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Systematic Risk in Energy Businesses: Empirical Evidence for the ASEAN

Duc Hong Vo[1]*, Thach Ngoc Pham[2]

[1]Ho Chi Minh City Open University, Vietnam, [2]Ho Chi Minh City Open University, Vietnam. *Email: duc.vhong@ou.edu.vn

ABSTRACT

This paper is conducted to provide an additional empirical evidence in relation to the estimates of equity beta for energy businesses in the ASEAN-5 including Vietnam, Thailand, the Philippines, Malaysia, and Singapore. Listed energy companies for the period from 2005 to 2015 are used. Quantile regression, together with the ordinary least square (OLS) and least absolute deviations (LADs), has been used. Findings from this paper indicate that: (i) As long as the OLS and the LAD approaches are adopted, estimates of equity beta are relatively consistent across various research periods; (ii) estimates of equity beta appear to vary substantial across different quantiles; and (iii) estimates of equity beta have appeared to vary across research periods. However, as an overall level across time and methods, a level of risk faced by a company in the energy sector is below the average of the level of risk for the entire market for the above nations.

Keywords: Beta, Listed Energy Firms, Quantile Regression, ASEAN
JEL Classifications: G11; G18

1. INTRODUCTION

In the ASEAN region, a significant number of energies businesses are currently regulated. These regulations allow these regulated firms to earn a fair rate of return for their investment. However, a significant unsolved issue, which has prevailed for an extensive period of time, is that regulated businesses and their regulators have disagreed on various aspects of the estimation of this "fair" rate of return. Among other issues, the equity beta - a key input of the Sharpe - Lintner capital asset pricing model (CAPM) to determine an expected return on equity, has attracted attention from both researchers and practitioners. This study was conducted to revisit the economic aspects of estimating equity beta for regulated businesses for selected countries in the ASEAN, including Vietnam. The motivation of this study is to provide regulators with an additional piece of evidence in relation to the determination of the rate of return for the regulated businesses. In addition, for those countries where energy businesses are still government owned such as Vietnam, findings from this empirical study provide additional evidence in a determination of the sale prices of these government owned assets during the process of privatization and equitisation.

Prior studies related to energy industry indicated that the equity beta of these businesses is below 0.8 (Henry, 2008; Henry and Street, 2014; Vo et al., 2014). Main methodologies which are applied in these studies are ordinary least squares (OLS) and least absolute deviations (LADs). However, due to the effect of existing outlying observations and the advantages compared to OLS, the quantile regression (QR) is considered as an appropriate approach to provide a full description of the conditional distribution at various percentiles of the relation between stock return and market return. The results suggest that estimates of equity beta appear to vary substantially across different quantiles using QR at both individual stock and portfolio level.

The paper is structured as follows. Following the introduction, an economic aspect of estimating equity beta is considered in Section 2. Section 3 presents various approaches in which equity beta is estimated. Data and empirical findings are presented in Section 4. Section 5 concludes the paper with policy implications.

2. LITERATURE REVIEW

2.1. The CAPM

The CAPM, introduced by Sharpe (1964) and Lintner (1965) describes the relationship between the expected return and risk.

In this model, the expected return of a security (an asset) is given by the following equation:

$$E(r_i) = r_f + \beta_i\,[E(r_m - r_f)] \quad (1)$$

Where:
- (r_i) is the expected return of security i,
- r_f is the risk free rate,
- r_m is the expected return of the market portfolio,
- $\beta_i = \dfrac{Cor[r_i, r_m]}{Var[r_m]}$ is the beta coefficient of security i.

Moreover, β_i is defined as the profitability volatility measurement, and therefore it is considered as a stock's risk measurement.

The CAPM indicates that the expected return of security is positively correlated with its beta coefficient. Assuming that the capital market is efficient and unsystematic risk can be reduced completely through diversification, the return of a security is only affected by its systematic risk. The higher the beta coefficient is, the riskier the security is. Therefore, investors tend to require a higher return to compensate the higher risk (or high beta). While various models have been attempted for the purpose of estimating the expected return on equity, the Sharpe - Lintner CAPM has been widely adopted as the most popular formula by economic regulators overseas. Table 1 presents evidence to support this view.

2.2. Current Approaches to Estimating Equity Beta

Generally, the equity beta is currently investigated using various techniques including OLS, LAD (Brooks et al., 2013), QR (Chang et al., 2011; Fin et al., 2009), and generalized autoregressive conditional heteroscedasticity (Lie et al., 2000).

Henry (2009) established his work in estimating equity beta for the Australian Utilities regulation as advice to the Australian Competition and Consumer Commission. 5 years later, Henry and Street (2014) updated the estimates. In these two studies, the OLS and LAD approaches were utilized and the results suggested that utilities beta estimations are about 0.3-0.8 across various estimations, firms and portfolio levels. These results indicate that the energy industry in Australia faces a lower risk level compared to the whole market.

Vo et al. (2014) re-examined the estimates of beta in the Australian regulatory context. Their study uses an updated data set in comparison to with Henry's study in 2009. In addition, another key contribution from Vo et al. (2014) study is that two additional approaches were added in their study: (i) The maximum likelihood robust theory (MM) and (ii) the Theil Sen methodology. The authors argued that among the robust regression estimators currently available, the MM regression has the highest breakdown point (50%) and high statistical efficiency (95%) while the Theil Sen estimator, as noted by Fabozzi (2013), is insensitive to outliers. From the estimation results, the authors concluded that Australian regulated businesses' equity beta should lie in the range 0.5-0.7.

We acknowledge that the two additional approaches adopted in the Vo et al. (2014) study were a choice of different, arguably more advanced, econometric techniques. However, for the purpose of this paper, these two approaches are not considered. Instead, we use a different approach for the purpose of estimating equity beta, QR, which is best known for its capacity to limit the effects of outliers on the estimates.

2.2.1. OLSs

The OLS method estimates the α_i and β_i in the equation (1) by minimizing the sum of squared residuals:

$$\sum_{t=1}^{T}\varepsilon_{i,t}^2 = \sum_{t=1}^{T}\left(r_{i,t} - \hat{r}_{i,t}\right)^2 = \sum_{t=1}^{T}\left(r_{i,t} - \hat{\alpha}_i - \hat{\beta} r_{m,t}\right)^2 \quad (2)$$

The β coefficient from OLS indicates the average relationship between the regressor and the outcome variable based on the conditional mean function.

2.2.2. LADs

In the LAD approach, the absolute value of residuals is minimized to achieve the estimates from equation (1) as follows:

$$\sum_{t=1}^{T}\left|\varepsilon_{i,t}\right| = \sum_{t=1}^{T}\left|r_{i,t} - \hat{r}_{i,t}\right| = \sum_{t=1}^{T}\left|r_{i,t} - \hat{\alpha}_i - \hat{\beta} r_{m,t}\right| \quad (3)$$

Since the sum of the absolute value of residuals is minimized rather than minimizing the sum of squares, the estimators obtained from the LAD method may alleviate the effect of outliers.

Table 1: Models adopted by international regulators in estimating a return on equity

Regulator	Australia	Germany	New Zealand	USA	Canada	UK
	Australian Energy Regulator/Economic Regulation Authority (AER/ERA)	The Federal Network Agency (FNA)	The Commerce Commission (CC)	New York State Public Utilities Commission (NYSPUC)	The Ontario Energy Board (OEB)	The Office of Gas and Electricity Markets (Ofgem)
Primary model	CAPM	CAPM RPM	CAPM	DDM	RPM	CAPM
Secondary model				CAPM		
Other use of DDM	Cross-check on MRP		Cross-check on MRP		Cross-check on MRP	Cross check on the overall cost of equity but not for individual firms

Source: Sudarsanam et al. (2011). CAPM: Sharpe-lintner capital asset pricing model, RPM: Risk premium model, DDM: Dividend discount model

2.3. QR

In relation to a validity of a QR approach, it has been argued that:

> *"On the average" has never been a satisfactory statement with which to conclude a study on heterogeneous populations. Characterization of the conditional mean constitutes only a limited aspect of possibly more extensive changes involving the entire distribution."*
>
> -Buchinsky (1994. p. 453)

When all of the OLS assumptions are satisfied, the β coefficient estimated from (1) is the best linear unbiased estimator. It indicates the average relationship between the regressors and the outcome variable based on the conditional mean function. Indeed, using OLS method leads to some attractive statistical properties of estimators which are straightforward to interpret and easy to calculate (Hao and Naiman, 2007).

However, the OLS estimator has some limitations. The strict assumptions cannot always be met in reality. In particular, the homoscedasticity and normality assumption are likely to fail and make the estimates less efficient (Buchinsky, 1998b). Also, heavy-tailed distributions commonly occur in many economic agendas (Chang et al., 2011). Secondly, the conditional mean attracts the researchers' attention into the central location and steers them away the whole distribution' properties as well as the non-central locations. Koenker and Bassett Jr (1978) considered that when the exogenous variables affect the dependent variable at different parameters in the distribution from the mean, the analysis would be seriously weakened. Thirdly, the effect of existing outliers tends to be magnified and leads to infinite bias due to the squared effect in the OLS optimization function (Kodila-Tedika and Bolito-Losembe, 2014).

This paper applies the QR, which deals with these problems. With the QR method proposed by Koenker and Bassett Jr (1978), the estimator can be found with the following minimization function:

$$\beta_{QR} = \arg\min\left[\sum_{Y_i > \beta X_i} \tau\left|Y_i - \beta X_i\right| + \sum_{Y_i < \beta X_i} (1-\tau)\left|Y_i - \beta X_i\right|\right] \forall \tau \in (0,1) \tag{4}$$

The vector of parameter from equation (4), β_QR, can be found by linear programming technique. When τ is equal to 0.5, the QR becomes a special case of median regression, or LAD. Other specific values of τ yields a conditional percentile coefficient.

The QR method, considered as an ordered statistics-based estimation, might estimate a coefficient vector which is not sensitive to the influences of outliers since the minimization function is a weighted sum of absolute deviations (Hung et al., 2010). Moreover, it loosens some of OLS assumptions such as normality, homoscedasticity, etc. (Johnston and DiNardo, 1997). Estimating simultaneously many different percentiles could provide a full description of the conditional distribution and extend the analysis to non-central locations (Buchinsky, 1998b; Hao and Naiman, 2007).

The interpretations for the OLS and QR coefficients have different meanings. While the OLS estimators suggest the average marginal effect of a regressor on the dependent variable, the QR estimators examine the marginal effect under each conditional percentile. By using QR, it is possible to investigate the relationship between returns and Beta at the lower and upper tail observations relative to the mean.

With the above mentioned advantages as compared to OLS estimations, QR has been applied widely in various areas of research since the approach was first introduced by Koenker and Bassett Jr (1978). Buchinsky (1998a) and Buchinsky (2002) used QR to analyze the female wage distribution in the US in relation to demographic characteristics. Taylor (1999) found that QR to be a good estimator of the distribution of daily Value at Risk. Researchers in survival analysis, pharmaceutical and many other scientific areas of research have also applied QR in their studies, as noted by Yu et al. (2003). Recently, various papers used QR as a new approach to their empirical studies. For example, Atella et al. (2008) applied QR to investigate the heterogeneous impact of obesity on various percentiles of wage distribution. In addition, by using QR, Hung et al. (2010) examined the determinants of hotel room pricing at high and low price quantiles, and suggested some useful strategies for hoteliers. Ramdani and Witteloostuijn (2010) studied the impacts of board independence and CEO duality on performance of listed enterprises and concluded that estimating various quantiles can be more insightful than the mean effect estimation.

3. METHODOLOGY AND DATA

3.1. Data

Relevant data for all five ASEAN nations (Vietnam, Malaysia, the Philippines, Singapore, and Thailand) adopted in this empirical study are collected from Bloomberg. A number of companies classified as "Energy" by Bloomberg varies from country to country. For example, as presented in Table 2, Vietnam has 28 listed firms classified as "Energy" whereas Singapore has only 8 firms. Vietnam has a slightly different research period due to the availability of the relevant data required for this study. The sample of companies in each of the five countries is summarized in the Appendix 1.

The market return volatility for each of the above countries is measured by its relevant stock market index as presented in Table 2. As such, the VN index, FBMKLCI index, PCOMP index, FSSTI index and SET index are the market index for Vietnam, Malaysia, the Philippines, Singapore and Thailand respectively.

3.2. Methodology

3.2.1. Estimating the return and determining the return period

The systematic risk of each asset, which cannot be managed through portfolio diversification, is obtained in this study from the following regression:

$$r_{i,t} = \alpha_i + \beta_i r_{mt} + \epsilon_{i,t} \tag{5}$$

In which, the residual is $\epsilon_{i,t} = r_{i,t} - \alpha_i - \beta_i r_{mt}$.

When estimating equation (5), this study considered whether to use the raw return of stocks or the excess return, which is the

Table 2: Listed energy companies in the sample

Country	Number of company	Market index	From	To
Vietnam	28	VN index	13/01/2006	31/07/2015
Malaysia	12	FBMKLCI index	15/07/2005	31/07/2015
The Philippines	12	PCOMP index	15/07/2005	31/07/2015
Singapore	8	FSSTI index	15/07/2005	31/07/2015
Thailand	12	SET index	15/07/2005	31/07/2015

difference between the raw return of stock and the risk free rate of return. Both of these methods are applied widely in empirical studies. Assuming that the risk free rate does not fluctuate significantly, the excess return may be obtained by transforming the data

$R_{i,t} = r_{i,t} - r_{f,t}$, $R_{m,t} = r_{m,t} - r_{f,t}$ and equity beta is estimated from:

$$R_{i,t} = \beta_i R_{m,t} + \epsilon_{i,t} \quad (6a)$$

or

$$r_{i,t} - r_{f,t} = \beta_i (r_{m,t} - r_{f,t}) + \epsilon_{i,t} \quad (6b)$$

Subtracting $r_{f,t}$ from both sides of (6b) and rearranging yields (5):

$$r_{i,t} = (1 - \beta_i)\, r_{f,t} + \beta_i\, r_{m,t} + \epsilon_{i,t} \quad (7)$$

In the circumstances when the variance of the risk free rate is low as the intercept term, $(1\text{-}\beta_i)\, E(r_{f,t}) = \mu$, the beta yielded from equation (7) should be consistent with those estimated from equation (5) (Henry and Street, 2014). In addition, Bartholdy and Peare (2005) found that the correlation between the beta results from raw and excess return estimations are up to 0.999. Furthermore, no assumptions about possible variations in chosen risk free rate are required when raw returns instead of excess returns are used. For these reasons, and for simplicity, this paper follows Henry and Street (2014) and Vo et al. (2014) by employing raw returns in equation (5).

The return period of a stock or market can be calculated at different frequencies such as daily, weekly, or monthly. Henry and Street (2014) argued that weekly frequencies of returns should be used to avoid both the noisy nature in daily data and unreliable estimators from monthly data due to a smaller sample. In addition, Vo et al. (2014) pointed out that monthly return estimation is not able to capture the "day-of-the-week effect." Therefore, weekly returns are used in this paper.

The weekly stock return is measured by the difference between a closing price on Fridays and an opening price on Monday in a same week. The reason behind this choice is the common and conventional use of closing data in the finance literature. Since stock trading does not happen on Saturdays and Sundays, the closing price of Friday of the week before is used instead of an opening price on Monday. This weekly return represents the change in stock prices during a particular week. An alternative measurement of weekly return, which is the average of weekday return, was also considered in the study of Henry (2008) and the result suggested that the latter measurement of weekly return is not significantly different from the former. In general, the stock return in period t can be calculated as follows:

$$r_{i,t} = \ln \frac{\text{Stock price}_t}{\text{Stock price}_{t-1}} \quad (8)$$

The above process is applied to estimate equity beta for each listed individual company included in the "Energy" sector for the 5 selected ASEAN nations.

3.2.2. Portfolio construction

Estimates of equity beta for each listed energy firm in the above sample of countries have exhibited wide variations across firms, years and countries. More importantly, the estimates for each listed energy firm cannot be used to provide evidence for regulators and the government because the entire energy industry may be a key focus for policy purposes. In response to this challenging question, portfolios are constructed in order to provide a general view for those who are interested in more than one stock in the energy sector. Doing so for all five countries is time consuming. As such, in this paper, Vietnam is used as an illustration.

There are two set of portfolios used in this paper: (i) An equally-weighted portfolio and (ii) a value-weighted portfolio with the company's market capitalization being used as a weight. Furthermore, because companies in the sample were listed at different points in time, portfolios are updated every 6 months. This choice is arbitrary. However, the choice is to ensure that 10 portfolios, a current practice of testing the multi factor asset pricing models, are able to be formed in this study. As a result of this design, 20 portfolios are formed in this paper including 10 equally-weighted and 10 value-weighted portfolios (Appendix 2 for the details of the companies in each portfolio).

For example, for Vietnam, the first portfolio, P1, includes companies with the following abbreviations: VSH, KHP, SJD, HJS, PPC, SHP and TBC with the available data from 09 Fed 2006. The full names of all listed firms in the energy sector in each of the 6 nations included in the sample can be found in the Appendix 2. The second portfolio P2 is formed by adding the stock CHP into portfolio 1 (P1) which started trading on the 11 January 2008. Similar approaches have been used to determine the last 8 portfolios, from portfolio 3 (P3) to portfolio 10 (P10).

Listed firms included in each of the recently formed portfolios (from portfolio 1 to portfolio 10) may have different level of gearings. As such, the process of de-levered/re-levered estimates of beta is required to ensure that the estimated beta from each portfolio is to represent a level of systematic risk for that particular portfolio. This process is discussed in detail in the following section.

3.2.3. De-levered/Re-levered estimates of β

Following the practice adopted in Henry and Street (2014) and Vo et al. (2014) studies, all equity betas are de-levered using the relevant company's gearing ratio (for a particular company) over the examined period and re-levered using the average leverage ratio for the whole industry. Supposing that the debt β equals to zero, the de-levering/re-levering equation is:

$$\beta_A = \beta_E \frac{E}{V} \quad (9)$$

In which β_A and β_E are the asset β and equity β; E/V is the ratio between the market value of equity and the company's total asset.

The gearing ratio is usually defined as the proportion of the book value of debt and the value of the company which is measured by its total asset. Considering $\bar{G}$ as the gearing ratio, $\bar{D}$ as the book value of debt and E is the market value of equity, then:

$$\bar{G} = \frac{\bar{D}}{\bar{D}+E} \quad (10)$$

Currently, for 28 companies in the energy sector in Vietnam, the average leverage ratio is approximately 31%. For the raw beta estimation, the following re-levering factor is applied:

$$\omega = \frac{1-\bar{G}}{1-0.31} \quad (11)$$

Assume $\bar{G}$ that is independent of $\hat{\beta}$ and ω is constant, the re-levered β, $\hat{\beta}_r$ has a mean of $\hat{\beta}\,\omega$.

3.2.4. Estimation method

As stated above, in order to provide the equity beta coefficients for the energy industry in five ASEAN countries which it not sensitive to outliers and more robust in the condition of non-normal error term, this paper applies the QR. In addition, the traditional approach, OLS, is also in use in this study for comparison purposes. To convey a complete correlation of individual stock/portfolio on market across the entire conditional return distribution, various quantiles are estimated include: 0.05, 0.2, 0.4, 0.5 (LAD), 0.6, 0.8, and 0.95.

In this study, the standard error of QR coefficients is obtained by bootstrap method which is illustrated by Buchinsky (1995) and Hao and Naiman (2007). These authors suggested using the bootstrap method to produce the asymptotic variance of the coefficient, and to obtain heteroskedasticity-robust estimates. To be consistent with prior studies related to QR (Anderson and Pomfret, 2000; Bauer and Haisken-DeNew, 2001; Fattouh et al., 2005; Hung et al., 2010), this study uses 1000 repetitions bootstrapping to obtain the standard error of the estimates. For the OLS estimates, robust standard errors are also applied.

4. RESULTS AND DISCUSSION

Estimates of equity beta in this paper are presented in the following two orders. First, beta estimates for individual listed firms in the energy sector are presented for the ASEAN-5. Second, beta estimates for portfolios of listed firms are also presented for Vietnam as an illustration to consider significant differences, if any, between betas for individual firms and for portfolios of firms.

4.1. Beta Estimates for Individual Listed Firm in the ASEAN-5

As previously discussed, the stock return used in the CAPM regression in this paper is the raw returns of the stocks. The weekly frequency is chosen to take advantage of avoiding the noise in comparison with the use of daily data and obtaining the statistical accuracy from many observations in comparison with the use of yearly data. Weekly return is measured by the change of return within a week, from last week Friday (a closing price) and this week Friday (a closing price). Table 3 reports the equity beta estimated from OLS, LAD, and different quantiles for individual companies for each of the countries in the ASEAN-5. Details of the estimates are presented in Appendix 3.

As presented in Appendix 3, most beta OLS estimates are statistically significant and lower than 1 - the relevant market beta for each country in the research sample. When the market return changes by 1%, these stock returns would change in the same direction with a magnitude of <1%. These findings are consistent with our expectation: Energy businesses are expected to face a relatively lower risk in comparison with the market as the whole in each country in the research sample.

It is interesting to note that, there is a divergence of the OLS beta estimates at the individual listed firm levels for the six countries in the research sample. Listed energy businesses in Malaysia and Singapore have relatively higher equity beta, approximately at the market level, in comparison with the other nations in the sample. However, it is noted that the OLS beta estimates for Vietnam, Thailand and the Philippines indicate that estimates of equity beta are within a tight range of 0.6 and 0.8, which are lower than the market level.

In relation to the estimates of equity beta at individual firm level using QR, the estimates appear to vary across different quantiles in which 95% quantile consistently produces the relatively higher beta in comparison with all other quantiles utilized in this study. This observation raises a practical question of an appropriate quantile to be used to derive the final estimate of equity beta for energy businesses in practice.

4.2. Beta Estimates of Various Portfolios for Vietnam

Two set of portfolios including (i) an equally-weighted portfolio and (ii) a value-weighted portfolio are formed in Vietnamese context as a case study in order to provide a deeper analysis for various portfolios of stocks and to test the robustness of beta estimates for individual companies. The OLS, LAD and QR at different percentiles are all adopted. It is also noted that weekly returns and Friday-to-Friday period are also used. Tables 4 and 5 present the estimates of equity beta for each portfolio for Vietnam.

The results from Table 4 show that, for the equally-weight portfolios, the estimates of beta using the OLS, LAD and QR

Table 3: Estimates of equity beta for individual listed energy firms in the ASEAN-5, using the weekly return from Friday-to-Friday week closing prices

Country	OLS	LAD	τ=0.05	τ=0.20	τ=0.40	τ=0.60	τ=0.80	τ=0.95
Vietnam								
Average	0.5695	0.4623	0.5982	0.5351	0.4831	0.4702	0.5234	0.9011
Median	0.6496	0.5303	0.6598	0.5614	0.5615	0.5670	0.6594	0.8564
Malaysia								
Average	1.1220	0.8924	1.2326	0.9655	0.8738	0.9117	1.1230	1.5263
Median	0.9612	0.7111	1.1674	0.8978	0.7016	0.7746	1.0659	1.5751
The Philippines								
Average	0.7678	0.5731	0.8673	0.7653	0.5883	0.5640	0.5340	1.3949
Median	0.8501	0.5939	0.9108	0.7747	0.5937	0.6302	0.7089	1.3081
Singapore								
Average	0.9790	0.6721	1.0234	0.9477	0.8226	0.7357	1.0488	1.0064
Median	0.8787	0.6763	1.1083	1.0330	0.7342	0.7266	1.0668	1.3401
Thailand								
Average	0.6297	0.5915	0.6841	0.6331	0.6154	0.5666	0.5637	0.5256
Median	0.4394	0.4942	0.5691	0.5226	0.5046	0.5064	0.4534	0.5569

OLS: Ordinary least squares, LAD: Least absolute deviations

Table 4: Estimates of equity beta using equally-weighted portfolios

Portfolio	OLS	LAD	τ=0.05	τ=0.20	τ=0.40	τ=0.60	τ=0.80	τ=0.95	Average
P1	0.7054	0.702	0.7259	0.6801	0.6637	0.7085	0.7243	0.7683	0.7098
P2	0.6184	0.6195	0.6351	0.5624	0.5796	0.6222	0.6284	0.6237	0.6112
P3	0.572	0.5541	0.6199	0.525	0.5458	0.5578	0.5616	0.5077	0.5555
P4	0.5331	0.529	0.5904	0.5015	0.5418	0.4842	0.5096	0.6001	0.5362
P5	0.5879	0.5304	0.6887	0.5311	0.5353	0.5089	0.5442	0.7256	0.5815
P6	0.5112	0.403	0.6321	0.4426	0.3855	0.3962	0.436	0.6563	0.4829
P7	0.3593	0.3005	0.4677	0.3876	0.3067	0.3242	0.3581	0.4149	0.3649
P8	0.3369	0.2639	0.3675	0.3676	0.3079	0.2943	0.3464	0.2719	0.3196
P9	0.3566	0.2708	0.3879	0.3372	0.2801	0.3262	0.3771	0.2787	0.3268
P10	0.3599	0.2612	0.3651	0.3111	0.279	0.336	0.3726	0.1845	0.3087
Average	0.4941	0.4434	0.5480	0.4646	0.4425	0.4559	0.4858	0.5032	
Median	0.5222	0.4660	0.6052	0.4721	0.4604	0.4402	0.4728	0.5539	

OLS: Ordinary least squares, LAD: Least absolute deviations

Table 5: Estimates of value-weighted portfolios equity beta

Portfolio	OLS	LAD	τ=0.05	τ=0.20	τ=0.40	τ=0.60	τ=0.80	τ=0.95	Average
P1	0.9445	0.9465	0.7895	0.8693	0.9207	0.9944	0.9814	1.1210	0.9459
P2	0.9120	0.9041	0.7831	0.8418	0.8957	0.9537	0.9698	1.0425	0.9128
P3	0.8782	0.8036	0.7473	0.7913	0.8156	0.8569	0.9351	1.0332	0.8577
P4	0.8383	0.7895	0.6071	0.7774	0.7908	0.8651	0.9136	1.0237	0.8257
P5	0.7904	0.7933	0.7508	0.7490	0.8094	0.8171	0.8713	0.8575	0.8049
P6	0.6639	0.6674	0.6345	0.6511	0.6329	0.6365	0.6739	1.0687	0.7036
P7	0.6206	0.6555	0.6781	0.6424	0.5835	0.6309	0.6403	0.6447	0.6370
P8	0.5982	0.5754	0.6824	0.5977	0.6154	0.6131	0.6634	0.5338	0.6099
P9	0.6768	0.6892	0.8057	0.7010	0.6237	0.6172	0.6588	1.0949	0.7334
P10	0.7796	0.7025	0.8645	0.8840	0.7820	0.6730	0.7269	1.2284	0.8301
Average	0.7703	0.7527	0.7343	0.7505	0.7470	0.7658	0.8035	0.9648	
Median	0.7850	0.7460	0.7491	0.7632	0.7864	0.7451	0.7991	1.0379	

OLS: Ordinary least squares, LAD: Least absolute deviations

at all percentiles fall within a range of 0.1845-0.7683. Moving from Portfolio 1 to Portfolio 10, the estimates of beta decrease significantly, on average. While Portfolio 1 including stocks which has started trading in February 2007 produces the highest beta at around 0.70 across various estimations, Portfolio 10 - the most up to date portfolio, presents the lowest estimate of 0.30.

As presented in Table 5, the estimates of equity beta using various valued-weighted portfolios produce the significant higher values compared to those from the equally weighted portfolios. On average, Portfolio 1 produces the highest beta estimates of 0.9459. The average lowest beta estimate of 0.6099 is observed from portfolio 8. At 95% percentile regression, most of the estimates of beta are higher than 1 except those found in P5 and P8. Other estimates of beta exhibit a declining trend from P1 to P9 and an increase of the estimates of equity beta in P10.

The above decreasing trend in the portfolio betas could be explained by one of the following two hypotheses: (i) Limited available data across portfolios (i.e., portfolio 1 has the most information of stock returns from listed firms included in the portfolio); and/or (ii) the nature of components' returns

Table 6: Differences in the estimates of equity beta for portfolio 1: A longest period 9 February 2007-31 July 2015 and the 13 April 2012-31 July 2015 period

Portfolio	OLS	LAD	τ=0.05	τ=0.20	τ=0.40	τ=0.60	τ=0.80	τ=0.95
Equally-weighted portfolio								
P1	0.1056	0.2058	0.0986	0.1246	0.1481	0.2803	0.2584	−0.0916
P2	0.0697	0.1911	0.0468	0.0845	0.1290	0.1879	0.1802	−0.2006
P3	0.0192	0.0720	−0.0495	0.0478	0.0630	0.1157	0.1142	−0.0613
P4	0.0225	0.0771	−0.0353	−0.0509	0.0943	0.0443	−0.0195	0.0509
P5	0.1152	0.0855	0.1472	0.0673	0.0859	0.1010	0.0144	0.3141
P6	0.1299	0.0412	0.2572	0.0514	0.0076	0.0522	0.0319	0.4557
P7	0.0286	0.0587	0.0907	0.1251	0.0700	0.0545	0.0148	0.0841
P8	−0.0378	0.0386	0.0019	0.0012	0.0556	0.0389	0.0033	−0.2496
P9	−0.0168	0.0135	0.0022	0.0091	0.0000	0.0013	0.0009	−0.1613
P10	0.1056	0.2058	0.0986	0.1246	0.1481	0.2803	0.2584	−0.0916
Average	0.0485	0.0871	0.0622	0.0511	0.0726	0.0973	0.0665	0.0156
Valued-weighted portfolio								
P1	0.0993	0.2012	−0.0850	0.0328	0.1929	0.2830	0.1230	0.1297
P2	0.1639	0.4376	0.0072	0.0866	0.3183	0.3865	0.1417	0.0561
P3	0.2021	0.3514	−0.0358	0.0807	0.4135	0.3424	0.2384	0.3801
P4	0.0160	0.0284	−0.3053	−0.0827	0.0179	0.1501	0.0809	−0.0291
P5	0.0148	0.0294	−0.1194	−0.0124	0.1071	0.0832	0.0410	−0.1217
P6	0.0381	0.0732	−0.0267	0.0180	0.0354	0.0382	0.1105	−0.1142
P7	−0.1013	−0.0556	−0.1805	−0.1708	−0.1501	−0.0261	0.0541	−0.5518
P8	−0.1452	−0.1932	−0.1763	−0.1875	−0.1051	−0.0661	−0.0279	−0.6279
P9	−0.0652	−0.0198	−0.0265	−0.1099	−0.1419	−0.0741	−0.0155	−0.0377
P10	0.0993	0.2012	−0.0850	0.0328	0.1929	0.2830	0.1230	0.1297

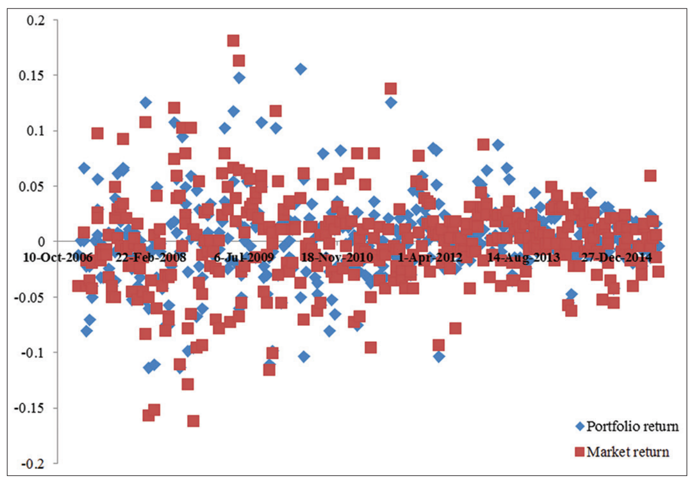
OLS: Ordinary least squares, LAD: Least absolute deviations

(i.e., the additional stocks produces a relatively lower beta than the available ones). Using Portfolio 1 and Portfolio 10 as the examples. In particular, the first hypothesis indicates that since portfolio 10 is estimated in a shorter period (i.e., 13 April 2012 - 31 July 2015), it cannot capture some different information contained in the previous period when portfolio 1 is estimated. If we assume that the period took place before 13 April 2012 did not contain any "extra" information in relation to the stocks' returns, or the changes in the estimates of equity beta from the portfolio are caused by the second hypothesis, then estimates of equity beta from Portfolio 1 for the period from 13 April 2012 to 31 July 2015, the same research period for Portfolio 10, should be consistent with these estimates obtained from its original research period, from 9 February 2007 to 31 July 2015. However, estimates of equity beta for Portfolio 1 using the period from 13 April 2012 to 31 July 2015, as presented in Table 6, rejects this hypothesis.

Table 6 presents the differences between portfolio's betas estimated from their longest period, from 13 April 2012 to 31 July 2015, and the period from 13 April 2012 to 31 July 2015. For the equally weighted portfolios, most of the beta coefficients estimated using the portfolio's longest period are higher than those obtained using the 13 April 2012 - 31 July 2015 period. The scatter plot of Portfolio 1 returns shown in Figure 1 is utilized to explain for this difference.

Accordingly, the portfolio 1's returns fluctuate significantly before 1 January 2012, from approximately -17-18%. This could be the impact of global financial crisis occurred in 2008/2009. From 2012, the returns of Portfolio 1 have been quite stable in the range of −10% to approximately 10%. As a result, estimating the beta of Portfolio 1 using the longest possible period would generate a higher coefficient compared to beta yielded from 13 April 2012 to 31 July 2015 period.

Figure 1: The scatter plot of Portfolio 1's returns and market returns



4.3. De-levered/Re-levered Estimates of β

The weekly returns measured by the change of stock prices from closing price of last Friday and this Friday are also adopted in this analysis. The results of de-levered and re-levered beta estimates of individual companies and portfolios are shown in Tables 7 and 8.

The de-levered/re-levered estimates of individual companies' equity β for the OLS estimates are from 0.0614 to 1.1525 while the corresponding de-levered LAD β estimates range from 0.0304 to 1.2032 (See Appendix 4 for details). The existence of outliers still affects seriously on the outcomes. For instance, at 95% percentile, the equity β of BTW, MTG, NTW, PCG, PGT and POV are much higher than those obtained from OLS and LAD. In addition, the effect of lower tail observations can be seen at the 5% percentile regression for DRL and NTW.

Table 7: De-levered/re-levered estimates of β for weekly frequency: Individual companies

Individual companies	Gearing (%)	ω	OLS	LAD	τ=0.05	τ=0.20	τ=0.80	τ=0.95
Average	31.07	1.00	0.5718	0.4706	0.6706	0.5588	0.4891	0.8515
Median	29.32	1.03	0.5712	0.4703	0.6691	0.5562	0.4839	0.8568

OLS: Ordinary least squares, LAD: Least absolute deviations

Table 8: De-levered/re-levered estimates of β for weekly frequency: Portfolios

Portfolio	Gearing (%)	ω	OLS	LAD	τ=0.05	τ=0.20	τ=0.80	τ=0.95
Equally-weighted portfolios								
Average	33.14	0.97	0.4783	0.4288	0.5307	0.4497	0.4703	0.4870
Median	33.08	0.97	0.5050	0.4510	0.5771	0.4564	0.4575	0.5295
Value-weighted portfolios								
Average	33.14	0.97	0.7465	0.7294	0.7127	0.7280	0.7785	0.9359
Median	33.08	0.97	0.7894	0.7256	0.7187	0.7473	0.7991	0.9932

OLS: Ordinary least squares, LAD: Least absolute deviations

Similarly, the de-levered estimates are applied for portfolio betas. Both the equally-weighted portfolios and the value-weighted portfolios results are quite stable with a magnitude of lower than 1 for all estimates except at the 95% percentile regression for P10 (Details are in Appendix 5).

5. CONCLUSIONS

This paper is conducted in order to provide an additional empirical evidence in relation to equity beta for energy businesses in the context of the ASEAN-5 including Vietnam, Thailand, the Philippines, Malaysia, and Singapore. These evidences can be used by the government and/or the economic regulators in the process of estimating a fair and reasonable expected return on equity for energy businesses.

Like many other advanced countries, effort from the governments from various ASEAN nations to a process of privatization and equitization of key government owned assets in the energy sector has attracted attention from both local and international investors. Privatization and/or equitization requires a sale of government owned assets to the private investors. A question is how the government can determine a reasonable price for these assets to ensure that the people will get the fair share. In a transitional period when these assets are still within the government's ownership, findings from this study can also be used for the same purpose to the regulated energy businesses in the ASEAN-5.

In response to this complicated question, this study is conducted to estimate a key input, the equity beta, adopted in the Sharpe-Lintner CAPM, which then can be used to determine a rate of return on equity for both purposes: (i) The privatization and equitization of the government-owned assets; and (ii) the regulated rate of return on equity for regulated energy businesses.

Research samples are formed from listed energy companies in the ASEAN-5 nations for the period of more than 11 years (from 2005 to 2015 inclusive). In addition, a new approach (a QR approach); together with the other two traditional approaches (the OLS and the LAD), have been used to estimate the equity beta for these listed firms in this study. Estimates of beta were conducted at the individual firms' level and at the portfolios' level. At the firms' level, all countries in the sample are used. At the portfolios' level which Vietnam is utilized as a case study, two different types of portfolios are formed: (i) The equally-weighted portfolio; and (ii) the value-weighted portfolio.

The following key conclusions have been achieved from this empirical evidence.

First, as long as the OLS and the LAD approaches are adopted, estimates of equity beta are relatively consistent across samples. These findings raised an attention for economic regulators and policymakers in relation to their decision on the value of equity beta for regulated energy businesses when only these two econometric techniques are adopted.

Second, estimates of equity beta appear to vary substantial across different quantiles using the QR. Without further information in relation to the most preferred quantile, we consider that determining the final value of equity beta for energy businesses using available estimates from all different quantiles are appropriate. However, given a QR is also a form of robust regression, estimates from this technique should be used together with the traditional approaches such as the OLS and the LAD and other robust regression techniques.

Third, estimates of equity beta have appeared to vary across research periods. As such, it is highly recommended that relevant period for the public decisions should be used for the purpose of estimating equity beta.

In relation to this empirical study for the period from 2005 to 2015, under all approaches, estimates of beta indicate that the appropriate value of the equity beta for companies operating in the energy industry in the ASEAN-3 nations (including Vietnam, the Philippines and Thailand) fall within a range of 0.6 and 0.8 - which is still below the market beta of the entire market for a relevant country in the research sample. It is noted that equity beta for Malaysia and Singapore may be higher than this proposed range. However, as an overall level across time and methods, the findings from this empirical evidence provides an evidence to conform that a level of risk faced by a company in the energy sector is below the average of the level of risk for the entire market.

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APPENDIX

Appendix 1: Listed energy companies in the sample

Appendix 1a: Listed energy companies in Vietnam

Short name of company	Code	From	To
Baria Thermal	BTP VN Equity	04/11/2008	31/07/2015
Ben Thanh Water	BTW VN Equity	01/09/2009	31/07/2015
Central Hydropow	CHP VN Equity	01/11/2008	31/07/2015
Cho Lon Wasuco	CLW VN Equity	01/09/2009	31/07/2015
CNG Vietnam JSC	CNG VN Equity	10/14/2011	31/07/2015
Hydro Power JSC	DRL VN Equity	04/13/2012	31/07/2015
Gia Dinh Waters	GDW VN Equity	06/25/2010	31/07/2015
Gia Lai Hydropow	GHC VN Equity	01/15/2010	31/07/2015
Nam Mu Hydropowe	HJS VN Equity	01/12/2007	31/07/2015
Khanh Hoa Power	KHP VN Equity	01/05/2007	31/07/2015
Mt Gas JSC	MTG VN Equity	01/09/2009	31/07/2015
Ninhbinh Thermal	NBP VN Equity	07/10/2009	31/07/2015
Northern Electri	ND2 VN Equity	08/06/2010	31/07/2015
Petrovietnam Nho	NT2 VN Equity	01/29/2010	31/07/2015
Nhon Trach Water	NTW VN Equity	01/14/2011	31/07/2015
Petroviet Gas CI	PCG VN Equity	01/07/2011	31/07/2015
Petrovietnam Low	PGD VN Equity	10/09/2009	31/07/2015
Saigon Petrolime	PGT VN Equity	10/09/2009	31/07/2015
Vung Ang Petrole	POV VN Equity	10/01/2010	31/07/2015
Pha Lai Thermal	PPC VN Equity	01/12/2007	31/07/2015
Gia Lai Cane Sug	SEC VN Equity	01/15/2010	31/07/2015
Southern Hydropo	SHP VN Equity	01/12/2007	31/07/2015
Can Don Hydro Po	SJD VN Equity	01/05/2007	31/07/2015
Thac Ba Hydropow	TBC VN Equity	02/09/2007	31/07/2015
Thu Duc Water	TDW VN Equity	07/09/2010	31/07/2015
Tay Nguyen Elect	TIC VN Equity	10/09/2009	31/07/2015
Thac Mo Hydropow	TMP VN Equity	06/26/2009	31/07/2015
Vinh Son-Song	VSH VN Equity	01/13/2006	31/07/2015
Baria Thermal	BTP VN Equity	04/11/2008	31/07/2015

Appendix 1b: Listed energy companies in Malaysia

Short name of company	Code	From	To
Brite-Tech Bhd	BTEC MK Equity	07/15/2005	31/07/2015
Eden Inc Bhd	EDN MK Equity	07/15/2005	31/07/2015
Kumpulan Perangs	KUPS MK Equity	07/15/2005	31/07/2015
Mega First Corp	MFCB MK Equity	07/15/2005	31/07/2015
Malakoff Corp BH	MLK MK Equity	07/15/2005	31/07/2015
MMC Corp Bhd	MMC MK Equity	07/15/2005	31/07/2015
PBA Holdings Bhd	PBAH MK Equity	07/15/2005	31/07/2015
Puncak Nia Hld B	PNH MK Equity	07/15/2005	31/07/2015
Salcon Bhd	SALC MK Equity	07/15/2005	31/07/2015
Tenaga Nasional	TNB MK Equity	07/15/2005	31/07/2015
Taliworks Corp	TWK MK Equity	07/15/2005	31/07/2015
Ytl Corp Bhd	YTL MK Equity	07/15/2005	31/07/2015

Appendix 1c: Listed energy companies in the Philippines

Short name of company	Code	From	To
Alsons Cons Res	ACR PM Equity	07/29/2005	31/07/2015
Aboitiz power	AP PM Equity	07/20/2007	31/07/2015
Energy Developme	EDC PM Equity	12/15/2006	31/07/2015
First Gen Corpor	FGEN PM Equity	02/10/2006	31/07/2015
First Philip Hld	FPH PM Equity	07/15/2005	31/07/2015
H2O Ventures Inc	H2O PM Equity	11/25/2011	31/07/2015
Manila Electric	MER PM Equity	07/15/2005	31/07/2015
Metro Pacific In	MPI PM Equity	12/22/2006	31/07/2015
Manila Water	MWC PM Equity	07/15/2005	31/07/2015
SPS Power	SPC PM Equity	09/16/2005	31/07/2015
Trans-Asia Petro	TAPET PM Equity	08/29/2014	31/07/2015
Vivant Corp	VVT PM Equity	09/09/2005	31/07/2015

Appendix 1d: Listed energy companies in Singapore

Short name of company	Code	From	To
Citic Envirotech	CEL SP Equity	07/15/2005	31/07/2015
China Everbright	CEWL SP Equity	07/22/2005	31/07/2015
Charisma Energy	CHEN SP Equity	07/15/2005	31/07/2015
Gallant Venture	GALV SP Equity	04/07/2006	31/07/2015
Hyflux Ltd	HYF SP Equity	07/15/2005	31/07/2015
Keppel Infrastru	KIT SP Equity	02/16/2007	31/07/2015
Moya Holdings As	MHAL SP Equity	07/15/2005	31/07/2015
SIIC Environment	SIIC SP Equity	07/15/2005	31/07/2015

Appendix 1e: Listed energy companies in Thailand

Short name of company	Code	From	To
Amata B. Grimm	ABPIF TB Equity	10/04/2013	31/07/2015
CK Power PCL	CKP TB Equity	01/04/2013	31/07/2015
Energy Absolute	EA TB Equity	10/05/2012	31/07/2015
Eastern Water Re	EASTW TB Equity	07/15/2005	31/07/2015
North Bangkok Po	EGATIF TB Equity	07/17/2015	31/07/2015
Elec Generating	EGCO TB Equity	07/15/2005	31/07/2015
Glow Energy PCL	GLOW TB Equity	07/15/2005	31/07/2015
Global Power Syn	GPSC TB Equity	01/09/2015	31/07/2015
Ratchaburi Elec	RATCH TB Equity	07/15/2005	31/07/2015
Rojana Indus Par	ROJNA TB Equity	07/15/2005	31/07/2015
Sahacogen Chonbu	SCG TB Equity	07/15/2005	31/07/2015
SPCG PCL	SPCG TB Equity	12/23/2005	31/07/2015

Appendix 2: Portfolios construction

Portfolio	Companies	From	To
P1	VSH, KHP, SJD, HJS, PPC, SHP, TBC	02/09/2007	31/07/2015
P2	VSH, KHP, SJD, HJS, PPC, SHP, TBC, CHP	01/11/2008	31/07/2015
P3	VSH, KHP, SJD, HJS, PPC, SHP, TBC, CHP, BTP	04/11/2008	31/07/2015
P4	VSH, KHP, SJD, HJS, PPC, SHP, TBC, CHP, BTP, BTW, CLW, MTG	01/09/2009	31/07/2015
P5	VSH, KHP, SJD, HJS, PPC, SHP, TBC, CHP, BTP, BTW, CLW, MTG, TMP, NBP, PGD, PGT, TIC	10/09/2009	31/07/2015
P6	VSH, KHP, SJD, HJS, PPC, SHP, TBC, CHP, BTP, BTW, CLW, MTG, TMP, NBP, PGD, PGT, TIC, GHC, SEC, NT2	01/29/2010	31/07/2015
P7	VSH, KHP, SJD, HJS, PPC, SHP, TBC, CHP, BTP, BTW, CLW, MTG, TMP, NBP, PGD, PGT, TIC, GHC, SEC, NT2, GDW, TDW, ND2, POV	10/01/2010	31/07/2015
P8	VSH, KHP, SJD, HJS, PPC, SHP, TBC, CHP, BTP, BTW, CLW, MTG, TMP, NBP, PGD, PGT, TIC, GHC, SEC, NT2, GDW, TDW, ND2, POV, PCG, NTW	01/14/2011	31/07/2015
P9	VSH, KHP, SJD, HJS, PPC, SHP, TBC, CHP, BTP, BTW, CLW, MTG, TMP, NBP, PGD, PGT, TIC, GHC, SEC, NT2, GDW, TDW, ND2, POV, PCG, NTW, CNG	10/14/2011	31/07/2015
P10	VSH, KHP, SJD, HJS, PPC, SHP, TBC, CHP, BTP, BTW, CLW, MTG, TMP, NBP, PGD, PGT, TIC, GHC, SEC, NT2, GDW, TDW, ND2, POV, PCG, NTW, CNG, DRL	04/13/2012	31/07/2015

Appendix 3: Estimates of equity beta for individual companies, using the weekly return from Friday-to-Friday week closing prices

Appendix 3a: Estimates of equity beta for individual companies in Vietnam

	OLS	LAD	τ=0.05	τ=0.20	τ=0.40	τ=0.60	τ=0.80	τ=0.95
BTP	0.7238***	0.5902***	0.8747***	0.7778***	0.6218***	0.5692***	0.7779***	0.8615
BTW	0.1005	0.1183	0.332	0.3036	0.2627	−0.0661	−0.0121	−1.3998
CHP	0.3369***	0.2484***	0.6234***	0.2740**	0.2089	0.2352**	−0.0396	0.2004
CLW	0.2710*	0.2042	0.2995*	0.1363	0.2378	0.1787	0.3915*	0.7376*
CNG	0.6810***	0.5307**	0.6286***	0.5461***	0.6615***	0.6685***	0.7065**	0.6836
DRL	0.6241**	0.2077	1.4975*	0.5638	−0.0782	−0.1122	0.0569	0.6222
GDW	−0.7648	−0.9071	0.0468	−0.9182	−0.2486	−0.7121	−1.1196	−1.5351
GHC	0.0929	−0.0463	0.1617	0.1196	0.0000	−0.1098	0.0921	1.5611
HJS	0.8836***	0.7641***	0.6987**	0.9006***	0.7759***	0.7172***	0.7995***	1.2107***
KHP	0.7223***	0.6280***	0.7854***	0.6808***	0.6221***	0.6231***	0.7471***	1.0266***
MTG	0.9468***	0.9391***	0.7964***	0.8728***	0.8230***	0.9442***	1.1001***	1.6467***
NBP	0.9302***	0.8638***	0.9128***	0.7897***	0.7856***	0.8862***	1.0278***	1.3294***
ND2	0.4825	0.0084	−1.594	−0.3806	0.0000	0.4388	1.6185*	2.5663
NT2	0.5567*	0.5299**	0.4473	0.5542*	0.4843**	0.5648**	0.2550	0.6715
NTW	0.7005	0.4869	2.6812	1.0423	0.5269	0.3579	−0.3043	1.6518
PCG	0.8664**	0.7498*	0.6759	0.8691*	0.7742*	0.7921*	1.0874*	1.9858
PGD	0.8411***	0.7118***	0.9997***	0.8067***	0.6889***	0.7881***	0.8637***	1.0188***
PGT	0.8229***	0.8591***	0.6887	0.8721***	0.7677***	0.7900***	0.8493**	1.3059
POV	1.0095*	0.8393	1.0315	1.1841	0.5960	1.0067	0.6877	3.5220
PPC	1.0166***	1.0136***	0.7449***	0.8754***	1.0306***	1.0256***	1.0560***	1.3083***
SEC	0.4099**	0.1769	0.0524	0.4382**	0.2984*	0.2475	0.5999*	0.5893
SHP	0.1903	0.1555	0.2575	0.2533	0.197	0.3026*	0.2759	−0.1358
SJD	0.6180***	0.6057***	0.5495***	0.5590***	0.6124***	0.6110***	0.6577***	0.8512***
TBC	0.6750***	0.5792***	0.7212***	0.5796***	0.6202***	0.6015***	0.6610***	0.8501***
TDW	0.3269	0.4700	−0.2183	0.5209	0.5111*	0.2040	0.0204	−0.1502
TIC	0.3839***	0.3200*	0.5952***	0.3981***	0.3214***	0.2681*	0.2568	0.4705
TMP	0.5560***	0.3516*	0.6437***	0.5068**	0.4639*	0.4264**	0.5626***	0.7224*
VSH	0.9400***	0.9445***	0.8164***	0.8567***	0.9602***	0.9162***	0.9790***	1.0547***

*,** and *** denote significance level at 10%, 5% and 1%, respectively

Appendix 3b: Estimates of equity beta for individual companies in Malaysia

	OLS	LAD	τ=0.05	τ=0.20	τ=v	τ=0.60	τ=0.80	τ=0.95
BTE	0.6345	0.5293	0.5778	0.2491	0.2863	0.5536	1.2856	2.0076
EDN	1.9469***	1.6468***	1.9192***	1.6666***	1.5570***	1.6764***	1.7325***	2.7479***
KUP	1.8210***	1.3917***	1.8031***	1.3956***	1.3998***	1.4653***	1.6585***	2.1810*
MFC	0.8919***	0.6994***	1.0952***	0.7866***	0.7059***	0.8020***	1.0616***	1.1036***
MMC	1.4100***	1.1718***	1.2395***	1.3863***	1.2007***	1.2421***	1.5094***	1.6608***
PBA	0.3693***	0.3127***	0.4328*	0.4105***	0.3439***	0.2745**	0.3362***	0.3848
PNH	1.3850***	0.7954***	1.7092***	1.0089***	0.8941***	0.8914***	0.9848***	2.1698***
SAL	1.7555***	1.5981***	2.0509***	1.5871***	1.5535***	1.4731***	1.7250***	2.1449**
TNB	0.8006***	0.7228***	1.0016**	0.7117***	0.6973***	0.7312***	0.8508***	1.0362***
TWK	1.0304***	0.6923***	1.2816***	1.0123*	0.6487***	0.7471***	1.0702***	1.4894***
YTL	0.7713***	0.6453***	0.8355***	0.6988***	0.6480***	0.6024***	0.6431***	0.8367***
YTL2	0.6471***	0.5034***	0.8443***	0.6726***	0.5501***	0.4808***	0.6187***	0.5525***
BTE	0.6345	0.5293	0.5778	0.2491	0.2863	0.5536	1.2856	2.0076

*,** and *** denote significance level at 10%, 5% and 1%, respectively

Appendix 3c: Estimates of equity beta for individual companies in the Philippines

	OLS	LAD	τ=0.05	τ=0.20	τ=0.40	τ=0.60	τ=0.80	τ=0.95
ACR	0.8193***	0.5246***	1.1308***	0.5957**	0.4548***	0.4928***	0.5987**	1.3705***
AP	0.7835***	0.6562***	0.6253***	0.6693***	0.6323***	0.7443***	0.8190***	1.2068***
EDC	1.0358***	0.7572***	0.9924***	0.8645***	0.7873***	0.8730***	1.0281***	1.2311***
FGEN	0.9796***	0.8651***	1.0172***	0.7810***	0.8677***	0.9413***	0.9497***	1.2962***
FPH	1.1526***	1.0469***	1.1384***	0.9410***	0.9506***	1.0534***	1.1828***	1.3199***
H2O	0.0166	0.0000	0.3504	0.0531	0.0205	0.0804	−0.1312	0.5666
MER	1.1876***	1.0186***	1.0896***	1.0050***	1.0302***	0.9986***	1.2377***	1.7027***
MPI	0.9984***	0.9408***	0.8291***	0.7683***	0.8805***	1.0379***	1.1136***	1.3688***
MWC	0.6814***	0.5316***	0.7736***	0.6053***	0.5550***	0.5161***	0.5617***	0.9226***
SPC	0.0961	0.1597	−0.7038	0.2590	0.2240	0.2569	−0.0994	0.5346
TAPET	0.5818	0.1809	2.4523*	1.6158	0.3957	0.1056	−1.4292	3.4218
VVT	0.8809	0.1955	0.7116	1.0257	0.2604	−0.3325	0.5760	1.7978
ACR	0.8193***	0.5246***	1.1308***	0.5957**	0.4548***	0.4928***	0.5987**	1.3705***

*,** and *** denote significance level at 10%, 5% and 1%, respectively

Appendix 3d: Estimates of equity beta for individual companies in Singapore

	OLS	LAD	τ=0.05	τ=0.20	τ=0.40	τ=0.60	τ=0.80	τ=0.95
CEL	0.8460***	0.6110**	0.8731***	0.8728***	0.6929***	0.7102***	1.0316***	1.4338*
CEWL	1.3572***	0.7568*	1.1310**	1.0830***	0.8053***	0.9359***	1.1896***	1.9644***
CHEN	0.6094	0.0000	0.6858	1.0713***	0.7272*	0.0000	0.9448***	−1.5769
GALV	1.4861***	1.3914***	1.3013***	1.3997***	1.5164***	1.5681***	1.6439***	1.8227***
HYF	0.8348***	0.7415***	1.0856*	0.6731***	0.7411***	0.7429***	0.7836***	0.9682*
KIT	0.3867***	0.3255***	0.4918***	0.3575***	0.3252***	0.3105***	0.2667**	0.2651*
MHAL	1.4005***	0.9824**	1.3855***	1.1292**	1.1275***	1.0685**	1.4282***	1.9268
SIIC	0.9113***	0.5678	1.2328***	0.9946**	0.6451**	0.5496	1.102	1.2463
CEL	0.8460***	0.6110**	0.8731***	0.8728***	0.6929***	0.7102***	1.0316***	1.4338*

*,** and *** denote significance level at 10%, 5% and 1%, respectively

Appendix 3e: Estimates of equity beta for individual companies in Thailand

	OLS	LAD	τ=0.05	τ=0.20	τ=0.40	τ=0.60	τ=0.80	τ=0.95
ABPIF	0.0811	0.0000	0.0819	0.0770	0.0000	0.0000	0.1492	−0.0166
CKP	1.3572***	1.2447***	1.1923***	1.2953***	1.2034***	1.1854***	1.4623***	1.9656**
EA	1.3319***	1.1609***	1.2914***	1.2738***	1.1763***	1.1093***	1.3936***	2.1459***
EASTW	0.4466***	0.2824***	0.4882**	0.3037***	0.3029***	0.3237***	0.4419***	0.5844***
EGCO	0.4088***	0.3696***	0.4798***	0.4111***	0.3870***	0.3769***	0.3331***	0.4244***
GLOW	0.6537***	0.5687***	0.5468***	0.5985***	0.6036***	0.6100***	0.6690***	0.7832***
RATCH	0.4321***	0.4196***	0.4082***	0.4445***	0.4579***	0.4027***	0.3564***	0.5294***
ROJNA	0.9821***	0.9080***	1.0874***	0.9431***	0.8972***	0.8888***	1.1023***	1.3344***
SCG	0.2712***	0.1080*	0.5914***	0.1992***	0.1365***	0.1423***	0.1645**	0.1628
SPCG	0.8478***	0.5708***	0.6096**	0.7021***	0.5512***	0.6802***	0.9589***	1.8443**
TAKUN	0.3522	1.0879	1.0232*	0.9017	1.3145	0.7115	−0.7320	−3.8797
TTW	0.3913***	0.3769***	0.4095***	0.4467***	0.3541***	0.3678***	0.4649***	0.4276**
ABPIF	0.0811	0.0000	0.0819	0.0770	0.0000	0.0000	0.1492	−0.0166

*,** and *** denote significance level at 10%, 5% and 1%, respectively

Appendix 4: De-levered/re-levered estimates of β for weekly frequency: Individual companies

	Gearing (%)	ω	OLS	LAD	τ=0.05	τ=0.20	τ=0.80	τ=0.95
BTP	43.88	0.81	0.5893	0.4805	0.7122	0.6333	0.6334	0.7014
BTW	16.00	1.22	0.1225	0.1442	0.4046	0.3700	−0.0146	−1.7049
CHP	41.64	0.85	0.2852	0.2103	0.5278	0.2320	−0.0330	0.1697
CLW	38.00	0.90	0.2438	0.1837	0.2694	0.1226	0.3521	0.6634
CNG	16.27	1.21	0.8272	0.6446	0.7635	0.6633	0.8582	0.8303
DRL	0.17	1.45	0.9038	0.3008	2.1687	0.8165	0.0824	0.9011
GDW	28.00	1.04	−0.7980	−0.9474	0.0489	−0.9589	−1.1688	−1.6034
GHC	54.45	0.66	0.0614	−0.0304	0.1069	0.0790	0.0609	1.0316
HJS	55.34	0.65	0.5725	0.4950	0.4527	0.5835	0.5180	0.7844
KHP	32.96	0.97	0.7025	0.6108	0.7638	0.6621	0.7266	0.9984
MTG	16.13	1.22	1.1520	1.1426	0.9690	1.0619	1.3385	2.0035
NBP	38.00	0.90	0.8367	0.7770	0.8210	0.7103	0.9245	1.1957
ND2	67.90	0.47	0.2247	0.0039	−0.7423	−0.1769	0.7537	1.1950
NT2	64.67	0.51	0.2853	0.2716	0.2293	0.2840	0.1307	0.3442
NTW	18.00	1.19	0.8333	0.5792	3.1896	1.2399	−0.3616	1.9650
PCG	20.00	1.16	1.0055	0.8702	0.7844	1.0087	1.2620	2.3047
PGD	52.00	0.70	0.5857	0.4957	0.6961	0.5618	0.6014	0.7095
PGT	3.46	1.40	1.1525	1.2032	0.9645	1.2214	1.1895	1.8289
POV	23.29	1.11	1.1234	0.9340	1.1478	1.3177	0.7653	3.9193
PPC	54.06	0.67	0.6776	0.6756	0.4965	0.5835	0.7038	0.8720
SEC	46.20	0.78	0.3199	0.1381	0.0409	0.3420	0.4682	0.4600
SHP	30.65	1.01	0.1915	0.1565	0.2591	0.2549	0.2776	−0.1358
SJD	43.02	0.83	0.5109	0.5007	0.4542	0.4621	0.5437	0.7036
TBC	1.57	1.43	0.9638	0.8270	1.0298	0.8276	0.9438	1.2139
TDW	15.72	1.22	0.3997	0.5747	−0.2666	0.6369	0.0249	−0.1834
TIC	3.09	1.41	0.5397	0.4499	0.8368	0.5597	0.3611	0.6615
TMP	26.47	1.07	0.5931	0.3751	0.6867	0.5406	0.6002	0.7706
VSH	18.91	1.18	1.1059	1.1112	0.9605	1.0079	1.1518	1.2408

Appendix 5: De-levered/Re-levered estimates of β for weekly frequency: Portfolios

	Gearing (%)	ω	OLS	LAD	τ=0.05	τ=0.20	τ=0.80	τ=0.95
Equally-weighted portfolios								
P1	33.79	0.961	0.6776	0.6743	0.6973	0.6533	0.6957	0.7380
P2	34.77	0.946	0.5852	0.5863	0.6010	0.5322	0.5947	0.5902
P3	35.78	0.932	0.5329	0.5162	0.5775	0.4891	0.5232	0.4730
P4	32.68	0.977	0.5206	0.5166	0.5766	0.4898	0.4977	0.5861
P5	30.30	1.011	0.5944	0.5363	0.6963	0.5370	0.5502	0.7337
P6	34.02	0.957	0.4893	0.3857	0.6050	0.4236	0.4173	0.6282
P7	33.98	0.958	0.3442	0.2878	0.4480	0.3713	0.3430	0.3974
P8	32.82	0.975	0.3283	0.2572	0.3582	0.3582	0.3376	0.2650
P9	32.21	0.983	0.3507	0.2663	0.3815	0.3316	0.3709	0.2741
P10	31.07	1.000	0.3599	0.2612	0.3651	0.3111	0.3726	0.1845
Value-weighted portfolios								
P1	33.79	0.961	0.9073	0.9092	0.7584	0.8350	0.9427	1.0768
P2	34.77	0.946	0.8631	0.8556	0.7411	0.7966	0.9178	0.9866
P3	35.78	0.932	0.8182	0.7487	0.6962	0.7372	0.8712	0.9626
P4	32.68	0.977	0.8187	0.7711	0.5929	0.7592	0.8923	0.9998
P5	30.30	1.011	0.7992	0.8021	0.7591	0.7573	0.8810	0.8670
P6	34.02	0.957	0.6354	0.6388	0.6073	0.6232	0.6450	1.0229
P7	33.98	0.958	0.5944	0.6279	0.6495	0.6153	0.6133	0.6175
P8	32.82	0.975	0.5830	0.5608	0.6650	0.5825	0.6465	0.5202
P9	32.21	0.983	0.6656	0.6778	0.7924	0.6894	0.6479	1.0768
P10	31.07	1.000	0.7796	0.7025	0.8645	0.8840	0.7269	1.2285