IJEEP
INTERNATIONAL JOURNAL OF ENERGY ECONOMICS AND POLICY

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2017, 7(6), 11-18.

Equity Beta for Regulated Energy Businesses in Australia: A Revisit

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

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

ABSTRACT

This paper aims to estimate the equity beta - a key input of the capital asset pricing model, for the energy businesses in Australia in the 11-year period from 2005 to 2015. Various methods are used in this paper including quantile regression (QR). Listed companies in the energy industry are considered at individual and portfolio levels. Findings from this paper are both consistent and contrast with prior related studies: (i) Energy sector in Australia face a relatively low risk level compared to the market; (ii) ordinary least squares results are higher than least absolute deviations; and (iii) QR vary across different percentiles.

Keywords: Equity Beta, Quantile Regression, Australia
JEL Classifications: G11; G18

1. INTRODUCTION

Energy plays a crucial role in Australia's economy since it made up for about 5% of the value added of all industries. Besides, Australia energy export accounted for around 5% of the world in total. Prior studies which used ordinary least squares (OLS) and least absolute deviations (LAD) indicated that the equity beta - a key input to calculate the expect rate of return based on the capital asset pricing model (CAPM), of energy businesses in Australia is below 0.8 (Henry, 2008; Henry and Street, 2014; Vo et al., 2014). However, estimating expected rate of return have become a controversy issue in recent years and attracted attention from both researchers and practitioners. The common phenomenon of existing outlying observations in the sample tends to make the estimated coefficients, and thus the equity beta, biased. Thus, there have been some efforts (Vo and Pham, 2017; Chang et al., 2011; Allen et al., 2009) to employ the quantile regression (QR) in estimating equity beta.

As such, this paper re-examines the equity beta estimation for the energy businesses in Australia for the period 2005-2015 and contributes to the literature in two dimensions. First, this paper provides an updated evidence related to equity beta for Australian regulators in order to determine a "fair" rate of return for the energy businesses. Second, this paper applies the QR to minimize the effects of outlier observations in estimating equity beta in the context of Australian energy businesses.

The results suggest that estimates of equity beta appear to vary substantially across different quantiles using QR at both individual stock and portfolio level. Overall, the estimated results from all methods (OLS, LAD, and QR) indicated that the equity beta of energy businesses in Australia should lie in the 0.6-0.8 range.

The paper is structured as follows. Following the introduction, a literature review on models estimating equity beta is conducted in Section 2. Section 3 presents our data and methodology for estimating equity beta. Empirical findings are presented in Section 4. Section 5 concludes the paper with policy implications.

2. LITERATURE REVIEW

Sharpe (1964) and Lintner (1965) introduced the CAPM in which 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:

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

Where:
$E(r_i)$ is the expected return of security i,
r_f is the risk free rate,
r_m is the expected return of the market portfolio,

$\beta_i = \frac{Cor[r_i, r_m]}{Var[r_m]}$ is the beta coefficient of security i.

Assuming that the capital market is efficient and unsystematic risk can be eliminated completely through diversification, the return of a security is only affected by its systematic risk, represents by β_i From the given formula, β_i is understood as the profitability volatility measurement between a particular stock and the benchmark market, and therefore it is considered as a stock's risk measurement. If $\beta_i = 1$ then stock i has the same risk level with the market; if $\beta_i > 1$ then stock i volatile more than the market portfolio and vice versa.

By its simplicity, the Sharpe-Lintner CAPM has been widely adopted as the most popular formula by economic regulators in Australia and overseas. Table 1 presents evidence to support this view.

Generally, the equity beta for firms and portfolios is currently investigated using various techniques including OLS, LAD (Brooks et al., 2013; Henry, 2009; Vo et al., 2014), QR (Vo and Pham, 2017; Chang et al., 2011; Allen et al., 2009), and generalized autoregressive conditional heteroscedasticity (Lie et al., 2000).

In Australia, there have been some academic reports which examined the equity beta of energy and utilities businesses. For instance, Henry (2009) estimated equity beta for the Australian Utilities regulation using the OLS and LAD. The results showed that equity beta for utilities companies were below 0.8 at both individual and portfolio levels. 5 years later, Henry and Street (2014) updated the estimates and the findings were consistent with the former. Vo et al. (2014) re-examined the estimates of beta in the Australian regulatory context with an updated data set. In addition, two additional approaches were added, which were the maximum likelihood robust theory (MM) and the Theil Sen methodology. From the estimation results, the authors concluded that Australian regulated businesses' equity beta should lie in the range 0.5–0.7.

Recently, Vo and Pham (2017) applied QR together with OLS and LAD to estimate the equity beta for energy companies in the ASEAN-5 including Malaysia, Singapore, the Philippines, Thailand, and Vietnam. The results showed that the equity betas of energy industry in Vietnam, the Philippines and Thailand were between 0.6 and 0.8. However, the results for Malaysia and Singapore were higher than this range but still below the entire market level.

3. METHODOLOGY AND DATA

3.1. Data

Listed companies belonging to the "Energy" sector as classified by Bloomberg in Australia are examined in this paper. Specifically, there are currently 23 companies. Daily closing stock prices of each individual company are collected from 15/07/2005 until 31/07/2015, which updates the prior research and includes a range of economic circumstances such as the global financial crisis. The sample of companies and their corresponding time period are presented in Table 2.

The market return volatility is measured by the All Ordinaries Index, which includes the 500 largest listed companies on the Australian Stock Exchange in term of market capitalization. This choice is in line with Henry and Street (2014) and Vo et al. (2014).

3.2. Methodology

This section will briefly introduce the methodology used in this paper. Detailed information can be found at Vo and Pham (2017).

According to the Sharpe-Lintner CAPM, the systematic risk, which was represented by the equity beta, of a security can be estimated via following common practiced models:

$$r_{i,t} = \alpha_i + \beta_i r_{mt} + \varepsilon_{i,t} \quad (3)$$

Or

$$r_{i,t} = (1-\beta_i) r_{f,t} + \beta_i r_{m,t} + \varepsilon_{i,t} \quad (4)$$

Model (3) shows the estimation of raw return while Model (4) represents the excess return estimation. Henry and Street (2014) suggested that these two model should be consistent when the

Table 1: Models adopted by Australian and 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 RPM		Cross-check on RPM		Cross-check on RPM	Cross check on the overall cost of equity but not for individual firms

Source: Sudarsanam, Kaltenbronn, and Park (2011). CAPM: Sharpe-Lintner Capital asset pricing model, RPM: Risk premium model, DDM: Dividend discount model variance of the risk free rate is low. Besides, a 0.999 correlation between two models are found by Bartholdy and Peare (2005). Thus, raw return in Model (3) will be used in this paper.

The return period of a stock or market can be calculated at different frequencies such as daily, weekly, or monthly. Weekly returns are used in this paper for consistency with prior studies (Henry and Street, 2014; Vo et al., 2014; Vo and Pham, 2017). As such, the stock return in week t can be calculated as follows:

$$r_{i,t} = \ln \frac{Stock\ price_t}{Stock\ price_{t-1}} \quad (5)$$

Table 2: Listed energy companies in the sample

Short name of company	Code	From	To
REDBANK ENERGY L	AEJ AU equity	15/12/2006	31/07/2015
AGL ENERGY LTD	AGL AU equity	13/10/2006	31/07/2015
AUSNET SERVICES	AST AU equity	16/12/2005	31/07/2015
BLACK ROCK MININ	BKT AU equity	15/07/2005	31/07/2015
DUET GROUP	DUE AU equity	15/07/2005	31/07/2015
ENEABBA GAS LTD	ENB AU equity	28/04/2006	31/07/2015
ENERGY DEVEL	ENE AU equity	15/07/2005	31/07/2015
ERM POWER LTD	EPW AU equity	12/10/2010	31/07/2015
ENERJI LTD	ERJ AU equity	05/08/2005	31/07/2015
ENVIROMISSION	EVM AU equity	15/07/2005	31/07/2015
ENERGY WORLD COR	EWC AU equity	15/07/2005	31/07/2015
GEODYNAMICS LTD	GDY AU equity	15/07/2005	31/07/2015
GREENEARTH ENERG	GER AU equity	08/02/2008	31/07/2015
HIGH PEAK ROYALT	HPR AU equity	30/03/2007	31/07/2015
HRL HOLDINGS LTD	HRL AU equity	16/11/2007	31/07/2015
INFIGEN ENERGY	IFN AU equity	28/10/2005	31/07/2015
KALINA POWER LTD	KPO AU equity	15/07/2005	31/07/2015
ORIGIN ENERGY	ORG AU equity	15/07/2005	31/07/2015
PAWNEE ENERGY LT	PAW AU equity	14/12/2007	31/07/2015
PACIFIC ENERGY	PEA AU equity	05/08/2005	31/07/2015
PETRATHERM LTD	PTR AU equity	22/07/2005	31/07/2015
SPARK INFRASTRUC	SKI AU equity	16/12/2005	31/07/2015
WHL ENERGY LTD	WHN AU equity	14/09/2007	31/07/2015

3.3. Portfolio Construction

There are two sets of portfolios will be considered in this paper: (i) An equally-weighted portfolio and (ii) a value-weighted portfolio. While the equally-weighted have the same weight for each stock, the company's market capitalization will be used as the weight in the portfolio. Since companies in the sample were listed at different points in time, portfolios are updated every 6 months. As a result of this design, 16 portfolios are formed in this paper including 8 equally-weighted and 8 value-weighted portfolios as shown in Table 3.

Listed firms included in each of the portfolios (from portfolio 1 to portfolio 8) may have different levels of gearing. As such de-levered/re-levered estimates of beta are required to ensure that the estimated beta from each portfolio represents a level of systematic risk for that particular portfolio. This process is discussed in detail in the following section.

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

Following the practice adopted in Henry and Street (2014), Vo et al. (2014) and Vo and Pham (2017), all equity betas at individual and portfolio level are re-levered using the relevant gearing ratio calculated as follows:

$$\omega = \frac{1-\bar{G}}{1-0.43} \quad (6)$$

In which is the gearing ratio of individual stock or portfolio; 0.43 is the average gearing of 23 current stocks in the energy industry in Australia.

3.5. Estimation Method

As stated above, in order to provide equity beta coefficients for the Australian energy industry which are not sensitive to outliers and more robust in the presence of non-normal error terms, this paper applies QR. In addition, the traditional approach, OLS, is also in used in this study for comparison purposes. To convey a complete

Table 3: Portfolio construction

Portfolio	Companies	From	To
P1	ORG, DUE, ENE, EWC, KPO, EVM, GDY, BKT	15/07/2005	31/07/2015
P2	ORG, DUE, ENE, EWC, KPO, EVM, GDY, BKT, PTR, PEA, ERJ, IFN, AST, SKI	16/12/2005	31/07/2015
P3	ORG, DUE, ENE, EWC, KPO, EVM, GDY, BKT, PTR, PEA, ERJ, IFN, AST, SKI, ENB	28/04/2006	31/07/2015
P4	ORG, DUE, ENE, EWC, KPO, EVM, GDY, BKT, PTR, PEA, ERJ, IFN, AST, SKI, ENB, AGL	13/10/2006	31/07/2015
P5	ORG, DUE, ENE, EWC, KPO, EVM, GDY, BKT, PTR, PEA, ERJ, IFN, AST, SKI, ENB, AGL, HPR	30/03/2007	31/07/2015
P6	ORG, DUE, ENE, EWC, KPO, EVM, GDY, BKT, PTR, PEA, ERJ, IFN, AST, SKI, ENB, AGL, HPR, WHN, HRL, PAW	14/12/2007	31/07/2015
P7	ORG, DUE, ENE, EWC, KPO, EVM, GDY, BKT, PTR, PEA, ERJ, IFN, AST, SKI, ENB, AGL, HPR, WHN, HRL, PAW, GER	08/02/2008	31/07/2015
P8	ORG, DUE, ENE, EWC, KPO, EVM, GDY, BKT, PTR, PEA, ERJ, IFN, AST, SKI, ENB, AGL, HPR, WHN, HRL, PAW, GER, EPW	10/12/2010	31/07/2015

correlation of an individual stock/portfolio on the market across the entire conditional return distribution, various quantiles are estimated including: 0.05, 0.2, 0.4, 0.5 (LAD), 0.6, 0.8, and 0.95.

With the QR method proposed by Koenker and Bassett Jr (1978), the estimator can be found with the following minimization function:

$$\beta_{QR} = \arg\min \left[\begin{array}{l} \sum_{Y_i > \beta X_i} \tau \left| Y_i - \beta X_i \right| + \\ \sum_{Y_i < \beta X_i} (1-\tau) \left| Y_i - \beta X_i \right| \end{array} \right] \forall \tau \in (0,1) \qquad (7)$$

The linear programming technique can be applied to estimate the vector of parameter from equation (6), β_{QR} (Hao and Naiman, 2007). Details discussion and applications of QR could be found in Vo and Pham (2017). Recently, QR is applied in various research fields. For example, the impacts of obesity on wage distribution are examined by Atella et al. (2008); Hung et al. (2010) investigated the determinants of hotel pricing; Carfora et al. (2017) examined the effect of climate finance on greenhouse gas emission; and Keho (2017) re-visited the Environment Kuznets Curve.

In this study, the standard error of QR coefficients is obtained by a bootstrap method in order 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 et al., 2001; Fattouh et al., 2005; Hung et al., 2010), this study uses 1000 bootstrapping repetitions 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 order. First, beta estimates for individual listed firms in the Australian energy sector are presented. Second, beta estimates for portfolios of listed firms are also presented in order to consider significant differences, if any, between betas for individual firms and for portfolios of firms.

4.1. β Estimates for Individual Firms

As previously discussed, beta estimates use raw returns and weekly frequency. Table 4 reports the equity beta estimated from OLS, LAD, and different quantiles for individual Australian energy companies.

As presented in Table 4, most beta OLS (i.e., 16 stocks) estimates are statistically significant and lower than 1 - the relevant market beta in the research sample. When the market return changes by 1%, these stock returns would change in the same direction with a magnitude of less than 1 percent. However, some of the OLS equity beta estimates (i.e., 7 stocks) are higher than 1 with an average of 1.298. On average, the OLS equity beta value of 23 companies is 0.837. Besides, there are 17 stocks which have the OLS estimates higher than the LAD ones. On average, the LAD equity beta is 0.680. This difference could be explained by the existence of outlying observations in the examining sample which could lead to the biased estimation in the OLS. Overall, these findings are consistent with our expectation: Energy businesses in Australia are expected to face a relatively lower risk in comparison with the market as the whole in the research sample.

In relation to the estimates of equity beta at individual firm level using QR, the estimates appear to vary across different quantiles. Specifically, the 95% quantile estimates produce relatively higher betas in comparison to other quantiles. However, some of the 95% quantile estimates are insignificant some of these being negatively insignificant (i.e., ERJ, EVM, GER and HPR). Conversely, the 5% quantile estimates produce ambiguous equity beta in comparison with all other quantiles. These results provide more evidence to indicate that estimating equity beta suffers from the effect of extreme outliers. Also, this observation raises the practical question of an appropriate quantile to be used to derive the final estimate of equity beta for energy businesses in practice.

4.2. β Estimates of Various Portfolios for Australia

Two set of portfolios[1] including (i) an equally-weighted portfolio and (ii) a value-weighted portfolio are formed 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 Monday-to-Friday periods are also used. Tables 5 and 6 present the estimates of equity beta for each portfolio for Australia.

The results from Table 5 show that, for the equally-weighted portfolios, the estimates of beta using the OLS, LAD and QR at all percentiles fall within a range of 0.262–0.889. Moving from Portfolio 1 to Portfolio 8, the estimates of beta decrease significantly, on average. While Portfolio 1, which includes stocks that started trading in July 2005, produces the highest beta at around 0.723 across various estimations, Portfolio 8 - the most up to date portfolio, presents the lowest estimate of 0.506. In general, estimates of beta exhibit a slightly increasing trend from P1 to P2 and keep declining to P8. And again, the OLS results are higher than the LAD at every portfolio, re-confirm the effects of outliers in the current sample.

As presented in Table 6, the estimates of equity beta using various valued-weighted portfolios produce significantly higher values compared to those from the equally weighted portfolios. On average, Portfolio 1 produces the highest beta estimates of 0.826. The lowest average beta estimate of 0.671 is observed from portfolio 7. At 95 per cent percentile regression, most of the estimates of beta are higher than 1 except those found in P6 and P7. Compared to equally weighted portfolios, estimates of equity beta for valued-weighted portfolios exhibit a declining trend from P1 to P2, increasing in P3 and then keep decreasing to P8.

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

The weekly returns measured by the change of stock prices from opening price of Monday to closing price of Friday are adopted

1 AEJ is excluded from this table since its market capitalization is weighted more than 90% of total market capitalization. This could lead to a bias in the result of the value-weighted portfolio.

Table 4: Estimates of equity beta for individual listed energy firms in Australia

Companies	Obs	OLS	LAD	Quantile regression					
				5th	20th	40th	60th	80th	95th
AEJ	450	1.935	0.678	3.094	1.686	0.790	0.591	0.693	2.541
		(0.000)	(0.002)	(0.000)	(0.001)	(0.000)	(0.023)	**(0.101)**	(0.060)
AGL	459	0.491	0.540	0.337	0.504	0.510	0.548	0.480	0.476
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.005)
AST	502	0.344	0.389	0.401	0.436	0.418	0.370	0.362	0.277
		(0.000)	(0.000)	(0.010)	(0.000)	(0.000)	(0.000)	(0.000)	(0.095)
BKT	524	0.854	0.000	0.730	0.758	0.606	0.000	0.553	1.815
		(0.037)	**(1.000)**	**(0.239)**	(0.065)	(0.000)	**(1.000)**	**(0.178)**	**(0.272)**
DUE	524	0.510	0.441	0.636	0.561	0.447	0.452	0.475	0.505
		(0.000)	(0.000)	(0.023)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
ENB	483	0.890	0.890	0.410	0.841	1.156	0.668	0.451	1.982
		(0.327)	(0.053)	**(0.446)**	(0.069)	(0.001)	**(0.147)**	**(0.633)**	(0.08)
ENE	524	0.404	0.213	0.533	0.254	0.253	0.268	0.401	0.450
		(0.000)	(0.022)	(0.027)	(0.17)	(0.000)	(0.002)	(0.000)	(0.06)
EPW	250	0.462	0.270	0.601	0.372	0.332	0.421	0.707	0.730
		(0.005)	**(0.179)**	(0.071)	(0.012)	(0.096)	(0.028)	(0.089)	**(0.108)**
ERJ	521	0.957	1.478	0.197	0.731	1.073	0.000	2.131	−1.686
		(0.067)	(0.000)	**(0.826)**	(0.076)	(0.000)	**(1.000)**	(0.000)	**(0.548)**
EVM	524	0.327	0.414	0.196	0.485	0.655	0.265	0.494	−0.900
		(0.247)	(0.063)	**(0.735)**	**(0.248)**	(0.000)	**(0.335)**	**(0.101)**	**(0.446)**
EWC	524	1.628	1.435	1.557	1.511	1.535	1.500	1.688	1.633
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.022)
GDY	524	1.073	0.914	1.293	0.949	0.890	1.027	1.043	1.713
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)
GER	390	0.293	0.000	0.385	0.353	0.637	0.370	0.262	−1.292
		(0.429)	**(1.000)**	**(0.408)**	**(0.431)**	(0.076)	**(0.324)**	**(0.669)**	**(0.485)**
HPR	435	1.082	1.418	1.020	1.309	1.276	1.175	1.528	−0.751
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	**(0.549)**
HRL	402	0.627	0.650	0.382	0.773	0.754	0.565	1.468	1.107
		(0.050)	(0.001)	(0.522)	(0.022)	(0.000)	(0.024)	(0.008)	**(0.418)**
IFN	509	1.073	0.990	1.393	0.999	0.911	1.010	0.870	0.829
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.212)
KPO	524	0.984	0.334	1.157	0.902	0.875	0.382	0.791	1.956
		(0.000)	**(0.324)**	(0.009)	(0.000)	(0.000)	**(0.291)**	(0.040)	(0.001)
ORG	524	0.868	0.934	0.919	0.860	0.848	0.805	0.784	0.526
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)
PAW	398	1.082	0.950	−0.280	0.079	1.014	0.000	0.448	3.655
		(0.102)	**(0.161)**	**(0.851)**	**(0.931)**	**(0.026)**	**(1.000)**	**(0.693)**	**(0.119)**
PEA	521	0.751	0.580	0.600	0.923	0.497	0.566	1.054	1.970
		(0.001)	(0.019)	**(0.205)**	(0.006)	(0.022)	(0.004)	(0.000)	(0.005)
PTR	523	1.215	0.961	1.441	0.977	1.007	0.821	1.510	2.440
		(0.000)	(0.001)	(0.030)	(0.000)	(0.000)	(0.018)	(0.000)	(0.015)
SKI	502	0.442	0.427	0.390	0.429	0.399	0.449	0.460	0.496
		(0.000)	(0.000)	(0.008)	(0.000)	(0.000)	(0.000)	(0.000)	(0.03)
WHN	411	0.956	0.747	0.663	0.875	0.966	0.483	0.635	1.746
		(0.003)	(0.001)	**(0.238)**	(0.017)	(0.000)	(0.085)	**(0.248)**	**(0.243)**
AEJ	450	1.935	0.678	3.094	1.686	0.790	0.591	0.693	2.541
		(0.000)	(0.002)	(0.000)	(0.001)	(0.000)	(0.023)	(0.101)	(0.060)
Average		0.837	0.680	0.785	0.764	0.776	0.554	0.839	0.966
Median		0.868	0.650	0.601	0.773	0.790	0.483	0.693	0.829

QR is estimated from 1000 bootstrap repetitions. P value is in parentheses; bold figures are insignificant at 10%

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 0.005 to 2.261 while the corresponding de-levered LAD β estimates range from 0 to 2.002. The existence of outliers still seriously affects the outcomes. For instance, at 95% percentile, the equity β of KPO, PTR 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 EVM and IFN.

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.

Table 5: Estimates of equity beta using equally-weighted portfolios

Portfolio	Obs.	OLS	LAD	Quantile regression						Average
				5th	20th	40th	60th	80th	95th	
P1	508	0.709	0.572	0.881	0.672	0.661	0.652	0.748	0.889	0.723
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	
P2	487	0.751	0.657	0.818	0.722	0.644	0.706	0.667	0.558	0.690
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.018)	
P3	469	0.682	0.584	0.664	0.646	0.563	0.601	0.572	0.713	0.628
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)	
P4	436	0.670	0.561	0.671	0.637	0.568	0.598	0.585	0.632	0.615
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.005)	
P5	422	0.679	0.564	0.818	0.677	0.585	0.580	0.583	0.483	0.621
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.006)	
P6	386	0.622	0.524	0.683	0.676	0.531	0.501	0.482	0.296	0.539
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.040)	
P7	378	0.591	0.512	0.675	0.660	0.507	0.473	0.479	0.307	0.526
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.029)	
P8	237	0.516	0.596	0.504	0.511	0.530	0.517	0.610	0.262	0.506
		(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	**(0.380)**	
Average		0.653	0.571	0.714	0.650	0.574	0.579	0.591	0.518	
Median		0.675	0.568	0.679	0.666	0.566	0.589	0.584	0.521	

QR is estimated from 1000 bootstrap repetitions. Figures in the parenthesis ( ) are the P values

Table 6: Estimates of value-weighted portfolios equity beta

Portfolio	Obs.	OLS	LAD	Quantile regression						Average
				5th	20th	40th	60th	80th	95th	
P1	508	0.842	0.682	0.646	0.908	0.672	0.685	0.709	**1.463**	0.826
		(0.000)	(0.000)	(0.004)	(0.000)	(0.000)	(0.000)	(0.001)	(0.006)	
P2	487	0.806	0.653	0.683	0.841	0.663	0.671	0.688	**1.099**	0.763
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.032)	
P3	469	0.817	0.655	0.684	0.843	0.665	0.689	0.704	**1.239**	0.787
		(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.013)	
P4	436	0.745	0.613	0.580	0.757	0.619	0.640	0.647	**1.196**	0.725
		(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.006)	
P5	422	0.743	0.605	0.583	0.773	0.625	0.642	0.627	**1.126**	0.716
		(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.006)	
P6	386	0.742	0.628	0.519	0.787	0.630	0.668	0.806	0.667	0.681
		(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.135)	
P7	378	0.720	0.614	0.497	0.779	0.634	0.660	0.800	0.663	0.671
		(0.000)	(0.000)	(0.004)	(0.000)	(0.000)	(0.000)	(0.000)	(0.124)	
P8	237	0.651	0.571	0.136	0.626	0.604	0.638	0.722	**1.450**	0.675
		(0.000)	(0.000)	(0.509)	(0.003)	(0.000)	(0.000)	(0.000)	(0.006)	
Average		0.758	0.628	0.541	0.789	0.639	0.662	0.713	**1.113**	
Median		0.744	0.621	0.582	0.783	0.632	0.664	0.707	**1.161**	

QR is estimated from 1000 bootstrap repetitions. P value is in parentheses

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

Companies	Gearing (%)	ω	OLS	LAD	5th	20th	80th	95th
AGL	44.33	1.02	0.501	0.551	0.343	0.514	0.489	0.485
AST	73.07	1.70	0.584	0.661	0.681	0.740	0.614	0.470
BKT	4.79	0.09	0.076	0.000	0.065	0.068	0.049	0.162
DUE	79.83	1.86	0.946	0.818	1.180	1.042	0.881	0.936
ENB	1.22	0.01	0.005	0.005	0.002	0.004	0.002	0.010
ENE	35.29	0.81	0.326	0.172	0.430	0.205	0.324	0.363
EPW	65.41	1.52	0.701	0.409	0.910	0.564	1.072	1.106
ERJ	58.56	1.35	1.297	2.002	0.266	0.990	2.888	−2.284
EVM	90.19	2.10	0.687	0.868	0.411	1.019	1.037	−1.888
EWC	60.00	1.39	2.261	1.993	2.162	2.098	2.344	2.268
GDY	25.76	0.58	0.626	0.533	0.754	0.553	0.608	0.998
GER	19.84	0.44	0.130	0.000	0.171	0.157	0.116	−0.573
HPR	2.98	0.05	0.050	0.066	0.048	0.061	0.071	−0.035
HRL	14.89	0.33	0.205	0.212	0.125	0.253	0.480	0.362
IFN	80.52	1.87	2.008	1.854	2.607	1.870	1.629	1.551
KPO	72.13	1.67	1.647	0.560	1.936	1.511	1.324	3.274
ORG	61.87	1.43	1.243	1.338	1.317	1.232	1.123	0.754

Table 7: ***(Continued)***

Companies	Gearing (%)	ω	OLS	LAD	5th	20th	80th	95th
PAW	44.89	1.03	1.118	0.982	−0.289	0.082	0.463	3.776
PEA	30.72	0.70	0.526	0.406	0.420	0.645	0.737	1.378
PTR	39.66	0.91	1.105	0.874	1.311	0.889	1.374	2.220
SKI	38.89	0.89	0.394	0.380	0.347	0.382	0.410	0.442
WHN	11.80	0.25	0.243	0.190	0.168	0.222	0.161	0.444
Average			0.811	0.677	0.805	0.731	0.822	0.818
Median			0.626	0.551	0.420	0.564	0.614	0.485

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

Portfolio	Gearing (%)	ω	OLS	LAD	5th	20th	80th	95th	Average
Equally-weighted portfolios									
P1	53.73	1.24	0.880	0.710	1.094	0.834	0.928	1.104	0.897
P2	53.66	1.24	0.931	0.814	1.014	0.895	0.827	0.692	0.856
P3	50.17	1.16	0.789	0.676	0.768	0.748	0.662	0.825	0.727
P4	49.80	1.15	0.770	0.644	0.771	0.732	0.672	0.726	0.707
P5	47.05	1.08	0.736	0.611	0.887	0.734	0.632	0.524	0.673
P6	43.57	1.00	0.623	0.525	0.684	0.677	0.483	0.297	0.540
P7	42.44	0.98	0.576	0.499	0.658	0.644	0.467	0.299	0.513
P8	43.48	1.00	0.516	0.596	0.504	0.511	0.610	0.262	0.506
Average	47.99	1.11	0.728	0.635	0.798	0.722	0.660	0.591	
Median	48.42	1.12	0.753	0.628	0.770	0.733	0.647	0.608	
Value-weighted portfolios									
P1	53.73	1.24	1.045	0.847	0.802	1.127	0.880	1.816	1.025
P2	53.66	1.24	0.999	0.809	0.847	1.043	0.853	1.362	0.946
P3	50.17	1.16	0.946	0.758	0.792	0.976	0.815	1.434	0.911
P4	49.80	1.15	0.856	0.704	0.666	0.870	0.743	1.374	0.832
P5	47.05	1.08	0.805	0.656	0.632	0.838	0.680	1.220	0.776
P6	43.57	1.00	0.744	0.629	0.520	0.789	0.808	0.668	0.682
P7	42.44	0.98	0.702	0.599	0.485	0.760	0.780	0.647	0.654
P8	43.48	1.00	0.651	0.571	0.136	0.626	0.722	1.450	0.675
Average	47.17	1.09	0.843	0.697	0.610	0.878	0.785	1.246	
Median	47.05	1.08	0.831	0.680	0.649	0.854	0.794	1.368	

5. CONCLUSIONS

This study was conducted to apply the QR in estimating the equity beta for energy businesses in the Australia context. The findings can be used as an additional evidence for the government and/or the economic regulators in estimating a fair and reasonable expected return on equity for energy businesses - a crucial industry in Australia economy.

Research samples include the listed energy companies in Australia stock market in the 2005–2015 period. Specifically, there are 23 individual stocks and 16 portfolios (8 equally-weighted and 8 value-weighted) which were examined in this study. Findings from this study seem to be in line with Vo and Pham (2017) when the QR estimates vary across different quantiles. However, the higher OLS figures in relation to the LAD are contrast with what have been found in Vo and Pham (2017). Besides, the results suggested that the equity beta of energy industry in Australia, at both individual and portfolio level, fall within a range of 0.6 and 0.8 - which is still below the market beta of the entire market in the research sample. These results are slightly higher than what has been found by previous studies (Henry, 2009; Henry and Street, 2014; Vo et al., 2014).

REFERENCES

Allen, D.E., Gerrans, P., Singh, A.K., Powell, R. (2009), Quantile regression: Its application in investment analysis. The Finsia Journal of Applied Finance (JASSA), 4, 7-12.

Anderson, K., Pomfret, R. (2000), Living standards during transition to a market economy: The Kyrgyz republic in 1993 and 1996. Journal of Comparative Economics, 28, 502-523.

Atella, V., Pace, N., Vuri, D. (2008), Are employers discriminating with respect to weight? European evidence using quantile regression. Economics and Human Biology, 6, 305-329.

Bartholdy, J., Peare, P. (2005), Estimation of expected return: CAPM vs. Fama and French. International Review of Financial Analysis, 14, 407-427.

Bauer, T.K., Haisken-DeNew, J.P. (2001), Employer learning and the returns to schooling. Labour Economics, 8, 161-180.

Brooks, R., Diamond, N., Gray, S., Hall, J. (2013), Comparison of OLS and LAD Regression Techniques for Estimating Beta.

Carfora, A., Ronghi, M., Scandurra, G. (2017), The effect of climate finance on greenhouse gas emission: A quantile regression approach. International Journal of Energy Economics and Policy, 7(1), 185-199.

Chang, M.C., Hung, J.C., Nieh, C.C. (2011), Reexamination of capital asset pricing model (CAPM): An application of quantile regression. African Journal of Business Management, 5, 12684-12690.

Fattouh, B., Scaramozzino, P., Harris, L. (2005), Capital structure in South Korea: A quantile regression approach. Journal of Development Economics, 76, 231-250.

Hao, L., Naiman, D.Q. (2007), Quantile Regression. London, UK: Sage. p149.

Henry, O. (2008), Econometric Advice and Beta Estimation: Report for the AER.

Henry, O. (2009), Estimating β'. Report Submitted to ACCC.

Henry, O., Street, C. (2014), Estimating β: An Update: April.

Hung, W.T., Shang, J.K., Wang, F.C. (2010), Pricing determinants in the hotel industry: Quantile regression analysis. International Journal of Hospitality Management, 29, 378-384.

Keho, Y. (2017), Revisiting the income, energy consumption and carbon emissions nexus: New evidence from quantile regression for different country groups. International Journal of Energy Economics and Policy, 7(3), 356-363.

Koenker, R., Bassett Jr G. (1978), Regression quantiles. Econometrica: Journal of the Econometric Society, 46, 33-50.

Lie, F., Brooks, R., Faff, R. (2000), Modelling the equity beta risk of Australian financial sector companies. Australian Economic Papers, 39, 301-311.

Lintner, J. (1965), The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. The Review of Economics and Statistics, 47, 13-37.

Sharpe, W.F. (1964), Capital asset prices: A theory of market equilibrium under conditions of risk. The Journal of Finance, 19, 425-442.

Sudarsanam, S., Kaltenbronn, U., Park, P. (2011), Cost of Equity for Regulated Companies: An International Comparison of Regulatory Practices. UK: Cranfield School of Management, UK, and Member, Competition Commission.

Vo, D.H., Pham, T.N. (2017), Systematic risk in energy businesses: Empirical evidence for the ASEAN. International Journal of Economics and Financial Issues, 7(1), 553-565.

Vo, H.D., Mero, S., Gellard, B. (2014), Equity beta for the Australian utilities is well below 1.0'. Hobart, Australia: Paper Presented at the Australian Econometric Society Meeting.