"Estimating Systematic Risk: The return interval and estimation period issue: evidence from Malaysia 2000-2006"

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Abstract

Estimating the beta coefficient is central to the CAPM concept of rewarding the investors according to the systematic risk of an asset. However, while the concept is intuitively appealing, the estimation is biased by measurement issues such as thin trading, regression tendency, stability and choice of interval issues. While techniques have been developed to address the regression tendency, thin trading biases, no specific rules on the interval issues have been formulated. The trade-off between a longer estimation period for more observations and accuracy has to be weighted for a biased coefficient resulting from higher measurement errors. The results for this study provided support that daily returns provided the most efficient estimation in terms of smallest estimated coefficient errors but biased as any estimation period more than three years saw half of the sample experiencing a shift in their estimated beta.

Introduction

The Capital Asset Pricing Model states that the expected return of an asset is linearly related to its systematic risk (beta), the higher the systematic risk, the higher the required return. However, true beta is unobservable and need to be estimated. While estimating the beta of an asset is a straight forward regression of the market model, biases in estimating the beta coefficient could arise due to the regression tendency of betas to regress to the grand mean of one, thin trading of securities, time varying nature of the beta coefficients and the numerous return interval options available.

Common compensation of the above biases have been via the Blume and Vasicek techniques for the regression tendency, Scholes and Williams and Dimson techniques for the thin trading effect, and an estimation period of four to five years at monthly or weekly intervals to address the stability issue. Unlike the other biases no specific techniques exist to compensate the return interval biases.

The optimal estimation period and return interval of the regression of an asset is not defined in the market model and the most common methodology is an estimation period of five years based on monthly returns. This is a measurement issue commonly known as the return interval issue.

Statistically true beta is estimated as lying within two standard errors of the estimated beta. Hence, the smaller the error of the estimated beta, the greater the reliability and confidenee that we have the true beta in our estimate.

The issue requires a trade off between a longer estimation with more observation to improve estimation accuracy but this increases the likelihood that the estimated beta may not be relevant as the capital structure, business risk, core business and business operations may have shifted.

A shorter estimation period is more relevant to capture the latest systematic risk of the business, but too few observations leads to suspect unreliable results.

Literature Review

Literature investigating the return measurement issues includes Pogue and Solnik (1974) who examined the impact of varying the return intervals frequency over five years and seven European markets and suggested that beta measurement is dependent on the return interval with the ratio of monthly and daily beta being indicative of market efficiency.

Smith(1978) also showed that estimates of beta were influenced not only by the choice of interval but also the character of whether the estimated beta were aggressive or defensive.

Cohen, Hawanini, Maier,Schwartz and Whitecomb(CHMSW)(1983) argued that the market friction biased short term estimation and these should be adjusted for a long term asymptotic beta .

Larson and Moore (1987) applies a modified CHMSW technique for a similar conclusion in the Hong Kong market.

Subsequent papers by Handa, Kothari and Wasley(HKW)(1989) supports the notion that beta is a function of the return measurement as covariance of an asset's return with the market and the market own variance may not change proportionately as the return interval is varied. HKW(1993) provided evidence of the ambiguity of the CAPM model when monthly returns do not support the linear relationship of the model but annual returns did.

Daves, Ehrhart and Kunkel (2000) reported a trade off of daily returns of three years provides an optimum balance between beta stability and minimum standard error using NYSE/AMEX database.

Underlying all the above literature is that daily return is the most efficient estimator of the beta coefficient due its greater observations but biased as the greater observations leaded to greater measurement errors.

Methodology

The methodology adapted for this paper largely follows that of Daves, Ehrhardt and Kunkel (2000). The test design consists of four return intervals of daily, weekly, half monthly and monthly returns for seven years from January 2000 to December 2006. The estimation period ranged from one year (2000) to seven years.(2000-2006)

The sample consists of 40 securities obtained from Perfect Analysis data base. The beta coefficients are estimated based on the standard market model:

Rit=ái+âiRmt+åit

Where Rit is the return for firm i in period t, Rmt is the composite index return in period t, ái is the intercept, âi is the beta for the firm I, and åit is the random error of the regression.

The standard error of the beta coefficient, Sâ is defined as:

Sâ P% 1D $(N-1)^{0.5}$ x(Se/Sm)

Where Se is the standard deviation of the estimated errors in the market model, Sm is the standard deviation of the market returns and N is the number of observations.

The market and each sample's standard deviation are estimated based on the assumptions the securities maintain their capital structure and business and operations were constant during the whole estimation period. It can then be assumed that Se and Sm are constant.

The aim is to study the improvement in precision with increasing numbers of observations as the estimation is increased from one year to seven years. Using daily returns, beta is estimated for the market model and the mean Se obtained for each security. The mean Se is then obtained for the whole sample. The Sm for each year is also similarly obtained. The process is then repeated for the other return intervals. The results are recorded as Table 1.

Table 1:

Estimates of Se and Sm using daily, weekly, half-monthly and monthly returns for each year from 2000 to 2006.

Year	Return Interval							
	Daily		Weekly		½ monthly		Monthly	
	Sm	Mean Se	Sm	Mean Se	Sm	Mean Se	Sm	Mean Se
2006	0.0051	0.0204	0.0142	0.0435	0.0200	0.0502	0.0275	0.0693
2005	0.0047	0.0214	0.0127	0.0421	0.0180	0.0515	0.0265	0.0691
2004	0.0070	0.0189	0.0177	0.0428	0.0261	0.0478	0.0393	0.0634
2003	0.0070	0.02184	0.0192	0.0508	0.0258	0.0607	0.0429	0.0806
2002	0.0079	0.0217	0.0200	0.0429	0.0325	0.0578	0.0509	0.0756
2001	0.0124	0.0318	0.0326	0.0671	0.0448	0.0868	0.0755	0.1022
2000	0.0134	0.0234	0.0349	0.0503	0.0528	0.0623	0.0706	0.0914
Mean	0.0082	0.0228	0.0216	0.0485	0.0314	0.0595	0.0475	0.0887

Sm, the standard deviation of the market shows a steady decline from 2000 to 2006. The Se is relatively stable except for year 2001. It can also be noted that the mean standard error using the daily interval is the smallest supporting earlier observations that daily returns provided the most efficiency estimates.

The mean of Se and Sm is then used to simulate the different Sâ from one year to seven years. The results are reported in Table 2.

Table 2:

Simulated mean standard errors of estimated betas as a function of the estimation period and return interval. Se and Sm are overall means from Table 1, based on 2000 to 2006 data.

Estimation Period (years)	**Return Interval**							
	Daily (Se/Sm=2.7613)		Weekly (Se/Sm=2.2402)		½ monthly (Se/Sm=1.8872)		Monthly (Se/Sm=1.7352)	
	Returns	Sβ	Returns	Sβ	Returns	Sβ	Returns	Sβ
1	250	0.1749	52	0.3136	24	0.3774	12	0.5231
2	500	0.1236	104	0.2207	48	0.2617	24	0.3618
3	750	0.1008	156	0.1799	72	0.2224	36	0.2933
4	1000	0.0873	208	0.1557	96	0.2150	48	0.2531
5	1250	0.0781	260	0.1392	120	0.1859	60	0.2259
6	1500	0.0662	312	0.1270	144	0.1661	72	0.2059
7	1750	0.0617	364	0.1175	168	0.150	84	0.1904

For a short estimation period of one year, Sâ is the largest for all the seven estimation periods. For example for daily return of one year estimation period, at 95% confidence interval, a security with an estimated â of one, the Sâ confidence level ranges from a low of 0.65 to 1.35. If the estimation period is increased to two years, the confidence level improves to 0.75 to 1.28, and the confidence level narrows to 0.80 to 1.20 for a three year estimation period. When the estimation is increased to seven years of daily returns, the confidence level improves to a range of 0.88 to 1.12.

The Se/Sm ratio decreases from 2.76 to 1.73 as the return interval is increased from daily to monthly returns, indicating a smoothing of the noise effect, a noted phenomenon when the return interval or return period is increased.

For any estimation period, Sâ is smallest when estimated on a daily basis, reflecting the benefits of additional observation over the additional noise increased.

From Table 2, on a daily basis it is noted that the maximum reduction in Sâ from one year to eight years is 0.1132.Increasing the estimating period from one year to two years captures about 45% of the maximum reduction. Increasing the estimation period to three years and four years captures about 65% and 77 % respectively

The conclusion to be inferred is that a shorter return interval provides the better estimate of â, in terms of the standard error and about 65% of maximal reduction is achievable using only three years of data.

To test if the above conclusion, derived on the assumption of stable financial structure and risks exposure is support by actual data, â for each securities is estimated at each return interval ranging from one year to seven years, with the estimation to commence from 2006 to 2005 for one year beta and 2006-2004 for two years beta and so on until the seven years period beta is obtained from 2006-2000. For each beta estimated, the standard error is saved.

Table 3 reports the mean beta standard error for each interval and estimation period. For one year of daily return the mean standard error is 0.0204, for two years the mean standard error is 0.0215, three years 0.0211, with the mean standard error increasing to 0.02531 for the final seven years estimation. The overall increase in standard error is 0.00121 or 24% over the seven years estimation. While the standard error did not reduced as the period is increased as projected in table 2, the value is relatively stable up to 5 years of estimation, but standard error jumps when 2001 data is included. Identical pattern is also noted in the other return interval.

What causes the deviation from the theoretical conclusion arrived at from Table 2? The most logical conclusion is that the sample securities have experienced shifts in the systematic risk due to changing operation, financial or business risk, emphasing the importance of selecting the correct beta for project estimation due to time varying nature of beta. The reduction of the standard error in beta in Table 2 is obtained in an idealized situation of constant financial and operation environment while the local Malaysian business have seen companies undergoing major financial restructuring following the financial crisis of 1997.

Table 3:

Actual mean standard errors of estimated beta as a function of the return interval and estimation period over the 2000 to 2006 period.

Estimation Period (years)	**Return Interval**							
	Daily		**Weekly**		**½ monthly**		**Monthly**	
	Returns	**Sβ**	**Returns**	**Sβ**	**Returns**	**Sβ**	**Returns**	**Sβ**
1(2006)	250	0.0204	52	0.0424	24	0.0502	12	0.0704
2(2006-2005)	500	0.0215	104	0.0437	48	0.0536	24	0.0767
3(2006-2004)	750	0.0211	156	0.0442	72	0.0536	36	0.0775
4(2006-2003)	1000	0.0216	208	0.0468	96	0.0530	48	0.0826
5(2006-2002)	1250	0.0222	260	0.0472	120	0.0600	60	0.0866
6(2006-2001)	1500	0.0251	312	0.0535	144	0.0692	72	0.1025
7(2006-2000)	1750	0.0253	364	0.0532	168	0.0696	84	0.1030

A longer estimation period is suppose to lead to a more precise estimation if the fundamental risk do not change as reflected in Table 2. However, Table 3, indicates that this condition is unlikely to hold for periods when the market players are experiencing structural changes.

To test the time varying nature of beta, the following research is designed. One additional year of data is added to the estimation period commencing from 2006, and the number of companies with stable betas is noted and the estimation is continued next year to see if the estimated beta remains constant or have shifted. If constant the beta value is estimated with another year of data added and beta is tested again for stability. This process is repeated until the whole seven years is tested.

The following equation is applied for the test using monthly returns for 2006-2005:

$$R\,it = ái + ã_{2005i} D_{2005+} âiRmt + ”_{2005i} Rmt + åit$$

where Rit is the stock return for firm i in period t, Rmt is the composite index return in period t, ái is the intercept for firm i in 2006, âi is the beta for firm I in 2006, åit is the error for firm I in period t. $D_{2005}=1$ for observations in 2005, and 0 otherwise, ã2005i is the intercept for firm I in 2005 and $“_{2005i}$ may be interpreted as the shift in beta by adding the 2005 monthly returns to the estimation period. If $“_{2005i}$ is significantly different from zero, then the beta for 2005-20006 is significantly different from the beta of 2006. The estimation is then repeated for firms with stationary using monthly returns for the period 2006-2004.The following equation is applied for 2006-2004 monthly returns.

$$Rit = ái + ã_{2005i} D_{2005+ ã2004} D_{2004+} âiRmt + ”_{2004} Rmt + åit$$

The intercept is allowed to vary in each period. âi may be interpreted as the beta for 2005-2006 and $“_{2004}$ may be interpreted as the shift in beta by adding the 2004 monthly returns to the estimation. If $“_{2004\,i}$s significantly different from zero, then the beta for 2006-2004 is significantly different from the beta of 2006-2005.

The procedure is then repeated for firms that had stationary betas in the previous estimation with intercept dummies for each period.

The results are reported in Table 4. The period over which beta is assumed stable and the test period appear in column one. The number of firms with stable betas is reported in column two (this is the number of firms with stable betas in previous period) Column three reports the firms with shift in the betas and column four reports the cumulative figures.

Table 4: Stationary test results in betas for firms over the 2006-2000 period.

Stable period vs test period	Number of firms with stationary betas	% Stocks with significant change	Cumulative % stocks with significant change
2006vs 2005	40	0.275	0.275
06-05vs04	29	0.31	0.50
06-04vs03	20	0.15	0.575
06-03vs02	17	0.235	0.675
06-02vs01	14	0.21	0.75
06-01vs00	11		

The results supports the view that as beta is time varying, the estimation period should not be too long. When one year of returns, are added to the 2006 estimation, 11 or 27.5% of the sample experience a shift in beta. If two years are added then 50% of the sample experienced a shift. At the end of the seven periods, 75% of the beta have experience shift in their beta estimation.

Conclusion

Estimating the beta coefficient is central to the CAPM concept of rewarding the investors according to the systematic risk of an asset. However, while the concept is intuitively appealing the estimation is biased by measurement issues such as thin trading, regression tendency, stability and choice of interval issues. While techniques have been developed to address the regression tendency, thin trading biases, no specific rules on the interval issues have been formulated. The trade-off between a longer estimation period for more observations and accuracy has to be weighted for a biased coefficient resulting from higher measurement errors. The results for this study provided support that daily returns provided the most efficient estimation in terms of smallest estimated coefficient errors but biased as any estimation period more than three years saw half of the sample experiencing a shift in their estimated beta.

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