-.002 (-.36)
Panel B: Scholes-Williams Beta		
0.017 (3.65)		-.002 (-0.36)
0.018 (3.17)	-.0003 (-0.33)	-.002 (-0.7)

Note: We regress the monthly returns (R_{it}) for individual stocks on beta and size. Here i represents the month and t the year. A stock's beta is defined as the post-formation beta of the portfolio it is in for year t. Its size is defined as the natural log of the market value of equity at the end of June in year t-1. A cross-sectional regression is estimated for each month from January 1980 through to December 1992. The coefficients reported in the table are the time-series average of those from the monthly regressions. The t-statistics, which are in parentheses, are based on the time-series standard errors.

Next, we turn to an examination of beta's usefulness as an explanatory variable for average returns using the traditional second-pass regression methodology of CAPM tests. Like Fama and French, we regress the monthly returns (R_{it}) for individual stocks on beta and size. Here i represents the month and t the year. A stock's beta is defined as the post-formation beta of the portfolio it is in for year t. While a portfolio's post-formation beta is constant throughout the test period, a stock's post-formation beta may change when the portfolios are re-balanced annually. Its size is defined as the natural log of the market value of equity at the end of June in year t-1. A cross-sectional regression is estimated for each month from January 1980 through to December 1992. **Table 5** outlines the time-series average of the coefficients estimated from the 156 cross-sectional regressions. The t-statistics, which are based on the time-series standard errors, show that beta is not able to explain the cross-section of returns. However, unlike Fama and French, we find no evidence to support size as an explanatory variable for return. When we isolate the month of January, we find the expected positive relation between beta and return (**Table 6**). Size is, again, insignificant in the January regressions. Furthermore, it does not effect the magnitude or significance of the parameter on beta. Since April has been noted as unusual in the UK, we also examined this month in isolation. The results (not reported here) of the second-pass regressions for April reveal a weak (significant at approximately 10% level) positive relation between ß and return.

The overall results are not encouraging for CAPM. While beta does not explain, or even contribute to the explanation of, the cross-section of returns, this does not preclude its usefulness. One potential use might be to establish how responsive the return on a stock is to extreme market movements. Following Chan and Lakonishok (1993), we examined the relation between beta and portfolio returns in extreme bull and bear markets. These authors used portfolios formed on pre-ranking beta. We used our size-beta or Fama and French-formed portfolios for the analysis. The results are presented in **Table 7**, which contains the average return on each of the 25 size-beta portfolios over the 10 months of the post-formation period when the stock market showed the greatest gains or losses. **Table 7** shows a strong positive relation between beta and returns in extreme bull and bear markets. Thus, if a portfolio manager is interested in how his portfolio might behave in extreme bull or bear markets the beta of the portfolio is definitely relevant. Interestingly, the size of firms in a portfolio is not particularly useful in predicting its performance in extreme down-markets. However, portfolios comprised of large firms seem to have out-performed, after controlling for beta, those comprised of small firms in extreme bull markets over the period.

Table 6: Company Level Second-Pass Regressions for January

$R_{it} = \gamma_0 + \gamma_1 Size_{it-1} + \gamma_2 \beta_t$		
Intercept	**Size**	**ß**
Panel A: Ordinary Beta		
0.004 (3.05)		.047 (2.9)
0.041 (3.07)	.001 (0.75)	
0.002 (0.14)	-0003 (-0.16)	.049 (3.2)
Panel B: Scholes-Williams Beta		
.004 (0.29)		.042 (2.59)
-.002 (-0.14)	.001 (0.68)	.042 (2.63)

Note: We regress the monthly returns (R_{it}) for individual stocks on beta and size. Here i represents the month and t the year. A stock's beta is defined as the post-formation beta of the portfolio it is in for year t. Its size is defined as the natural log of the market value of equity at the end of June in year t-1. A cross-sectional regression is estimated for each January from 1980 through to 1992. The coefficients reported in the Table are the time-series average of those from the monthly regressions. The t-statistics, which are in parentheses, are based on the time-series standard errors.

The tests described above were repeated having formed the portfolios in a manner akin to that employed by Fama and MacBeth (1973) – forming portfolios on the basis of beta in two pre-formation periods. These tests confirm the results outlined above – beta does not explain the cross-section of returns but is a good predictor of the upside and downside potential of a portfolio in extreme market conditions, hence they are not presented here.

Table 7: Beta and Extreme Market Movements

Matrix A: Average Portfolio returns for 10 Highest-ranking Months (r_m), 1984-1992

$_{lo}$**Size**$_{hi}$

.042878	0.058321	0.065344	0.059904	0.061878	^{lo}ß
.034793	0.066733	0.096708	0.105042	0.089540	
.067457	0.083440	0.094870	0.097914	0.104497	
.075138	0.093825	0.109285	0.125468	0.106828	
.117501	0.101638	0.120010	0.135040	0.125463	$_{hi}$ß

Matrix B: Average Portfolio Returns for 10 Lowest-ranking Months (r_m), 1984-1992

$_{lo}$**Size**$_{hi}$

-0.089583	-0.078478	-0.085321	-0.089114	-0.086523	^{lo}ß
-0.094321	-0.112403	-0.110827	-0.119175	-0.113499	
-0.116062	-0.124862	-0.129045	-0.133988	-0.124777	
-0.126152	-0.128785	-0.123407	-0.135723	-0.123961	
-0.137064	-0.136217	-0.142612	-0.143265	-0.131407	$_{hi}$ß

Note: The numbers in the matrices are the average returns on each of the 25 size-beta portfolios over the 10 months when the stock market showed the greatest gains or losses.

SUMMARY

The results of our analysis using size-beta formed portfolios suggests that beta works as predicted by the CAPM only in January. In general, beta computed using monthly data does not explain, or even contribute to the explanation of, cross-sectional differences in return.

We also split the sample into portfolios based on (a) size and beta and (b) beta rankings in two separate prior periods. We then analysed the performance of these portfolios in extreme bull and bear markets. The results provide evidence that beta is a good predictor of portfolio performance in extreme up- and down-markets. Thus, beta is a useful statistic for a portfolio manager who is concerned about the volatility of his portfolio relative to that of the market.

In interpreting the evidence regarding beta presented here, cognisance must also be taken of the fact that the betas used were estimated using monthly data. While some efforts were made to overcome the problems induced by non-synchronous trading, we cannot claim that betas estimated in another way (for example, using annual returns (Kothari et al. 1995a)) may provide different results. In addition, our sample selection procedure may have induced a survivorship bias. We would expect such a bias to manifest itself in a significant negative relation between return and size. However, we find no evidence of a size effect. Kothari et al. (1995b) suggest that samples comprised of large companies are not susceptible to survivorship biases. Hillion and Rau demonstrate that using all companies with 24 months of data in the portfolio formation period results in a downward bias of the coefficient on size. Thus, our failure to find evidence of a size effect is probably due to our sample being drawn from a population of relatively large companies and/or the absence of the bias documented by Hillion and Rau.

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NOTES

[1] However, when the Scholes-Williams and Vasicek betas were estimated for size-beta portfolios, this relationship between size and beta almost disappears.

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