The Conditional Relation between Beta and Returns: the New Zealand Case

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Abstract

New Zealand market excess returns are often negative in the most recent decade. This renders the risk-return relationship in the stock market not significant. This paper extends the dual-beta framework (Wiggins 1992, Pettengill, Sundaram, and Mathur 1995, Isakov 1999, Tang and Shum 2004) to study the conditional relation between beta and realized returns in the New Zealand stock market. R-squared in the conditonal-beta framework is more than 100 times that in the unconditional beta model. There is a significant positive (negative) relation between beta and realized returns in the up (down) market. It is difficult to achieve a high level of diversification in New Zealand (Pinfold et al. 2001). As a result, total risk contributes to offset the negative returns in down markets.

1. Introduction

The Sharpe-Lintner-Black (SLB) model postulates a positive risk-return relationship for individual stocks included in a well-diversified portfolio. Early tests of Fama and McBeth (1973) confirm that the SLB model is valid and beta is positive. Hawawini and Michel (1982) argue that investors are only rewarded for bearing systematic risk and not unsystematic risk. However, the SLB model is facing challenges. Lakonishok and Shapiro (1984) and Miller (1999) find that the beta of a portfolio is not sufficient to explain the returns of a portfolio alone. Fama and French (1992), in

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particular, point out that beta is actually *flat* and not useful. They find that firm size and book-to-market ratio significantly explain average returns.

Pettengill et al. (1995) point out that the SLB model is tested by using realized returns as a proxy for expected returns. There is a positive relationship between beta and return in an up market. In a down market, this relationship becomes inverse. Isakov (2001) and Tang and Shum (2004) find similar conditional beta results in the Swiss market and Singapore market respectively.

The New Zealand stock market is small and illiquid compared to world standards. It provides a unique opportunity to test the conditional beta framework in this market. Our empirical results, consistent with Pettengill et al., Isakov, and Tang and Sum, show that beta is significantly positive (negative) in an up (down) market. Pinfold et al. (2001) report that that there are frictions to diversify well in the New Zealand market. Our empirical results show that total risk does contribute in explaining realized return, especially in the down markets.

This paper is organized as follows: Section 2 provides literature review for the conditional beta framework and New Zealand studies on beta. Section 3 reports the data and methodology to estimate conditional betas. Section 4 discusses our empirical results and Section 5 concludes the paper.

2. Literature review

In this section, we first review the challenges to the unconditional beta model. Then, we infer from the SLB model that betas in the up and down markets should both be considered. We conclude this section by reviewing past studies on the SLB model in the New Zealand market.

A positive relation between risk and return is firstly observed by Fama and MacBeth (1973) in the US market based on the data for the period from 1935 to 1968. Hawawini and Michel (1982) argue that investors are compensated for systematic risk and they are not compensated for unsystematic risk. Portfolios thereby shall be well diversified to bear only the systematic risk. However, Schwert (1983) points out that the positive risk-return relation is very weak in sub-periods. Tinic and West (1984) report that the risk and return relation is only significant in January of the year. Reinganum (1981) finds only limited evidence that higher beta portfolios are able to generate higher average returns for investors. Whether beta is related to average portfolio returns is not clear.

Haugen and Baker (1991) and Lakoniskok and Shapiro (1984) argue that the performance of individual stocks is closely related to their market capitalizations instead of their betas. Fama and French (1992) provide conclusive evidence that virtually no positive relation between risk and stock return could be identified when using a data sample set from 1963 through 1990. They further point out that portfolio returns can only be explained by the size and the book-to-market ratio (B/M) of the portfolios. The single beta value is simply not useful to explain portfolio returns (cf. Miller 1999). Roll (1988) states that the SLB model cannot even describe the historical returns of the stock in the market.

The unconditional SLB model may seem to be not useful, or dead. However, the SLB model is very useful when up and down market conditions are considered. We begin from the implicit two-factor SLB model to infer that the up and down market conditions should both be incorporated when estimating betas.

The SLB model is an ex ante model which predicts a positive risk-return relationship for stocks included in a well-diversified portfolio. The model implies that the expected return of a stock is the weighted average of the market return and the risk-free rate where the weight is beta, β.

$$E(R_i) = R_F + \beta\left[E(R_M) - R_F\right]$$

$$\Rightarrow \quad E(R_i) = R_F + \beta E(R_M) - \beta R_F$$

$$\Rightarrow \quad E(R_i) = \beta E(R_M) + (1-\beta) R_F$$

If the market excess return, $E(R_M) - R_F$, is positive with certainty, no investor would invest in the risk-free asset. On the other hand, if the sign of the market excess return, $E(R_M) - R_F$, is not known with certainty, an investor will always hold the two-asset portfolio. This implies that there is a positive probability that the market excess return, $E(R_M) - R_F$, is negative[2]. The SLB model thus incorporates up and down market conditions and therefore can be developed to estimate betas in up and down markets.

Empirical studies in this area begins with Jagannathan and Korajczyk (1986) who find that CRSP (Center for Research in Security Price) equally-weighted index exhibits a larger estimated up than down beta when regressed against the CRSP value-weighted index. Wiggins (1992) extends their work and find that up and down betas give a stronger explanation for monthly cross-sectional returns. Pettengill, Sundaram, and Mathur (1995) point out that empirical tests on the SLB model usually use

[2] Pinfold et al. (2001, p.295) report that "This is a reflection of the poor performance of the market during the period whereby it consistently yielded returns less than the risk-free rate." Note: the period is 1993-2001.

average realized market returns to proxy for expected market returns (p.101). When the realized market excess return is positive (up market), there should be a positive relation between beta and realized returns. When the realized market excess return is negative (down market), beta and realized returns are predicted to be inversely related. Isakov (1999) estimates dual betas in the Swiss stock market over the period 1973 to 1991. Empirical results show that beta is a valid measure of risk because it is significantly related to realized returns with expected positive and negative signs in up and down markets respectively. Isakov further finds that size or residual (firm-specific) risk do not contribute to the explanation of realized returns. Pettengill et al., Isakov, and Tang and Shum all find that the dual beta model consistently explains stock excess returns in the US, Swiss, and Singapore markets.

New Zealand Studies

New Zealand studies investigate the historical betas (Vos 1995), industry betas (Lally 2004), size and B/M effects (Bryant and Eleswarapu 1997, Vos and Pepper 1997, and Pinfold, Wilson, and Li 2001), and beta bias-correcting methods (Bartholdy and Riding 1994, Bartholdy et al. 1996, and Lally 1999). Vos (1995) uses two-stage regression

$$R_{it} = \alpha_i + \beta_i NZSE40_t + e_{it}$$
$$R_i = a + b\beta_i + \varepsilon$$

to study the return-beta relationship on the New Zealand stock market over the period 1993 to 1995. He finds that the slope *b* is significantly positive. There is therefore a positive risk-return relationship. However, the intercept *a* is not significantly different from zero. This means a risk-free investment earns zero return which however is not consistent with reality over the sample period. Vos thus concludes that beta can only be used with caution. The author asserts that high-beta shares perform well in an up market but worse in a down market. Unfortunately, no empirical evidences are provided. The dual-beta model adopted in this paper does present empirical evidences for Vos' assertion. Batholdy et al. (1996) examine the estimation of beta in the New Zealand stock market. They consider the effects of the length of the sample period, data frequency, the choice of the market index, and various estimation procedures to cope with thin trading. They find, for the best methods, that beta can explain at most 11.32% (i.e., R-squared) of the stock returns on average. In this paper, the adjusted R-squared in our dual-beta models is always larger than 18% without using any bias-correcting method. Pinfold, Wilson, and Li (2001) point out that the small number of listed firms and the high volatility of individual stocks hamper diversification in the New Zealand stock market. The empirical results in this paper confirms Pinfold et al.'s observation by showing that the stock total risk does contribute to explain realized returns, especially in down markets.

Both size and B/M effects do consistently explain New Zealand returns. We expect conditional betas will have a more significant effect than size and B/M. This paper only investigates the beta-return relation in up and down markets and leaves the combined effect of the conditional betas, size, and B/M for future study.

3. Data and methodology

In this section, we discuss our data source and how we deal with the thin trading problem embedded in the data. Then we set up the three-stage to estimate conditional betas. Finally, we specify the OLS regression models for unconditional beta as well as conditional betas with total risk to account for incomplete diversification.

Data

We collect New Zealand monthly stock prices, shares outstanding, three market indices, and the risk-free interest rate from Datastream. The full sample period spans from March 1991 through December 2003 covering 154 months. Our initial dataset contains 184 firms. As the New Zealand stock market experiences serious non-trading problems, we select only those stocks which trade more than 90% of the time over the sample period. Only 82 of the 184 firm are left in the sample. We argue that these 82 firms are representative of the New Zealand stock market as their aggregate market value represents 80% of the total stock market value, as at 1 December 2003. Roll (1977) critiques that the CAPM completes depends on the market index chosen. There are three New Zealand market indices available in Datastream (NZSE40, NZSE All, and Total Market). The three indices are highly correlated:

Table 1
Correlation matrix of the three indices

	NZSE 40	NZSE All
NZSE All	0.9946	1
Total Market	0.9755	0.9800

We find that our results respective to each of the indices are almost invariant. We therefore report only those results relative to NZSE40. The one-month New Zealand interbank offer rate is adopted as the risk-free rate in this study.

The New Zealand stock market is thinly traded. Bartholdy and Riding (1994) argue that beta estimates are biased downward when the stock is more infrequently traded than the market index. Blume and Stambaugh (1983) use the aggregated coefficient method of Dimson (1979) to adjust for the infrequent trading effect on US data. Berglund, Liljeblom and Löflund (1989) use a generalization of Scholes and Williams (1977) estimator to deal with non-synchronous stock price adjustments and infrequent trading in individual stocks on Finland data. Bartholdy and Riding use Dimson and Scholes and Williams estimators to adjust for thin trading on New Zealand data. They investigate 110 stocks listed on the New Zealand stock market for the six years from 1982 o 1987. There are on average less than 64.5% trades over the total trading days. The authors compare the efficiency of OLS beta estimates with the Dimson and Scholes and Williams estimators to correct for beta biases. They find that the beta-correcting methods actually do not offer incremental efficiency over standard OLS estimators. They conclude that OLS estimators are most efficiency and are closer to those based on synchronous data. Thus, in this paper, we use only OLS beta estimates without employing any bias-correcting procedures.

Tang and Shum (2004) Procedure to estimate conditional betas

To estimate conditional betas, we adopt the procedure described in Tang and Shum (2004). We divide our full 12 years and 8 months sample period into three consecutive none-overlapping sub-periods: the portfolio construction period (April 1991 – March 1994), the parameter estimation period, and the dual-beta model testing period (April 1997 – December 2003). In the portfolio construction period, each stock's beta is found by regressing 36 monthly stock excess returns against the market excess returns. All 82 New Zealand firms are then sorted by their beta value in descending order and grouped evenly into 10 portfolios. The first portfolio thus contains firms with the largest beta values and the last portfolio contains firms with the smallest beta values.

The few number of stocks and high-volatility of stock prices restrain investors to hold a well-diversified portfolio in the New Zealand stock market. In this paper, we investigate the effect of total risk together with dual betas on stock realized returns. Once the 10 portfolios are formed, the total risk of a portfolios is calculated by using stock monthly excess returns in the parameter estimation period (April 1994 – March 1997). In the model testing period, a portfolio equally-weighted excess returns in the first month (April 1997) are matched with its corresponding total risk. The overall process are then repeated in loop by deleting the first month's return (April 1991) of the portfolio forming period and adding the second month's return (May 1997) of the testing period. The first month's portfolio return of the testing period is moved into parameter calculation period for obtaining corresponding total risk as parameter period has to be maintained for 3 years. We continue this process until the last month (December 2003) of testing period is finally reached. In the end, we run a stack regression of all portfolio equally-weighted monthly excess returns in the testing period with the total risk of the corresponding portfolio.

OLS Regression Models

The unconditional beta and the dual betas with and without the presence of the total risk are estimated by the following regressions:

Unconditional beta: $$R_{jt} = \gamma_{0t} + \gamma_{1t}\beta_j + \gamma_{2t}\,\sigma_j^2 + \mu_{jt} \qquad (1)$$

where σ_{jt}^2 denotes total risk of portfolio j at time t.

Conditional beta: $$R_{jt} = \gamma_{0t} + \gamma_{1t}\lambda\beta_j + \gamma_{2t}(1-\lambda)\beta_j + \gamma_{3t}\lambda\sigma_j^2 + \gamma_{4t}(1-\lambda)\,\sigma_j^2 + \mu_{jt} \qquad (2)$$

where λ is a dummy variable to indicate up or down market condition; $\lambda = 1$ when the market return is larger than the risk-free, i.e., up market; and $\lambda = 0$ when the market return isles than the risk-free, i.e., down market.

Bartholdy et al. (1996) find that the unconditional "beta can at best explain 11% of the stock returns on average." In this study, we also report the adjusted R-squared for both the unconditional and conditional beta models. In the next section, we shall see that the adjusted R-squared in the conditional beta model is 100 times that in the unconditional beta model.

4. Empirical results

In this section, we first report a flat unconditional beta. The conditional betas are then shown to be significant in the up and down markets. The total risk variable in the conditional betas framework is only significant in down markets. Finally, our empirical results show that in the six sub-periods over six years and 9 months. The up market betas, while retaining their positive sign, are however not statistically significant. The down market betas are negative and are in general significant at 1%, 5%, and 10% level.

Unconditional betas

Table 2 contains the results of the unconditional beta model. The t-statistic of the unconditional beta, $t(\gamma_1)$=-1.57, is not significantly different from zero and carries the wrong sign. Consistently with the SLB hypothesis, the constant $t(\gamma_0)$=0.62, is not significantly different from zero. Adjusted R-squared (0.18%) reflects a very little explanatory power of the unconditional beta model. When *total risk* is added in as the extra variable, the unconditional beta becomes significantly different from zero, $t(\gamma_1)$=-2.71, but carries the negative sign. Total risk does explain realized returns significantly, $t(\gamma_2)$=2.20. This implies that New Zealand investors do not hold well-diversified portfolios. The adjusted R-squared has a nominal improvement.

Conditional betas

Table 3 reports the results of the conditional beta model. We use p-values instead of t-statistics in Table 3 and Table 4. There is a significantly positive beta in the up market (p-value of γ_1 is 0.0005) and a significantly negative beta in the down market (p-value of γ_2 is 0.0000). The R-squared (18.37%) in the conditional beta model is more than 100 times of that (0.18%) in the unconditional beta model. When *total risk* is included in the conditional beta model, the up beta (p-value of γ_1 is 0.0098) and down beta (p-value of γ_2 is 0.0000) retain their signs and are significant. Total risk explains realized returns in the down markets (p-value of γ_4 = 0.0004) but not up markets (p-value of γ_3=0.4237). The New Zealand market excess return is often negative (Pinfold et al. 2001). Our empirical result shows that an undiversified portfolio contributes to offset some of the negative stock excess returns in down markets.

Conditional betas in sub-periods

Table 4 presents the results of the conditional beta model in six sub-periods. The purpose of this test is to examine the robustness of the conditional beta mode in each sub-period. The first five sub-periods have a span of one-year and the last sub-period has a span of 21 months. We can see that all up market betas are now not significantly different zero. On the other hand, down market beta are, in general, significantly negative at various significant levels (from 1% to 10%). In each of the sub-periods (except April 1998 – March 1999), inclusion of *total risk* now contributes nothing to explain realized returns.

This implies that the effect of an undiversified portfolio requires more than one year to affect excess returns. Future studies can test the minimum lag required to gain the benefit of the undiversified portfolio. Our full period case represents an upper bound, six years and nine months.

Table 2
Results of unconditional model with an additional variable

Unconditional model: $R_{jt} = \gamma_{0t} + \gamma_{1t}\beta_j + \gamma_{2t}\,\sigma_j^2 + \mu_{jt}$

	γ_0	$t(\gamma_0)$	*p-value*	γ_1	$t(\gamma_1)$	*p-value*	γ_2	$t(\gamma_2)$	*p-value*	Adj r^2
None	0.0032	0.62	0.5329	-0.0103	-1.57	0.1173				0.0018
Total Risk (σ_j^2)	0.0056	1.09	0.2743	-0.0272	-2.71[a]	0.0069[a]	3.0628	2.20[b]	0.0279[b]	0.0080

t(.) *t*-statistic.
Above are the results of unconditional beta model based on equation (2), where monthly excess returns of the 10 equally-weighted portfolios are regressed on their corresponding portfolio beta and total risk in the period from May 1997 through December 2003. The statistical measures are estimated in previous 3-year period.
[a] Statistically significant at 1%
[b] Statistically significant at 5%

Table 3
Results of conditional dual-beta model with total risk

Conditional Dual-Beta model: $R_{jt} = \gamma_{0t} + \gamma_{1t}\lambda\beta_j + \gamma_{2t}(1-\lambda)\beta_j + \gamma_{3t}\lambda\,\sigma_j^2 + \gamma_{4t}(1-\lambda)\,\sigma_j^2 + \mu_{jt}$

	γ_0	*p-value*	γ_1	*p-value*	γ_2	*p-value*	γ_3	*p-value*	γ_4	*p-value*	Adj r^2
None	0.0016	0.7408	0.0232	0.0005[a]	-0.0366	0.0000[a]					0.1837
Total Risk (σ_j^2)	0.0037	0.4365	0.0267	0.0098[a]	-0.0717	0.0000[a]	-1.2385	0.4237	7.0381	0.0004[a]	0.2034

Above are the results of unconditional beta model based on equation (2), where monthly excess returns of the 10 equally-weighted portfolios are regressed on their corresponding portfolio beta and total risk in the period from May 1997 through December 2003. The statistical measures are estimated in the previous 3-year period. The dummy variable λ is added in to include up and down market effects for beta estimation, where the dummy λ=1 for up market (positive market excess return) and λ=0 for down market (negative market excess return).

[a] Statistically significant at 1%
[b] Statistically significant at 5%

Table 4

Results of conditional dual-beta model with total risk (sub-periods)

Conditional Dual-Beta model: $R_{jt} = \gamma_{0t} + \gamma_{1t}\lambda\beta_j + \gamma_{2t}(1-\lambda)\beta_j + \gamma_{3t}\lambda\sigma_j^2 + \gamma_{4t}(1-\lambda)\sigma_j^2 + \mu_{jt}$

	γ_0	$t(\gamma_0)$	*p-value*	γ_1	$t(\gamma_1)$	*p-value*	γ_2	$t(\gamma_2)$	*p-value*	γ_3	$t(\gamma_3)$	*p-value*	γ_4	$t(\gamma_4)$	*p-value*
None	-0.0093	-0.73	0.4643	0.0276	1.93[c]	0.0557	-0.0532	-3.07[a]	0.0027						
April 1997 – March 1998															
Total Risk	0.0012	0.08	0.9389	0.0311	1.98[c]	0.0507	-0.0335	-1.26	0.2120	-5.0828	-1.02	0.3076	-10.9379	-1.34	0.1820
April 1998 – March 1999															
None	0.0264	1.20	0.2323	0.0260	1.01	0.3144	-0.0671	-2.69[a]	0.0081						
Total Risk	0.0103	0.46	0.6487	-0.0082	-0.23	0.8210	-0.1030	-3.32[a]	0.0012	11.9356	1.65	0.1024	13.5890	2.58[b]	0.0110
April 1999 – March 2000															
None	0.0039	0.27	0.7905	0.0234	1.40	0.1652	-0.0307	-1.69[c]	0.0945						
Total Risk	0.0030	0.19	0.8490	0.0643	1.55	0.1240	-0.0759	-2.02[b]	0.0460	-6.4279	-1.43	0.1552	7.5347	1.47	0.1439
April 2000 – March 2001															
None	0.0115	0.90	0.3695	-0.0027	-0.19	0.8467	-0.0307	-1.70[c]	0.0917						
Total Risk	0.0145	1.10	0.2724	0.0047	0.17	0.8686	-0.0576	-1.25	0.2133	-1.6780	-0.52	0.6064	3.9089	0.57	0.5683
April 2001 – March 2002															
None	0.0089	0.89	0.3771	0.0047	0.29	0.7693	-0.0403	-2.43[b]	0.0168						
Total Risk	0.0092	0.96	0.3400	0.0207	0.82	0.4157	-0.0707	-1.85[c]	0.0674	-2.9310	-0.60	0.5494	5.6408	0.80	0.4250
April 2002 – December 2003															
None	-0.0073	-1.01	0.3121	0.0362	2.72[a]	0.0070	-0.0245	-2.31[b]	0.0217						
Total Risk	-0.0058	-0.82	0.4113	0.0241	1.36	0.1755	-0.0314	-1.83[c]	0.0692	3.0512	0.63	0.5262	1.4040	0.34	0.7367

[a] Statistically significant at 1%
[b] Statistically significant at 5%
[c] Statistically significant at 10%

5. Concluding remarks

We first employ the conditional beta model to estimate up and down market betas in the New Zealand stock market. Our full-period results show that unconditional betas are flat and are therefore not useful in explaining returns. *Total risk* contributes to explain realized returns in the unconditional setting. However, the unconditional beta becomes significantly negative.

The results of our full-period conditional beta models show that beta is significantly positive in up markets and significantly negative in down markets. *Total risk* contributes to explain realized return, but only in down markets. The adjusted R-squared recorded in the conditional beta model is more than 100 times of that in the unconditional beta model.

In each of the six sub-periods, only down market betas are marginal significant in explaining realized return. *Total risk* in each of the sub-periods is not significant. Isakov (1999) reports that realized returns are not related to specific risk in the Swiss market, Tang and Shum (2004) find that total risk explains realized returns only in up markets in the Singapore market. However, our empirical findings show that total risk contributes to explain realized returns only in down markets in New Zealand.

There may be a time lag for the stock market to respond to an up or a down market, say, for a lag of one month. We conduct the unconditional and conditional OLS regressions for one-month lag of the realized returns, $R_{j,t-1}$, and find that the results are almost the same as for realized returns without a lag. Out results are therefore valid for current or lagged market signals.

The results of our conditional beta model does not validate the SLB model. However, our results show that beta is a good measure between risk-return tradeoffs in up and the down markets in the New Zealand stock market.

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