The Impact of Sustainable Environmental Innovation on Companies' Financial Performance in Far East Asia for the Period of 2012-2019

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Abstract. This study aims to determine the effect of environmental innovation on companies' financial performance. The total sample used in this research is 275 publicly listed companies operating in China, Japan, South Korea, Hong Kong, Singapore, Taiwan, Indonesia, Malaysia, and the Philippines for the period of 2012-2019. In constructing the analysis, this study uses balanced panel data and robust fixed effect model. The result suggests insignificant relationship between environmental innovation and companies' financial performance in the short-term. While in the longer term, this study shows a significant relationship between environmental innovation and companies' financial performance. However, there are inconsistencies still found in the relationship between the two variables due to negative and positive associations in the regression result. This is mainly because the innovation success can be affected by other factors such as the innovation management and the market introduction timing as well. Thus, future research needs to take those factors into account when trying to identify the impact of innovation on financial performance.

1. Introduction
One of the ways to develop business and the economy is through innovations [1]. Since there is a positive association between innovation and company performance [2]–[4], there is an incentive for companies to innovate continuously. However, in the company's efforts to innovate, tragedy of the commons often occurs marked by overexploitation of publicly available resources [5].

Along with the worsening environmental conditions, demands from stakeholders (e.g., government, consumers) towards companies to address this issue also increases [6]. One way that companies can take in dealing with these pressures is to conduct environmental innovation, which also has the potential to improve company performance.

Countries in the Far East region have interesting characteristics to be studied further related to this topic. Countries in East Asia have long been known as world manufacturing hubs characterized by export-oriented countries like Japan and China [7]. Along with infrastructure and economic developments, the trend of Southeast Asia as an export center from manufacturing hubs has also begun, replacing China's position [8]. This condition causes countries in Southeast Asia also become country destinations for industries that are not environmentally friendly.

As a form of innovation, environmental innovation has also been shown to have a positive association with company performance [9], [10]. Nevertheless, there is still no consensus regarding the literature on
this topic [11]. In addition, one of the obstacles to environmental innovation is that the investment will only produce long-term results [12]. This is because innovations need to undergo several stages, with time lag at each stage, before it can have an impact on company performance [6].

Even though many previous studies have found a positive relationship between innovation and competitiveness and financial performance, empirical studies show that research results do not always show a positive relationship [13], [14]. Cordeiro & Sarkis (1997) found a significant and negative relationship between environmental pro-activism and company performance [15]. Research by Fernando et al. (2010) also shows that green companies do not experience better performance compared to environmentally neutral companies and green strategies do not contribute to an increase in the company’s market valuation[16].

Based on the conditions described above, the researchers decided to analyze the relationship between companies’ environmental innovation and their financial performance in the Far East Asia. This research novelty is the renewal of the research period (2012-2019 data), research on countries in the Far East Asia region, and the use of environmental innovation score as a substitution for the green patent variable as a proxy for environmental innovation carried out by the company.

2. Method
The data in this research were obtained from Thomson Reuters Datastream. The sample consists of 275 publicly listed companies in Taiwan, Japan, Hong Kong, South Korea, China, Indonesia, Singapore, Malaysia, and the Philippines during the period 2012-2019. This study replicates the research model made by Rezende, Bansi, Alves, and Galina in 2019 in an article entitled “Take your time: Examining when green innovation affects financial performance in multinationals companies”. The model will be iterated using lag variables ranging from t-0 to t-5 to examine the effect of time lag on environmental innovation.

The following is the model used in the study:

\[ ROA_{it} = \beta_0 + \beta_1 ENV_{it-j} + \beta_2 RDI_{it} + \beta_3 SIZE_{it} + \epsilon_{it} \]  

\( ROA \) = Return on Asset
\( ENV \) = Environmental Innovation Score
\( RDI \) = Research and Development Intensity
\( SIZE \) = Firm size

3. Results and discussion
Regression tests were performed on:
1. **Full samples** were carried out on all samples in Far East Asia included Taiwan, Japan, Hong Kong, South Korea, China, Indonesia, Singapore, Malaysia, and the Philippines.
2. **Sub-sample in the East Asia region** consists of South Korea, Taiwan, China, Hong Kong, and Japan. This sub-sample analysis was conducted to compare whether the unequal number of samples from each country dominated by East Asia affects the results of the full sample study.
3. **Sub-sample in the Japanese region**. The analysis of the Japanese sub-sample was conducted to compare whether the unequal number of samples in the East Asia region dominated by Japanese companies had an influence on the results of the full sample and East Asian sub-sample studies.
4. **Sub-sample in the East Asia region excluding Japan**. This sub-sample analysis was conducted to see if there was a difference between this sub-sample and the East Asian sub-sample (including) Japan.
5. **Sub-sample in the Southeast Asia region** consisting of Singapore, Indonesia, Malaysia, and the Philippines. This sub-sample analysis was conducted to see whether the Southeast Asia region was also represented in the full sample, considering that the number of companies from Southeast Asia was smaller than companies from East Asia.
3.1. Southeast Asia Full Sample Analysis
The results of the robust fixed effect regression show that there was insignificant relationship between ENV and ROA at t-0 and t-1. These results are in accordance with the research conducted by Rezende et al., (2019) which found insignificant relationship between green innovation and the company’s ROA at t-0 and t-1. The result shows a significant negative effect of the ENV variable on ROA after two years (t-2). Research by Rezende et al., (2019) also found a significant relationship after two years but the relationship found was a positive relationship. There was also a positive relationship between ENV and ROA after four years (t-4). While the results of study also explain that there is a significant negative effect of ENV on ROA after five years(t-5).

There are differences in the results of the study with previous research conducted by Rezende et al., (2019) which can be seen from the existence of a model that shows a negative effect of environmental innovation on ROA. Nevertheless, the results of the study which showed a negative coefficient value were in line with several previous studies which showed a significant negative relationship between company’s environment and company’s financial performance [4], [15]. The negative relationship between the two variables can be caused by several things. Technological innovation in general must go through a long and high-risk process [17]. In addition, the success of an innovation is influenced by many factors, some of which are innovation management and market introduction timing [18]. Therefore, not all innovations carried out can end successfully.

The differences between this study and the research by Rezende et al., (2019) can be caused by differences in the research sample regions and differences in the proxies used to measure the company’s environmental innovation. In the Rezende’s research, the regions used are at the world and Asian levels, while this study only covers countries in the Far East Asia. In terms of variables, Rezende et al., (2019) used the number of green patents as a proxy, while this study used an environmental innovation score obtained from Reuters.

| Variable | Coef. | Prob. | Coef. | Prob. |
|----------|-------|-------|-------|-------|
| ENV      | -0.01200.168 | ENV_lag4 | 0.0221 | 0.006*** a |
| ENV_lag1 | -0.00540.439 | ENV_lag5 | -0.0273 | 0.002*** a |
| ENV_lag2 | -0.01460.082* | RDI | -125.847 | 0.001*** a |
| ENV_lag3 | 0.00840.124 | SIZE | -9.7E-05 | 0.030** a |
| Obs.     | 825 |     |
| Prob > F | 0.0001 |
| R-sq     | 0.110 |

**a***.p < 0.01; **. p < 0.05; *.p < 0.10

3.2. East Asia Sub-Sample Analysis
The results of the robust fixed effect regression on the East Asian sub-sample showed similar results to the full sample. It shows that in all models there is insignificant relationship between ENV and ROA at t-0 and t-1, which is also in line with reference journal research. While at t-2 at a significance level of 5%, it was found that there was a significant relationship between the two variables with a negative coefficient of -0.018. At t-3, a significant positive relationship was found. This shows that after three years (t-3) ENV has a significant positive effect on ROA at significance levels of 5% and 10%, respectively. Similar results were also found at t-4 which showed a positive relationship at the 10% and 1% significance levels, respectively. Finally, at t-5, similar results were found, namely there was a significant negative relationship between ENV and ROA.

3.3. Japan Sub-Sample Analysis
The results of the robust fixed effect regression on the Japanese sub-sample showed different results from the results of the Far East Asia full sample the results of the East Asian sub-sample. It shows that the number of significant variables is very limited and is only found in at t-4 and t-5 with a significance level of 10%. At t-4 the relationship between the independent and dependent variables is positive, while
at t-5 there is a negative relationship. This very different result can be caused by the R2 value of the models also shows a small value compared to the reference journals and the East Asian sub-sample. These results indicate that although the full sample and sub-sample in this study are dominated by Japanese companies, the results are not only representative of Japan.

3.4. East Asia (without Japan) Sub-Sample Analysis
The results of the regression analysis on the East Asia sub-sample without Japan showed similar results to the whole East Asian sub-sample. The ENV variables at t-2 and t-5 showed significant negative coefficients at the 1% and 5% significance levels, respectively. This supports the results of the regression analysis in the East Asian sub-sample. In addition, ENV t-4 also shows the same results as the East Asian sub-sample, where there was a significant positive relationship between ENV and ROA. However, in other models in the East Asian sub-sample without Japan, insignificant independent variables were found. Thus, the results of this regression show that although the East Asian sample in this study is dominated by Japan, the results still show that the samples outside of Japan also contribute to the final results of the East Asian sub-sample regression.

3.5. Southeast Asia Sub-Sample Analysis
If a comparison is made between the results of the Southeast Asia sub-sample and the Far East Asia full sample, it is found that there are similarities. This similarity can be seen from the direction of the relationship between the coefficients of the variables that have significant values. In both regressions, a significant negative relationship was found for the ENV t-5 variable. These results indicate that although the sub-sample of Southeast Asia countries is relatively smaller than the full sample, the regression results also represent the Southeast Asia region. However, there is a slightly different trend in Southeast Asia, where a significant relationship between the two variables can be seen in the first few years (t-0 and t-1) after the innovation was carried out.

4. Conclusion
Based on the results, it can be concluded that even though the number of samples is uneven, but each sub-sample is still represented in the full sample regression analysis results. The following is a summary of the answers to the research problem formulation:

● In the period t-0 and t-1, there is insignificant relationship between environmental innovation and the company's financial performance, except for the Southeast Asia region. Meanwhile, in East Asian countries, it is impossible to find any effect of the two variables from zero to one year after the innovation was carried out. These results indicate that there are differences in trends in the East Asia and Southeast Asia regions.

● In the period t-2 and t-3, it was found that there was a significant positive and negative relationship between environmental innovation and the company's financial performance. This indicates that there is an effect of environmental innovation on the company's financial performance in the span of two to three years after the innovation is carried out. The results also showed that after three years the relationship was found to be more significant.

● In the period t-4 and t-5, it was found that there was a significant positive relationship between environmental innovation and the company's financial performance five years after the innovation was carried out. A significant relationship was also found after six years, but the relationship was negative.

In general, research results are still inconsistent because the success of an innovation is influenced by other factors as well, some of which are management and the market introduction timing. Therefore, the managerial implication for companies would be to further consider the other factors that might contribute to the success of the innovation, as mentioned earlier.

For future research, it is suggested that researchers can overcome the limitations of this study. The addition of data on countries in the Far East Asia region and an increase in the number of samples of companies that are evenly distributed in each country will make the research results more representative.
Moreover, the addition of the number of lagged variables can also be done to examine the relationship between the two variables over a longer period. Finally, the division of environmental innovation by type can also be done to examine whether there are different relationships in each type of innovation.

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