Energy efficiency and company performance in Japanese listed companies

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Abstract: This research empirically investigates the relationship between energy efficiency and company performance for a pooled sample of 177 listed companies in Japan over 2005–2014. We find that energy efficiency plays a significant role in company performance in Japan, thereby debunking the energy efficiency paradox. Our research further indicates that this energy efficiency not only affects the market-based performance (Tobin's Q), but it also significantly impacts the accounting-book performance (return on assets). The findings present significant contributions to both the academic body of knowledge and the industry. The findings can also provide a basis for the Japanese Government to encourage companies to enact more energy efficient practices.

Keywords: energy efficiency; company performance; Tobin's Q; return on asset; ROA; Japan.

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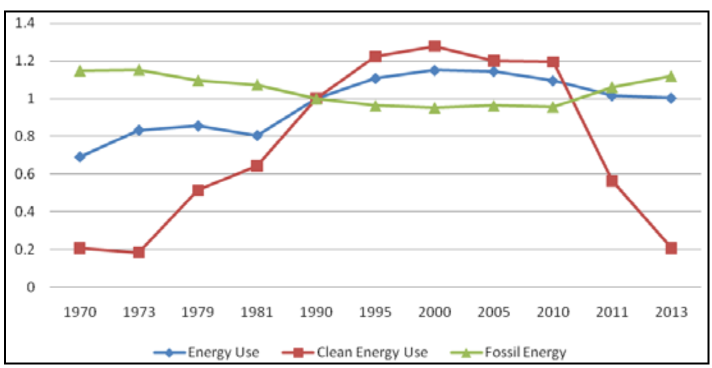
1 Introduction

During the rapid economic growth on 1950s, Japanese companies made large and notable investments without proper consideration for their environmental impact. The national pollution level has since increased, in addition to serious health problems including Minamata and asthma. The Japanese Government responded by introducing the Basic Law for Environmental Pollution Control 1967 and The Air Pollution Control Law 1968 to hold the increases of environmental impact of industrialisation.

The 1970s oil boom once again changed the game of energy for Japanese companies. Then, the issue was no longer just about tackling the emissions and pollutants in the air, but also the nation's energy use framework. The high cost of energy, due to expensive oil prices, forced Japan to introduce an energy management system based on energy conservation law of 1979 which changed the environmental issue perspective.

Because of the higher cost of oil, Japan's chief energy sources have gradually shifted over time to cleaner alternatives such as nuclear power. This is confirmed by our anecdotal evidence, where Figure 1 shows the uprising trends of clean energy use starting from 1970 to 2010. Yet, the Fukushima disaster has brought back Japan to 1973 levels of clean energy use. The dropping price of fossil fuel commodities, such as oil and coal, is also another motivation for Japan to return to fossil energy consumption. This explains the increasing trends of fossil energy in Japan after 2010. The anti-nuclear movement in Japan led by many politicians and NGOs[1] around this time may also be a contributing factor. Therefore, the clean energy use in Japan continues to drop steadily.

Figure 1 The index trends of energy use, clean energy use and fossil energy use of Japan 1970–2013 (see online version for colours)

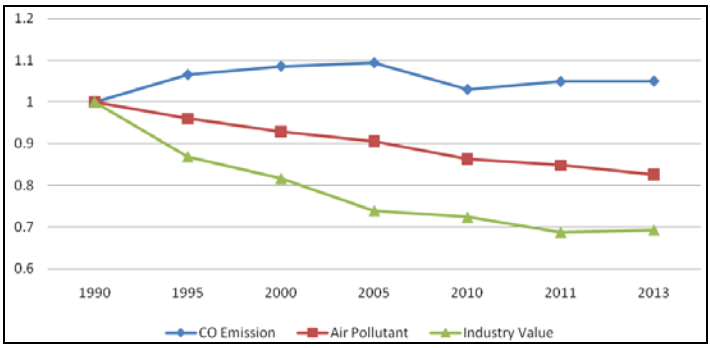


Note: Base year 1990.

Figure 2 confirms our anecdotal evidence of Figure 1, demonstrating that CO emissions in Japan are still higher than they were during the 1990s. In March 2014, Japan emitted 1.224 billion metric tons of CO_2, an increase of 1.4% from 2013 and up 16% from 1990, the base year for emission cuts previously targeted under the United Nations Framework Convention on Climate Change. On the other hand, air pollutants have decreased annually. Even so, it is noteworthy that Industrialisation in Japan has decreased since

1990. One possible explanation may be that the marginal abatement cost in Japan is very high, especially after the enactment of Energy Conservation Law 1979 and all its amendments.

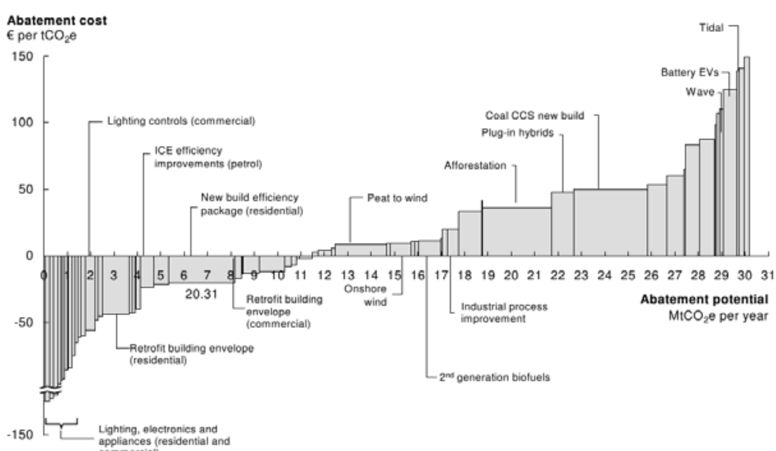
Figure 2 The trends of the index of co-emission, air pollutant and industry value of Japan 1990–2014 (see online version for colours)



Note: Base year 1990.

The anecdotal evidence shows Japan has faced the worst scenario of this environmental issue and as the consequences, the good deeds of Japanese Government to improve their position in climate change campaign is in the borderline. One backdoor to stop this stagnancy is using energy efficiency which has started back form 1980s. However, does imposing the energy efficiency policy really work?

Figure 3 The energy efficiency abatement cost



Note: Baseline cost curve based on 2007 IEA energy price forecasts (~60 USD / barrel in 2013) and a real cost of capital of 4%.

What benefits should Japan expect in setting energy efficiency goals? Firstly, Japan is a large net importer of fossil fuels. As the fossil fuel price is uncertain, the nation's dependency on such resources may create instability in their economy and energy use. Second, the renewable energy technology is an expensive modern technology. Figure 3 of abatement cost explains the expensive investment in renewable energy. Lastly, it may give competitiveness to companies and lead to better performance. According to the National Research Council (US) Committee on Grand Challenges in Environmental Sciences (2001) identified the potential to improve energy efficiency by up to 37% at zero economic cost. Similarly, the IPOC (1996) concluded that global carbon dioxide emissions could be cut by 10%–30% through the accelerated diffusion of least-cost energy technologies. Findings of this sort are substantial grounds to measure the impact of untested strategies. McMahon et al. (1990) and Geller (1997) estimate that the US appliance efficiency standards will save some 24 hexajoules of energy and $46 billion between 1990 and 2015 by mandating the adoption of least-cost design features.

Yet, at the micro level (firm level), fuel-based industry sees this certification or energy-efficiency policy as technology gimmicks[2]. Many companies staunchly oppose the introduction of so called cap-and-trade or a carbon tax or really apply the energy-efficiency for climate change campaign. Most of them believe that it will not bring any impact to firm performance (Howarth et al., 2000; Nakamura et al., 2001). Economists such as Sutherland (1991) argue that the normally-functioning market provides powerful incentives for consumers and firms to exploit investments in energy efficiency that yield accompanying cost savings.

The energy efficiency marginal abatement cost curve is the best way to explain this matter. As Japan has been in the peak of energy efficiency, pushing the company to invest more on energy efficiency tends to result in costs. Figure 3 shows that adding more energy efficiency is costly. This might be the reason why many company directors in Japan feel reluctant to invest more on energy efficiency.

Another explanation for this matter is the energy efficiency paradox. This paradox describes that when a firm increases their energy efficiency through technological progress to reduce energy use, at the same time, the firm's consumption rate of energy use rises because of increasing demand. The main objective of companies is to optimise profits; hence, having more cash in hand due to savings on energy induces companies to be more active, make more investments and perhaps consume more energy. Therefore, it would be interesting to examine whether energy efficiency really plays important parts for companies performance.

The purpose of this research is to empirically investigate the debate surrounding the economics of energy efficiency, in which companies feel reluctant to impose cleaner environmental practices due to a perceived threat to their profits. We examine Japanese listed companies over the period of 2005 to 2014. We pool these companies and run the White-test panel regression by clustering the industry and period effect of the data.

The contribution of this study is threefold. Firstly, we test the existence of an energy efficiency paradox, concerning whether the energy efficiency gives significantly company's performance or not. Secondly, we add to the literature by extending the understanding of this research area within the context of a well-developed market that has experienced energy efficiency since the1970s. Thirdly, we closely study the performance of energy efficiency by testing not only market-based performance, but also accounting book performance.

The rest of this paper is organised in the following manner: Section 2 reviews the prior literature in this area and describes its theoretical framework; Section 3 describes the methodology used in testing this relationship; Section 4 describes the empirical results and discusses their significance; and Section 5 concludes the research.

2 Prior studies

The oil price shocks during the 1970s introduced a new playbook for most industrial countries including Japan. Globally, it brought in energy efficiency across many industries which have shown improvement in their consumption rates – typically around 1% annually. However, these improvement rates can still potentially double through the use of policy mechanism (Sinton and Fridley, 2000; Worrel et al., 2009). This means that there is great potential to reduce energy use and emissions among firms by imposing energy efficiency policy.

It is noteworthy that industries still emit the largest share of emissions (IEA, 2008, 2009). IEA (2005) found that energy intensity in industrial process is at least 50% higher than the theoretical minimum, meaning that there is a significant opportunity to reduce energy use and its associated CO_2 emissions. Energy efficient solutions can be sought via a wide range of green and advanced technologies. Such solutions include fuel switching, material efficiency, renewable energy, and reduction of non-CO_2 GHG emissions.

There are numerous ways energy efficiency may reduce emissions significantly. For example, IEA (2006) estimates that the steam generation consumes around 15% of global final industrial energy use. By regularly undergoing general maintenance, insulation improvement, combustion controls and leak repair, steam boilers improved their efficiency up to 85%. Einstein et al. (2001) find that this technique provides the opportunity to increase economic potential by up to 20%. Another common method is conventional energy recovery, wherein the discarded heat or power can be reused in other processes. This technique may enhance cost-effectiveness from 5% to 40% (Worrell et al., 2009).

Despite these statistics, many companies still feel reluctant to enact energy efficiency policy through green technology investment. Investing in energy efficient technology means companies have to spend more cash. Putting up money for a long-term project within a short managerial tenure is perceived as unwise for a manager's reputation. Companies also feel this energy efficient technology is expensive and lacking from subsidies and incentives[3]. The high uncertainty surrounding the success of energy-efficient technology is also a factor that makes managers feel reluctant to enact new policy[4].

In neoclassical economy theory, firms seek to be well-informed, rational and systematically maximise their profits subject to the constraints from government, technology and the market. This tenet is the central framework in environmental economics, whereby it surmises that firms enjoy informational advantages over policy concerning the technological and economic dimensions of energy use. Clean Air Act amendments 1990 in the USA or the Air Pollution Control Law 1968 in Japan are examples of policies based on this framework. Even so, many academicians have contended this framework.

The most prominent contender is the postulation of energy-efficiency paradox (e.g., DeCanio, 1998; Van Soest and Bulte, 2001). This paradox states that when firms increase their energy efficiency through technological progress to reduce energy use, at the same time, firms' energy consumption rate rises because of increasing demand. In a simple example, a firm may install energy-efficient bulbs for their offices to save in the long-run. Yet, simultaneously, the firm may well install more bulbs or using their new savings, spend money on something else that also consumes energy.

The energy efficiency paradox has been argued for many years. The contention is that environmental interest and policy may not give any competitiveness to companies, but just add costs. Cleveland et al. (1984) are opponents to this paradox. They claim that a strong link exists between energy use and economic output, and this takes effect cross-sectionally and temporally. Schurr (1982) similarly argues that energy quality and efficiency plays an important role in productivity growth. Schurr (1982) surmises that the technology improvement from energy efficiency policy enhances the flexibility of energy use at a relatively low cost. This newly adopted energy-efficient technology transforms and enhances industrial production.

Energy policy and its impact on firm competitiveness have been heavily debated since the Porter and Van der Linde hypothesis was introduced in 1995. For instance, Dowell et al. (2000) examine whether environmental standards would improve US multinational company market value. By using 500 standard and poor corporations, they found that firms with better environmental standards would have much higher market value. They also found there is no lag effect (endogeneity) of environmental standards on the market value. Mohr (2002) uses a general equilibrium model to prove the Porter hypothesis. Hamamoto (2006) presents a study, albeit under-researched, about environmental policy and firm performance in the Japan context. The findings show that there is an impact of environmental regulation on the performance of Japanese manufacturing companies in the era of 1971–1988.

On the other hand, there are also studies disproving the Porter effects wherein environmental policy has minimal effect on a company's performance. For example, Gray and Shadbegian (1993) find that spending more on pollution abatement would result in lower productivity. Walley and Whitehead (1994) argue that environmental investment only adds more costs and would actually hamper economic performance. Boyd et al. (2002) find that production growth would be diminished at the moment that companies introduce the environmental control or energy efficiency. By using Swedish industrial firms, Brännlund and Lundgren (2010) find the inverse effect of environmental-related policy. They examine technological progress and profitability of Swedish companies affected by carbon policy in the period of 1990 to 2004. In more recent years, Bostian et al. (2016) find that there is no link between energy efficiency and productivity.

Kounetas and Tsekouras (2008) investigate the role of energy efficiency on its company investments within the Greece context. They found that energy efficiency is correlates significantly with the return on assets (ROAs) of Greek companies. Furthermore, DeCanio and Watkins (1998) find that energy efficiency gives positive net present value to the investment decision made by the companies when shifting to energy efficient production. Sornell (2009) also advocates that energy efficiency leads to better performance of the companies. Zhang et al. (2015) have a working paper that is similar to our research. They investigate the role of energy efficiency on firm performance of Swedish companies. Their findings show that the more companies achieving energy efficiency, the better their performance. Hence, we hypothesise that energy efficiency plays a significant role in Japanese company performances.

Presently, there is scant research investigating the energy efficiency-performance link. Much of the current research emphasises how energy efficiency boosts productivity (i.e., Fisk, 2000; Boyd and Pang, 2000; Worrell et al., 2003; Wang and Feng, 2015) or focuses on macro scale effects (i.e., Cleveland et al., 1984; Sorrell, 2009). These papers make indirect connections between energy efficiency and performance (i.e., DeCanio and Watkins, 1998; Van Soest and Bulte, 2001) and hold little weight as conceptual papers or single types of industry studies (i.e., Brännlund et al., 1995; DeCanio, 1998; Gray and Shadbegian, 2003; Hamamoto, 2006). This is the gap that this research aims to fill in.

3 Methodology

3.1 Data

We use WorldScope and Asset 4 databases to collect panel-set of annual financial data and energy efficiency for Japanese listed companies from the years of 2005 to 2014. The criteria for our sampling are that:

1 it must be manufacturing, industrialisation, or heavy industry companies and

2 the financial and energy efficient data must be available throughout the ten year period.

Our final sample covers 177 listed companies and our final observation consists of 1,770 pooled observation with complete data.

3.2 Baseline model

To examine the impact of energy efficiency policy on firm performance, we based our model on the corporate finance model, whereby, the theoretical baseline of firm performance is a function of operating performance, growth and leverage (i.e., Berger and Ofek, 1995; Fauver et al., 2004). The function is as follows:

$$Performane = f(OperatingGrowth, Leverage)$$

To estimate the above model empirically, we pooled all the sample firms and estimated the following regression model as the baseline model:

$$Performance_{i,t} = \beta_0 + \beta_1 Operating_{i,t} + \beta_4 Growth_{i,t} + \beta_3 Leverage_{i,t} + \varepsilon_{i,t}$$

The firm performance is measured by market-based performance proxy which is Tobin's Q. We follow prior research of Dowell et al. (2000) in calculating the Tobin's which is ratio of the market value and its replacement cost. For robustness check, we rerun the model with different proxy of measurement. Instead of using market-based performance, we retest the model by using accounting-based performance which is ROA. Its formula is the ratio of net income to total assets.

Meanwhile, the performance common factors are measured following prior research by Berger and Ofek (1995) and Anderson et al. (2003). The operating performance (operating) is the efficiency of the firm in generating profit. Capital expenditure – sales ratio acts as a measure of firm's growth (growth). Lastly, firm leverage (leverage) is measure by the ratio of debt to common share equity. Meanwhile, the symbols of i and t are the firm and time dimension of the data.

3.3 Full model

The main objective of this research is to test the energy efficiency paradox within the Japan context. We introduce the energy efficiency variable into our baseline model and rebuild our firm performance function. The new function is as follows:

$$Performane = f(EE, OperatingGrowth, Leverage)$$

We employ the function above empirically under panel regression. The regression model is as follow:

$$Performance_{i,t} = \beta_0 + \beta_1 Operating_{i,t} + \beta_4 Growth_{i,t} + \beta_3 Leverage_{i,t} + \beta_4 EE_{i,t} + \varepsilon_{i,t}$$

The energy efficiency policy is a categorical variable where

$$EE_{i,t} \begin{cases} 1 \text{ if the firm is energy efficient} \\ 0 \text{ if the firm is not energy efficient} \end{cases}$$

4 Results and discussions

4.1 Descriptive statistics

Table 1 and Table 2 describe the summary statistics for our sample of 177 companies across the ten year period. Table 1 shows the summary of the number of energy efficiency companies and their financial information. From the table, we find that there is an increasing trend of energy efficient companies through the year. There were only 29 companies that are energy efficient in 2005 and it quintupled to 159 in 2014. Meanwhile, the financial information generally follows the economic growth of Japan. The assets, debts and sales have grown steadily from 2005 to 2014.

Table 1 Summary statistics for sample firms on 2005–2014

	2005	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*
No. non-EE	148	142	108	66	43	39	26	27	25	25
No. EE	29	35	69	111	134	138	151	150	152	152
Assets (000,000)	3,233	3,704	3,817	3,893	3,764	3,880	4,030	4,232	4,513	4,875
Debt (000,000)	813	849	848	858	911	922	979	991	1,032	1,167
Sales (000,000)	1,156	1,266	1,391	1,476	1,342	1,247	1,298	1,316	1,357	1,522

Table 2 gives the insight of descriptive statistics of our samples. The ROAs which is a proxy for accounting book performance has a mean of 0.100. This means that the ROA of Japanese companies from 2005 to 2014 averaged 0.100. Meanwhile, the market-based performance (Tobin's Q) has the mean value of 0.267. This tells us that Japanese companies, on average, experienced good performances from 2005 to 2014. The energy efficiency has the mean value of 0.633 implying there are more energy efficient companies compared to non-energy efficient companies in Japan from the period of 2005 to 2014. This is in line with our anecdotal evidence in Table 1 and also with the background of Japan being the most experienced country in terms of energy efficiency. Other financial ratios such as operating performance, growth and leverage also give the insight that our sampling method is not far off the real condition of Japan's economy. Note also that Table2 implies our data has a normal distribution and good variance when we see the mean, standard deviation, minimum value and maximum value, except for leverage. Therefore, the leverage is normalised by using normal logarithm method.

Table 2 Descriptive statistics for sample firms on 2005–2014

Variable	*Mean*	*Std. dev.*	*Min.*	*Max.*
Return on assets	0.100	0.061	–0.218	0.504
Tobin's Q	0.267	0.166	–0.107	0.736
Energy efficiency	0.633	0.482	0.000	1.000
Operation performance	0.074	0.076	–0.465	0.546
Growth	0.061	0.044	0.001	0.386
Leverage	1.014	1.133	0.000	14.502

4.2 Correlation

Table 3 documents the correlation results of our samples. As expected, we found that ROA and Tobin's Q has negatively and significantly correlated. This means that these two variables actually measure the similar dimension of performance, yet, both measure different results. This is one of the reasons we estimate energy efficiency to both type performances. These two performances have significantly and positively correlated to energy efficiency. Moreover, these two performance proxies significantly correlate with its control variables.

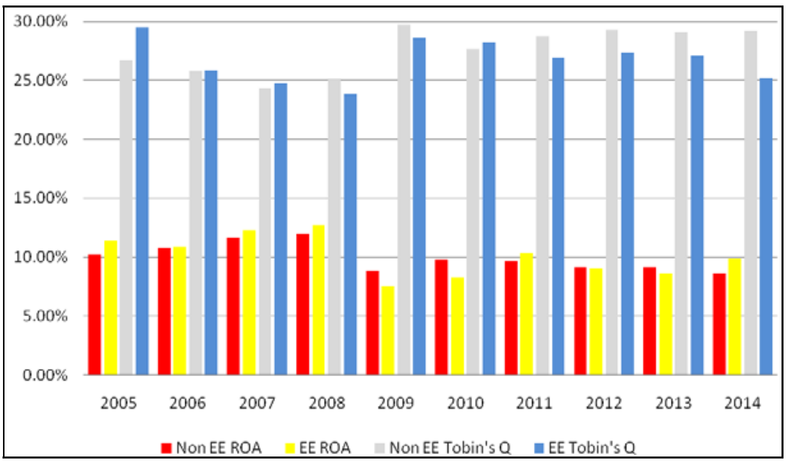
Table 3 Correlation matrix of the variables

	ROA	*TOBIN's Q*	*Energy efficiency*	*Operation performance*	*Growth*	*Leverage*
ROA	1					
TOBIN's Q	–0.3596**	1				
Energy efficiency	0.0616**	0.0048**	1			
Operation performance	0.7774***	–0.3049***	–0.1294**	1		
Growth	0.1312***	0.2761***	–0.0021	0.1209	1	
Leverage	0.331***	0.7905**	–0.05*	–0.2144*	0.1798	1

Notes: *, **, *** denotes the significance level of 10%, 5%, and 1% respectively.

Figure 4 portrays and compares the performance of energy efficient companies and the performance of non-energy efficient companies. It shows three interesting findings. First, market-based performance, which is Tobin's Q, is always higher than the accounting book performance (the ROA). Second, energy efficient companies do not always outperform the non-energy efficient companies. In fact, it was only in 2005, 2006, 2007 and 2010 that the Tobin's Q of energy efficient companies was higher than non-energy efficient companies. Third, the ROAs of energy efficient companies do not always outperform the ROAs of non-energy efficient companies. However, the energy efficient companies beat non-energy efficient companies in many years, which were in 2005, 2006, 2007, 2008, 2011 and 2014. Note also, Figure 4 does not show any nonlinear or quadratic trends.

Figure 4 The performance chart of energy efficient vs. not energy efficient (see online version for colours)



4.3 Baseline model result

Table 4 presents the pooled regression result with a few restriction variations. Our panel regression is a fixed effect model based on White robust standard error that control for heteroscedasticity errors. We also did the firm clustering, year clustering and industry clustering to minimise the serial correlation error structure. The R2 of the model is about 31.24% indicating our model is fit enough. Only two control variables contribute positively and significantly to the company's performance (Tobin's Q). The operating performance has a significant and positive relationship to the performance with the value of 0.3010 at the 1% significance level. This means the higher the operating performance, the higher is the company's Tobin's Q. This is a similar conclusion as leverage where there is a positive and significant relationship between leverage and Tobin's Q at 1% significance level with the coefficient value of 0.0428. However, company's growth has been found to have no significant effect on Tobin's Q.

Table 4 Baseline model

Operating	0.3010***
	(0.068)
	(0.000)
Growth	–0.0617
	(0.110)
	(0.574)
Leverage	0.0428***
	(0.009)
	(0.000)
Constant	0.2494***
	(0.014)
	(0.000)
N	1,770
R2	0.3136
Adj. R2	0.3124

Notes: For the baseline model pooled regression, the collected data of operating performance, growth and leverage are employed using STATA 11. The regression is performed using panel regression based on White robust standard errors that control for heteroscedasticity errors, as well as firm clustering, year clustering and industry effect, which induce a within firm serial correlation error structure. The figures stated first are the coefficient values. It is followed by the T-statistics value and p-values which are inside the parentheses. The level of significance are denoted by asterisk symbols *** which are equivalent to 10%, 5% and 1% level of significance respectively. The baseline model is as follows:

$$Value_{i,t} = \beta_0 + \beta_1 Operating_{i,t} + \beta_4 Growth_{i,t} + \beta_3 Leverage_{i,t} + \varepsilon_{i,t}$$

4.4 Energy efficiency and performance (Tobin's Q)

We add energy efficiency on the baseline model to estimate the link between energy efficiency and performance. The results are indifference. All the control variables have contributed positively and significantly on company's performance, except the growth. The adjusted R2 of the model is improved to 31.82%. Operating performance has a positive significant relationship with Tobin's Q with the coefficient value of 0.2810. It is significant at the 1% level. The leverage has positive and significant effects on company's Tobin's Q at the 1% significance level as well and the coefficient value is 0.0432. The main finding portrays that energy efficiency has a positive and significant relationship with Tobin's Q at the 5% significance level. The coefficient value is 0.0109. The result suggests that energy efficiency may cause the improvement of company performance. This indicates that energy efficient companies are relatively better than non-energy efficient companies. Our findings confirm prior research of DeCanio and Watkins (1998), Dowell et al. (2000) and Sornell (2009). What's more, our findings debunk the energy efficiency paradox postulation.

Table 5 Estimation model

Energy efficiency	0.0109**
	(0.005)
	(0.022)
Operating	0.2810***
	(0.068)
	(0.000)
Growth	–0.0587
	(0.108)
	(0.588)
Leverage	0.0432***
	(0.009)
	(0.000)
Constant	0.2404***
	(0.015)
	(0.000)
N	1,770
R2	0.3197
Adj. R2	0.3182

Notes: For the full estimation model pooled regression, we introduce energy efficiency variable into the baseline model. The regression is performed using panel regression based on White robust standard errors that control for heteroscedasticity errors, as well as firm clustering, year clustering and industry effect, which induce a within firm serial correlation error structure. The figures stated first are the coefficient values. It is followed by the T-statistics value and p-values which are inside the parentheses. The level of significance are denoted by ** and *** which are equivalent to 10%, 5% and 1% levels of significance respectively. The baseline model is as follows:

$$Value_{i,t} = \beta_0 + \beta_1 Operating_{i,t} + \beta_4 Growth_{i,t} + \beta_3 Leverage_{i,t} + \beta_4 EE_{i,t} + \varepsilon_{i,t}$$

4.5 Robustness check

Some researchers argue that Tobin’s Q only captures the market-based performance (i.e., Anderson and Reeb, 2003; Maury, 2006; Cheng, 2008) and using solely Tobin’s Q as proxy of performance means that we assume that accounting book performance is not important. Meanwhile, in reality, investors and debtors use accounting reports as financial evaluations. Therefore, we further investigate the role of energy efficiency on company’s performance by including the accounting book performance (ROAs). Hence, this research re-estimates the both models (baseline and energy efficiency) by taking ROA as the dependent variable.

Table 6 portrays the estimation results of the baseline model and energy efficiency model with a new dependent variable: ROA. The adjusted R2 is much better compared with Table 4 and Table 5. In Table 6, the baseline model shows 63.85% of adjusted R2 and the energy efficiency shows 63.9% of adjusted R2. It is almost double the R2 in Table 4 and Table 5. This implies that our variables are much better in explaining the accounting book performance (the ROA) than explaining the market-based performance (the Tobin's Q).

The conclusion is similar, where this time all control variables contribute significantly to ROA. The operating performance and growth have positive effects on ROA at the 1% significance level and the coefficient values are 0.5828 and 0.1041, respectively. Meanwhile, the leverage has a significant and negative effect on ROA at the 1% significance level, with the coefficient value –0.0100. The slight difference in sign compared to Table 5 may be due to the accrual system of the accounting. The main findings of Table 6 document that the energy efficiency contributes positively and significantly to ROA at the significant level of 1%. The coefficient value is 0.0300. This means that energy efficiency indeed plays an important role in company performance. This is tally with prior research by Kounetas and Tsekouras (2008) and Sornell (2009) and proves there is no energy efficiency paradox for Japanese companies.

Table 6 Robustness check

	Baseline	*Full model*
Energy efficiency		0.0030**
		(0.001)
		(0.023)
Operating	0.5799***	0.5828***
	(0.023)	(0.023)
	0.000	0.000
Growth	0.1052***	0.1041***
	(0.032)	(0.031)
	(0.001)	(0.001)
Leverage	–0.0101***	–0.0100***
	(0.002)	(0.002)
	(0.000)	(0.000)
Constant	0.0611***	0.0589***
	(0.003)	(0.003)
	(0.000)	(0.000)
N	1770	1,770
R2	0.6383	0.6388
Adj. R2	0.6385	0.639

Notes: ROA model.

The baseline model and full model are rerun by changing the dependent variable from Tobin's Q (market-based value) to ROA (accounting value). The regression is performed using panel regression based on White robust standard errors that control for heteroscedasticity errors, as well as firm clustering, year clustering and industry effect, which induce a within firm serial correlation error structure. The figures stated first are the coefficient values. It is followed by the T-statistics value and p-values which are inside the parentheses. The level of significance are denoted by ** and *** which are equivalent to 10%, 5% and 1% levels of significance respectively.

5 Discussions

The anecdotal evidence documents that some Japanese company directors feel reluctant to incorporate energy efficiency policy into their strategies. For them, this policy is only for the gimmick and good appearance. Our plot in Figure 4 seems to confirm that non-energy efficient companies outperformed the energy efficient companies in certain years. While several scholars support the energy efficiency paradox wherein environmentally conscious policy only increases costs (such as the abatement costs), our research shows contrarily.

Our findings show that energy efficiency leads to better performance. Table 5 documents that energy efficient companies would have increasing market value (Tobin's Q). This is in line with prior research such as DeCanio and Watkins (1998), Dowell et al. (2000) and Sornell (2009). We rerun the model by changing the proxy of performance into ROAs and found the same conclusion. Hence, energy efficiency plays a positive and significant role on the ROA's of Japanese companies.

There are four theories that may explain the link of energy efficiency and firm performance which are: managerial opportunism, resource-based view theory, institutional theory and contingency theory. In terms of managerial opportunism, the link between energy efficiency and performance can be described as the form of alignment. Our results suggest that managerial environmentalism bolsters not only performance, but also the tenure of managers within the company. Japan hands down heavy punishment and charges to the offenders of this energy use issue. Violating one of the regulations not only tarnishes the reputation of the perpetrating companies, but also to their managers. These regulations are complex, to some extent. Therefore, managers tend to employ energy efficiency to minimise protests or incidences, to avoid extra environmental costs and to win more market share (DeCanio and Watkins, 1998; Zhang et al., 2015)

Resource-based view theory states that companies with better resources outperform those companies with fewer resources (Wernerfelt, 1984). This implies that companies with advanced production processes or more efficient resources enjoy better performance. Our findings show that energy efficiency is likely to start a positive production chain and this would lead to better production. This is tally with Schurr (1982), Cleveland et al. (1984) and Mohr (2002) whereby the energy efficient companies tend to have better production process. By having smarter production due to energy efficiency, the companies gain competitive advantage which in turn leads to a better performance.

Institutional theory proffers that firms respond to institutional pressure, emphasising the importance of regulatory, normative and cognitive pressures (Scott, 2001). This theory explains that companies choose to be energy efficient as a preempt to the risks of contingency and the pressure of society (Campbell, 2006). Companies may promote their energy efficiency to attract more attention from peers as well as potential consumers. That is, in an environmentally educated society such as Japan, companies may plug energy efficiency to attract a wider market share and generate profits.

Lastly, our findings can be explained using contingency theory. This theory states that there is no 'best' way to organise company compared to optimise the contingent upon the internal and external situation. Energy efficiency may lead to reduction in energy costs, risks of energy price fluctuation, environmental loads and carbon tax price. These four factors are the chief contingency risk factors for companies. By employing energy efficiency policy, companies will have lesser contingency costs compared to non-energy efficient companies. Therefore, energy efficient companies enjoy enhanced performance.

6 Conclusions

Our study addresses the recent phenomenon of Japanese companies increasing their energy efficiency efforts. Our study is chiefly motivated by the lack of testing of the energy efficiency paradox. This paper lays the foundation for further research into this topic, which may venture into other dimensions such as the governance or institution settings. It may be the basis for comparative studies in other emerging markets.

This research empirically examines the argument of energy efficiency marginal abatement cost. We built an estimation model that can estimate the role of energy efficiency on company performance. Our results bring implications about certain conceptualised frameworks and empirical evidence about energy efficiency as more than a gimmick for good corporate governance. We found that companies may well enhance performance by imposing energy efficiency policy through more sustainable technology. What's more, our study argues that energy efficiency is not a long-run investment, given that our pooled data shows no endogeneity. Our study further contributes to the academia in our use of a panel data approach that allows for assessing changes in energy efficiency level over time, and thus giving more reliable estimates.

However, all our findings need to be validated by further research on other industrialisation countries in order to verify some facts about certain common characteristics embedded in certain countries and economies. A few extensions can be further built upon this analysis. Firstly, more in-depth insights can be gained by examining the possible value of ownership expropriation. Also, some internal corporate governance such as director capital, CEO publicity, board structure and roles of family managers is another interesting extension of study for this analysis.

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Notes

1 See http://mainichi.jp/english/articles/20160314/p2a/00m/0na/023000c and http://blogs.wsj.com/japanrealtime/2012/02/06/anti-nuclear-tokyo-mayor-challenges-big-utilities/.

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