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The Relevance of a "Beta Book" for Irish Equities*

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Abstract: This paper investigates the role of β coefficients in determining rates of return on equities traded in the Irish stock market. It concludes that a "Beta Book" would be inappropriate in this case due to institutional factors and related market inefficiencies. It suggests, however, that further research is needed to explore the relationship between rate of return and unique risk.

I INTRODUCTION

The development of capital market theory, in terms of the Single Optimal Portfolio Selection Model and its extension in the form of the Capital Asset Pricing Model (CAPM), has led to the regular publication in recent years of risk indices for individual companies listed on the major stock exchanges. These risk measurement publications or "beta books" are particularly prominent in the United States where the major publications are produced by Merrill Lynch, Pierce, Fenner and Smith; Wells Fargo Bank and Value Line. In the United Kingdom the London Business School produces a quarterly publication, the "Risk Measurement Service", which estimates risk for each of 2,000 British quoted companies.

To date, no comprehensive risk measurement publication exists for the Irish Stock Market. While the London Business School's publication includes risk measures for a number of leading Irish companies, these betas are cal-

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culated relative to a United Kingdom stock exchange index. Consequently, these risk measures are only relevant for investors who have unlimited access to the United Kingdom market. Given that Irish investors are primarily restricted to holding portfolios of Irish stocks, it is the intention of this article to explore the possibility of developing an Irish "beta book" based on an Irish stock exchange index.

The "Risk Measurement Service" bases its beta (β) estimates on a five year period of monthly share price data. As this is typical of other publications, the central issue in an Irish context is whether or not a similarly calculated set of βs can convey reliable information to Irish investors.

In large exchanges, with a wide range of actively traded stock and well established market indices, the application of the CAPM is relatively straightforward. In the small Irish market, however, it is not clear that a sufficiently diversified portfolio can be achieved, based on Irish stock alone. The Irish stock market, which in 1984 recorded approximately 44,000 bargains and a turnover of IR£1,032 million (approximately one-fifteenth of the turnover of the Irish gilt market), has a listing of under 100 companies. Within this listing, the 7 most actively traded stocks dominate, accounting for around 70 per cent of total equity market capitalisation. While the close links between the Irish and United Kingdom markets might imply that the benefits of diversification can be achieved in a wider market context, the imposition of strict exchange controls militates against this.[1] Referring to this situation Davy *et al.* (1984) argue:

> . . . Irish based fund managers bear the cost of distortions caused by exchange controls most directly. Given the narrowness of the Irish equity market, the restrictions on outward portfolio investment are a more severe restriction in Irish circumstances than they might be elsewhere.

These Irish based funds have a much higher proportion of investments in Irish gilts, between 35 per cent and 40 per cent, relative to their equivalents in the United Kingdom where investments in British gilts are around 15 per cent. The effect of Irish investors being "locked into" their domestic market by exchange controls can also be seen by comparing Dublin and London quoted equities which have broadly similar industrial characteristics. The best example is found in the banking sector where the Irish banks, relative to the

1. In March 1973 the exchanges of Great Britain and Ireland were united. Consequently, the Irish Stock Exchange may now be thought of as primarily a unit of the United Kingdom exchange. In practical terms this implies that Irish stocks can be simultaneously traded on the Dublin and London markets. Under exchange controls, however, institutions are restricted to investing no more than 10 per cent of their current cash flows overseas.

British banks, have lower yields and higher price-earnings ratios. At a more general level, the effect of these constraints on the efficiency of Irish equity portfolios has been demonstrated by Keenan (1985).

The imperfect segregation of the Irish market together with the small number of domestic stocks, the majority of which are thinly traded, implies that complete risk diversification is unobtainable. Thus with the likelihood that significant elements of unsystematic risk will be present in any "index portfolio", the direct application of the CAPM is unlikely to provide the private resident and/or institutional investor with unambiguous information on risk.

To obtain a clearer view on these issues, this paper applies the conventional CAPM to data on Irish stocks. In Section II, the estimation problems associated with discontinuously traded securities are reviewed. A summary of the β estimates obtained for Irish stocks is presented in Section III, with the testable propositions of the CAPM being examined in Section IV. In conclusion, Section V outlines areas where future research is required, if a comprehensive Irish risk measurement service is to be provided.

II

The standard equilibrium relationship of the CAPM, as developed by Sharpe (1964) and Lintner (1965), has normally been applied using a linear stochastic relationship of the form:

$$R_{it} = \alpha_i + \beta_i \, r_{mt} + \epsilon_{it}.$$

This relationship states that in period t, the rate of return on the i^{th} stock (R_{it}) is a linear function of the rate of return on a market index (r_{mt}) and a random disturbance term (ϵ_{it}). If the assumptions of the classical normal linear regression model hold, then the ordinary least squares estimates of the parameters α_i and β_i will be best linear unbiased.

One crucial factor in application is ensuring that the chosen market index closely approximates the theoretical market equilibrium portfolio, thus avoiding an "errors in variables" problem which tends to be compounded by dependence between the residuals and the market index. The latter arises from the small number of stocks making up the market. Another crucial factor is making allowance for the instability of β estimates which may arise from both "errors in equation" and "errors in variables", amongst other factors.[2]

2. For a discussion of these other factors see Blume (1975).

Alternative methods of tackling the instability problem have been advanced by Vasicek (1973), Blume (1975), Klemkosky and Martin (1975) and Lavely *et al.* (1980). In a review of these Hawawini and Vora (1983) state:

> . . . there is an uncertain and statistically insignificant gain from adjusting betas with the "appropriate technique" and there is a significant loss if an "inappropriate" technique is used. The implication should be clear: our advice to investors is to rely on simple, no-change, unadjusted betas . . .

The Hawawini and Vora argument, even if accepted, would not remove all difficulties in the Irish case; since their argument is primarily rooted in the "errors in equation" model. In the Irish market, the dominance of thinly traded stocks places most emphasis on the "errors in variables" situation. With timing errors occurring from the use of data on discontinuously traded stocks, problems of bias, as identified by Dimson (1979), arise. The β estimates of thinly traded stocks tend to be biased downwards while those relating to active trades tend to be biased upwards. Alternative approaches to this problem have been put forward by, amongst others, Pogue and Solnik (1974), Scholes and Williams (1977), Schwert (1977) and Dimson (1979). Given the data limitations inherent in the present study, Dimson's (1979) aggregated coefficient method was used. According to Fowler and Rorke (1983) the Scholes and Williams estimator would be a better choice but the difference between it and the Dimson adjustment technique is marginal.

Dimson advocates running a multiple regression of stock returns against the lagged, matching and leading values of the market index. A consistent β estimate is obtained by aggregating the slope coefficients in the estimated regression. This procedure requires neither the market index to be continuously traded nor supplementary data, such as transaction times, which are not available for the Irish market. As returns were calculated on a four week basis over a five year period, a one period lead/lag was deemed sufficient.

Turning to the choice of market index; the most comprehensive index available for the Irish market is that developed by J. and E. Davy (Stockbrokers, Dublin). The Davy index is based on market capitalisation weights and takes account of dividends, rights issues and stock splits. Given the serious "errors in variables" problem, it was decided to employ both the Davy index and an arithmetic mean index, with appropriate adjustments made for dividends, rights and splits. With the most serious measurement errors present in the thinly traded stocks, a value weighted index which is dominated by actively traded stocks might be expected to be more accurate than an arithmetic index. In the absence of information on measurement errors, however, it is unclear how these errors net out in aggregation. Index choice is an empirical issue the resolution of which partly depends on assessing the mean-variance efficiency of each index. This is explored in Section IV in the context of Roll's (1977) critique.

III

Beta coefficients were estimated for 52 Irish quoted companies over the period May 1979 to May 1984. Taking prices on a four week basis yielded 65 observations. The underlying method of estimation was ordinary least squares, with return data expressed in logarithmic form.

In Table 1, a summary of the equity market structure in terms of the percentages of defensive, average and aggressive stocks is presented; together with the percentages of systematic and unique risk, averaged over all stocks.[3]

Table 1: *The Risk Structure of the Irish Equity Market*

Index	*Percentage of stocks classified as:*[1] *Defensive* $\beta < 1$	*Average* $\beta = 1$	*Aggressive* $\beta > 1$	*Average ratio systematic: total risk (%)*	*Average ratio unique: total risk (%)*
J. and E. Davy Index	44	2	31	19.4	80.6
Arithmetic Index	44	4	38	10.35	89.65

[1]Stocks unclassified had either negative β coefficients or β coefficients which were insignificantly different from zero (5 per cent level of significance). Depending on the index employed the percentage of stocks unclassified ranged between 14 per cent and 23 per cent.

Use of the arithmetic index, relative to the Davy index, results in a smaller number of stocks being unclassified. While the percentage of stocks classified as defensive is the same in each case, the percentage of aggressive stocks is much lower when the Davy index is employed. It is interesting to note that this latter value weighted index records a higher average level of systematic risk. Despite these differences, the ranking of stocks in terms of their β coefficients is almost identical, the Spearman-Rank correlation coefficient, at .99, being significantly different from zero at the 1 per cent level.

To give a flavour of the more detailed estimates, β coefficients for six Irish

3. The authors on request will supply a detailed listing of Irish equity βs for the period under consideration.

companies are reported in Table 2. With the demand for the products of Carroll Industries (tobacco) and Independent Newspapers (printing) being relatively stable over the business cycle, it was to be expected that these stocks would be classified as defensive. Conversely, companies which specialise in products where demand variation is likely to exceed that of activity in the economy in general can be expected to exhibit aggressive tendencies. This hypothesis is supported in the case of Jefferson Smurfit (specialising in the paper and packaging) and Waterford Glass (specialising in crystal glass manufacture). Again, it was anticipated that the two banks, with their integrated activity in the national economy, would exhibit β coefficients close to unity.

Table 2: *Beta Estimates for Selected Irish Equities*

Company Name	*Beta Estimate Based on:*[1]	
	Arithmetic Index	*J. and E. Davy Index*
Carroll Industries	0.56	0.68
Independent Newspapers	0.69	0.71
The Bank of Ireland	1.12	1.11
Allied Irish Banks	1.19	1.18
Jefferson Smurfit Group	1.80	1.47
Waterford Glass	1.40	1.21

[1] Looking at the population as a whole, the deviation of the βs from unity was smaller in the case of estimates based on the value weighted index relative to the arithmetic index. This is in line with conventional wisdom.

The above type of arguments can be advanced in respect to most of the other stocks in the population. This might imply that while the problems encountered with Irish data preclude the use of β coefficients for quantitative inferences, the estimates can provide useful qualitative guidelines (irrespective of the choice of index),in terms of the standard aggressive-defensive classifications. Such a deduction is only valid, however, if it can be shown that, independent of data problems, the CAPM is the correct model to use in the Irish case.

There are methodological difficulties in testing the CAPM. In particular, Roll (1977) has shown that the mathematics of mean-variance analysis can imply that tests are tautological. The main problem centres on the impossibility in practice of identifying the theoretical market equilibrium portfolio. According to Roll, while an index portfolio can be judged to be mean-variance efficient on the basis of the R^2 of a conventional "second pass" regression,[4] only one of the mean-variance efficient portfolios will be the market equilibrium one. Consequently, in a strict sense the efficiency of the index portfolio and the validity of the CAPM are joint hypotheses. In a more recent article, however, Markowitz (1984) has clarified the relationship between factor or index models and the CAPM. If investors, as Roll indeed argues, view β in the context of factor models then the implications of the Roll critique may not be as stringent as first thought.

Bearing the above methodological discussion in mind, the following section analyses the model in terms of the testable propositions described in Levy and Sarnat (1984).

IV

The CAPM implies that the equilibrium rate of return on an individual asset is determined solely by its systematic risk. The model predicts that this relationship is linear, has a positive slope coefficient measuring the market risk premium and in the Sharpe-Lintner version, with unrestricted riskless borrowing, has an intercept term equivalent to the risk-free rate of interest.

These propositions were tested using the conventional ordinary least squares "second pass" regression method, with the mean rate of return on each stock ($\bar{R}_i$) being regressed against the stock's estimated β coefficient ($\hat{\beta}_i$). The underlying relationship was of the form:

$$\bar{R}_i = \delta_1 + \delta_2 \hat{\beta}_i + U_i,$$

where δ_1 and δ_2 are the parameters to be estimated and U_i is a random disturbance term. To test for linearity a quadratic relationship in the βs was used.

As indicated above the ordinary least squares estimators of the stocks' β coefficients are subject to biases because of measurement errors arising pri-

4. The linear stochastic relationship used for estimating β (as described at the beginning of Section I) is known as the "first-pass" regression. Given the ordinary least squares estimates of each stock's β ($\hat{\beta}_i$) thus obtained, the "second pass" regression consists of regressing the mean rate of return on each stock ($\bar{R}_i$) on $\hat{\beta}_i$. The implied underlying relationship of the "second pass" regression is:

$$\bar{R}_i = \delta_1 + \delta_2 \hat{\beta}_i + U_i.$$

In terms of the CAPM the parameters δ_1 and δ_2 are taken to represent, respectively, the risk-free rate of interest (r_f) and the market risk premium ($E(r_m) - r_f$), where $E(r_m)$ is the expected rate of return on the market equilibrium portfolio. Roll's argument is that if $\hat{\beta}_i$ is based on the index in the "first pass" regression, if that index lies on the Markowitz efficient frontier of the portfolio opportunity set, the "second pass" regression will turn out with a perfect fit.

marily from thin trading. The bias correction method initially employed was that proposed by Dimson (1979) which is in practice a form of instrumental variables estimator. In the initial "second pass" regressions (not reported) it was evident from the Goldfeld-Quandt test that heteroskedasticity was present and that even with the Dimson estimator all of the errors had not been removed.

It has been argued by Fama and MacBeth (1973), amongst others, that by considering portfolio β coefficients which are aggregates of individual stock βs, the effect of errors can be further reduced. There are two interrelated reasons leading to the rejection of this approach in the present study. First, the current paper is concerned with ascertaining whether or not individual stock β coefficients would represent a reliable foundation for an Irish "beta book" and as such is not concerned at this stage with the CAPM at a portfolio level. Second, and more importantly, Levy and Sarnat (1984) argue that caution should be exercised in the interpretation of the portfolio approach:

> . . . the CAPM is an equilibrium model for price determination of individual assets as well as portfolios . . . though it is true that the construction of portfolios eliminated some statistical errors, we cannot test the CAPM with portfolios and infer that it holds for individual risky assets.

With a heteroskedastic error variance an alternative approach to estimation involves the adoption of an appropriate transformation process. With subsequent work showing that the error variance was proportional to the square of $\hat{\beta}_i$ the above equation was transformed to:

$$\bar{R}_i\hat{\beta}^{-1} = \delta_1\hat{\beta}^{-1} + \delta_2 + U_i\hat{\beta}_i^{-1}.$$

Two sets of regression estimates, adjusted for heteroskedasticity, are reported in Table 3. In the first set, the explanatory variables are defined as the β estimates based on the Davy Index. In the second, as the β estimates based on the arithmetic index. It is interesting to note that the regression estimates are not over-sensitive to the index on which the explanatory variables were based. In terms of R^2 and regression significance as a whole, the arithmetic index (on the basis of Roll's critique) appears to be the more appropriate.

With respect to the testable propositions, comparisons of regressions (1:1) and (1:2) and of (2:1) and (2:2) tend to support the hypothesis that the risk/rate of return relationship is linear. The F-statistic computed from the general test for linear restrictions supports the null hypothesis that the parameter on $\hat{\beta}^2$ is zero.[5] In two important ways, however, the predictions of the CAPM are contradicted. First, the risk free rate of interest, taken as the annual average over the sample period of the Irish Government's Exchequer Bill Rate (15.8%), tends to be overestimated. Second, the estimated risk/rate of return relationship is negative but insignificant.

Table 3: *Adjusted Least Squares Regression Equations Explaining the Mean Rate of Return on Equities*[1]

Regression Number	*Estimated Intercept*	*Estimated Coefficient On:* $\hat{\beta}$	$\hat{\beta}^2$	R^2	F
		(Estimates based on the Davy Index)			
1:1	0.024 (36.4)	-0.007 (-0.52)		0.96	1,326.7
1:2	0.024 (35.74)	0.005 (0.243)	-0.019 (-0.844)	0.96	659.9
		(Estimates based on the Arithmetic Index)			
2:1	0.018 (281.0)	-0.008 (-0.919)		0.999	78,941.3
2:2	0.018 (275.8)	-0.011 (-0.814)	0.003 (0.288)	0.999	38,746.0

[1] Sample size 52, t-ratios in parentheses. The intercept and slope coefficient estimates are from equations adjusted for heteroskedasticity. For example, the equation in (1:1) is:

$$\bar{R}_i = \delta_1 + \delta_2\hat{\beta}_i + U_i.$$

In the transformation process the estimates of δ_1 and δ_2 are respectively the slope and intercept

$$\left(\frac{\hat{R}_i}{\hat{\beta}_i}\right) = \hat{\delta}_1 \frac{1}{\hat{\beta}_i} + \hat{\delta}_2.$$

5. The appropriate F statistic is:

$$F = \left[\frac{R^2_Q - R^2_K}{1 - R^2_Q}\right] \left[\frac{N - Q}{Q - K}\right],$$

where K is the number of parameters to be estimated in the original equation and Q the number of additional explanatory variables. R^2_Q and R^2_K are associated respectively with the original equation and the equation with the additional variables.

The majority of other studies, dating from Lintner (1965), demonstrate similar results with respect to the risk-free rate of interest. Explanations for these findings have been given in terms of inflation and have led to extensions of the CAPM, in particular, Black's (1972) zero-beta version. A relatively high level of inflation was experienced in Ireland over the sample period, with the wholesale price index rising from 169.5 to 326.2.

Explanations for the insignificant relationship are not clear-cut, although there is evidence in the Irish case that during the period under study there was a mildly negative premium for the whole market (see below). In general, Hawawini *et al.* (1983) argue that this insignificance could occur because tests are performed on an expectational relationship using historic data. Nevertheless, using a period of sufficient length the return on the market portfolio should outperform that on the riskless asset or indeed the return on the zero-beta asset. While the majority of studies suggest, at least in an efficient market, that a five year period should be sufficient for the arbitrage process to establish a positive trade-off, the Hawawini *et al.* (1983) results for the Paris stock exchange (1969-79) and those of Schalleim *et al.* (1980) for the American stock markets (1968-74) show negative relationships.

More recent research by Corhay *et al.* (1987) covering these exchanges and the exchanges in Brussels and the United Kingdom point in general to insignificant relationships. A key factor which appears to be emerging, however, is seasonality in the risk-return relationships. In the Belgium and French markets positive risk premia are observed in the month of January with negative premia over the rest of the year. A positive April seasonal effect is observed in the United Kingdom with a negative average risk premium over the rest of the year.

Turning to specific explanations in the Irish case, the data covered a period (1979-84) in which a combination of an expansionary domestic fiscal policy and international recession resulted in high domestic interest rates. Hutchinson *et al.* (1985) have shown that over this period the Irish stock market as a whole could just about compete, in terms of rate of return, with the short-term Irish gilt market. Their results, with an annual market risk premium of -0.76, are consistent with the findings of Corhay *et al.* In addition, in the current sample there is some evidence of seasonality in April but further research on this is pending. More importantly, however, Hutchinson *et al.*, demonstrate that the excess return on equity over gilt rates varies over trading category. The excess return is positive and highest in the case of semi-actively traded stocks and negative in the case of thin trades. Given seasonality and the predominance within the stock market of non-existent and thin trades, the insignificant relationship may be indicative in a more fundamental way of the inapplicability of the standard CAPM.

The information on trading category together with the exchange control restrictions in the Irish market implies that Irish investors are not efficient diversifiers but rather hold small portfolios containing few securities. Note that the implication is not that the Irish market is inefficient. In these circumstances it is likely that total risk, that is both systematic and unique risk, determine rates of return. To test for this, the mean rate of return on stocks was regressed against the arithmetic index based estimates of the β coefficients and each stock's unique risk, as approximated by residual variance ($\hat{\sigma}_{ei}^2$). The result reported below tends to confirm the latter hypothesis. The coefficient estimate on unique risk is significantly different from zero at the 1 per cent level.

$$\hat{\bar{R}}_i = \underset{(6.64)}{0.007} - \underset{(-0.26)}{0.001\hat{\beta}_i} + \underset{(9.526)}{0.707\hat{\sigma}_{ei}^2}; \quad R^2 = 0.99, \quad F = 110365.0$$

The evidence constitutes partial support for Levy's (1978) Generalised CAPM; however, the dominance in terms of size and significance of the coefficient estimate on $\hat{\sigma}_{ei}^2$, relative to that on $\hat{\beta}_i$, could suggest that the unique risk element in total risk is the crucial factor determining rates of return on Irish stocks.

V

The quarterly "beta book" publications familiar in countries like the United States and the United Kingdom are based on indices compiled from each country's domestic stocks. Each quarterly set of βs are normally calculated on a five year data period directly preceding each quarterly publication date. It is clear from the above that the construction of a "beta book" for Ireland in these conventional terms would be of little relevance to its investment analyst industry. A number of areas have been identified, however, where subject to further research, appropriate risk measures may be forthcoming.

Although unique risk as defined in the CAPM appears to be the predominant determinant of rates of return, econometrically it simply represents residual or unexplained variance. Interpreted in this manner our results could indicate that other important systematic influences operate on the Irish market. The position of Irish gilts in investment fund portfolios has not been explicitly considered nor has the relationship between the Dublin and London equity markets.

It is hoped to explore further the determinants of rates of return by developing a model which blends the important Irish bond portfolios with equity portfolios. The role of exchange controls and the importance of the relationships between the Dublin and London markets have also to be investigated. Not only are a number of Irish stocks traded on the London market, but the Irish economy is still highly dependent on the behaviour of the United Kingdom economy. This may, taking into account exchange rate movements between the punt and sterling, have implications for the measurement of systematic risk in the Irish economy as a whole. Adaptation of recent work by Jorion and Schwartz (1986) may prove illuminating in this context.

As a preliminary to pursuing the above, our current research is focusing on the properties of an "optimal" portfolio with allowance, within the constraint of exchange controls, being made for international diversification.

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