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Regulation of Reducing Carbon Emissions: Is It Effectively Implemented to Develop Competitiveness of Indonesian Manufacturing Firms?

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ABSTRACT

This research aims to examine the effectiveness of the implementation of the Indonesian Government Regulation "PP No. 70/2009 on Energy management" to reduce carbon emissions while improving firm competitiveness. This study involved 645 manufacturing firms with the consumed the energy of more than 6,000 ton equivalent oil. To measure the effectiveness of the regulation implementation, this research used a decoupling concept of elasticity developed by Tapio to classify firms into groups that successfully reduced their carbon and not succeed, as well as groups that were able to maintain their competitiveness and were unable to. Then by using two independent sample test, this research compared the competitiveness between successful and unsuccessful firms in reducing their carbon, and also compared to the competitiveness between firms classified as strong decoupling and non-strong decoupling firms. The result of this study shows the successful firms reducing carbon emission have higher competitiveness than those who are unsuccessful. Secondly, Strong decoupling firms have higher competitiveness than those non-strong decoupling. The regulation appears to begin having an effect on firms' carbon costs after the 5-year implementation.

Keywords: Carbon Emissions, Firm Competitiveness, Tapio Decoupling
JEL Classifications: G3, L6, M1, Q5

1. INTRODUCTION

The increase in fossil fuels and electricity consumption is generally to support the economic growth of a firm, in which the consumption eventually will increase carbon emissions. This consequence is a dilemma for the Indonesian government. On one hand, the government should maintain firms' competitiveness, whilst on the other hand, the government call for firms to reduce their carbon emissions that it means firms should reduce their energy consumption. This is because the government stipulates Regulation No. 70/2009 on "energy management" which requires the manufacturing sector to contribute to reducing carbon emissions (Kementerian Energi dan Sumber Daya Mineral Republik Indonesia, 2015). This could be the reason why the regulation does not appear to be effective in forcing companies to reduce their emissions and many companies still do not seriously comply with these regulations. According to the Directorate of Energy Conservation, most companies that participate in "energy management" are reluctant to comply with the auditor's recommendations because energy management requires expensive investment (APEC, 2012). As stated in Regulation No. 70/2009, there are auditors who audit the energy management of participating companies. The audit provides several recommendations for the company to fulfill. The most common recommendation suggested by the auditors is that companies must install machinery, or technology that is efficient in consuming energy. Meanwhile, such a machine or technology requires a large investment (APEC, 2012). Firms must make expensive investments in energy-efficient and environmentally friendly machines or technologies. A large amount of this investment is considered by many firms as a factor that will lower their competitiveness because to maintain the level of profit, the firms must increase the price or the firms must be willing to receive decreased profit or even to bear losses (Rokhmawati et al., 2015, Rokhmawati and Gunardi, 2017).

The increasing pressure of the global community on reducing carbon emissions has put a pressure on the Indonesian Government to encourage firms to reduce their carbon emissions while improving their competitiveness because the Indonesian government has already made the commitment to reduce its carbon emissions by 26% without international support, or 41% with international support by 2020 (Yudhoyono, 2009). To support the efforts, Regulation PP No 70/2009 provides incentives for firms that consistently comply with the regulation.

By the increasing concern of the global community on climate change issues, many scientists are exploring ways to achieve low-carbon economic growth (Böhringer, and Lange, 2005; Carmona, and Hinz, 2011). Basically, research on carbon emissions in relation to economic sustainability can be distinguished by their scope, i.e micro (data used is individual firm level) and macro (data used is country, region, or state level).

In the first group, the studies have been done by using microdata, i.e data at a firm level to test the impact of carbon emission reduction on the firm financial performance, especially in developing countries like Indonesia. It may be that data on carbon emissions at the firm level are not published publicly. Research has been mostly done in developed countries. Research that examines the impact of carbon emissions on firm financial performance, for example, research conducted by the following researchers. Busch and Hoffmann (2011), Lee (2012), and Iwata and Okada (2011) found negative impacts of carbon emissions on financial performance. While Rokhmawati and Gunardi (2017), Hatakeda et al. (2012), Wang et al (2013), and Delmas and Nairn-Birch (2010) found a positive impact of carbon emissions on financial performance. They claim that the positive effect because the marginal cost of reducing carbon emissions exceeds the marginal benefits of reducing carbon emissions. Wang et al. (2013), in Australia, found that carbon emissions have a significant positive correlation with Tobin's q. Existing research generally uses a regression model to know the impact of carbon emission on the firm's financial performance.

In the second group, in recent years, many studies based on macro data have been conducted. One of the research methods receiving great attention from scholars of sustainable economics is decoupling method (Kveiborg, and Fosgerau, 2007; Climent, and Pardo, 2007; Sorrell et al., 2012; Wan et al., 2016). In the sustainable economics literature, decoupling refers to reducing carbon emissions in a region without causing a negative impact on economic growth in the region (Wan et al., 2016). Many studies using macro data at the regional or state level are studies on the relationship between carbon emissions and gross domestic product (GDP) growth. Decoupling of this model looks at how carbon emission reductions impact on GDP growth. The decoupling model allows researchers to know the elasticity of GDP growth in carbon emissions. The model is not the one used for statistical testing and does not require testing of classical assumptions performed on the regression model. This decoupling model gives the result of elasticity. Many studies have used decoupling model to analyze the elasticity of GDP toward carbon emission reduction.

The works of literature on decoupling that has been used widely in the existing research have some limitations. First, decoupling usually focuses on macro data at the national, regional, and industry levels and very limited research has been undertaken using microdata at the individual firm level (Climent and Pardo, 2007). Van Caneghem et al. (2010) analyzed the decoupling of environmental impacts on economic growth in the Flemish industrial sector from 1995 to 2006 (Van Caneghem, et al., 2010). Several international organizations, including the European Union and the OECD, adopted a research perspective by using the data of energy consumption and carbon emissions at the macro level (Csutora and Mózner, 2012). The lack attention of researchers on phenomena at the micro level (individual firms) leads to the difficulty of researchers in determining what indices or what firms contribute greatly to the increase of carbon emissions. For example, the contribution of carbon emissions from the service industry is definitely much lower than that of heavy industry. Using micro data will allow researchers to compare between firms' group more detail. Hence, it allows policymakers to gain much understanding of a certain group of firms.

Second, the previous researchers tend to use the decoupling index method or the Tapio model to analyze the relationship between carbon emissions and economic growth. Zhang (2000) introduced a decoupling index of energy sources and environmental pressure where the decoupling is also divided into absolute and relative decoupling according. This method was also used by Freitas and Kaneko (2011) to explore the relationship between carbon emissions and economic growth in the UK in 2004-2009, and they showed that the relationship between carbon emissions and economic growth in 2009 is one of absolute decoupling. Climent and Pardo (2007) used the Tapio decoupling index to investigate the causal relationship between energy use and the Spanish economic growth. Chiou-Wei et al. (2008) examine the relationship between energy consumption and economic growth using Granger linear and nonlinear causality tests for a sample of new Asian industrial countries along with the US. Salim et al. (2008) looked at the effect of energy used in six non-OECD Asian countries on their outputs in the short run and the long run. The limitation of this method is that they did not examine the relationship by employing statistical tests so that it may not provide the powerful reason to do generality.

Given the limitations of the literature on decoupling mentioned above, this research, therefore, aims to examine the effectiveness of the implementation of the Government Regulation "PP No 70//2009 about energy management" to reduce firms' carbon emissions while improving firms' competitiveness by improving on the limitations of previous studies. This research used micro data at the individual level of firms, in which using such data enables researchers to analyze the data more detailed at firm level. To do so, we adjust the macro data used in Tapio Model into micro data. Macro data at nation, region, or industry level could be analogically replaced into firm level. For example, GDP could be analogized as firm revenues; national competitiveness could be analogized as firm competitiveness. That is the gap that this research will fill.

2. THEORY AND HYPOTHESIS

Carbon emission reductions at the manufacturing level are highly relevant to the Indonesian government's commitment to reduce carbon emissions by 26% without international support or 41% with international support by 2020 (Yudhoyono, 2009). To support this commitment, the contribution of the industrial sector is needed. However, the government must be careful in implementing this policy of reducing carbon emissions; because, an inappropriate policy will lead firms to lose their competitiveness.

Porter hypothesis on firm competitive advantage (Porter and van der Linde, 1995a) asserts that environmental regulations (in particular, market-based instruments) can trigger innovation that closes part or all of the more costs incurred for compliance. Many economists initially believed that environmental regulations will lead firms to make investments that will increase profits. The theory of competitiveness (Porter and van der Linde, 1995b) states that effective government policies can stimulate firms to abide by the rules. An effective policy will guarantee that firms will not be jeopardized; even they will get the benefit by complying with the regulation. Hence, firms will be happy to obey the rules. An effective policy can stimulate firms to be more creative in developing its potential to respond to the mandate of PP 70/2009 carbon emission reduction. This policy basically encourages firms to be more creative. Firms are also required to work more efficiently with regard to fuel consumption.

2.1. Tapio Decoupling Model

The concept of decoupling actually refers to the reduced relationship between two or more dependent variables (Li et al., 2008). In the sustainable economic literature, decoupling refers to reducing a region's carbon emissions without causing a negative impact on economic growth in that region.

Tapio decoupling model of an elasticity analysis was first introduced by Tapio for his research on the volume of transport and decoupling of European CO_2 standards during 1970-2001 (Tapio, 2005). Tapio decoupling model uses flexibility index to analyze the decoupling relationship between environmental pressure and economic growth where the equation can be seen as follows:

$$\gamma(CO_2, GDP) = \frac{\Delta CO_2}{CO_2} \Big/ \frac{\Delta GDP}{GDP} \quad (1)$$

The elasticity (γ) CO_2, GDP is a decoupling indicator between carbon emission growth and economic growth. This is the impact of CO_2 emission growth on economic growth. Tapio model is usually used macro data for the inputs such as CO_2 and GDP of a country. By the same analogy, we can implement the model for individual firm data with an adjustment. CO_2 of a country is substituted by CO_2 produced by individual firm and GDP is substituted by individual firm sales. As decoupling refers to reducing carbon emissions without reducing economic growth, sales may not be suitable to replace GDP since sales have not considered the costs of fossil fuels burnt by firms producing carbon emissions. Hence, this research uses return on sales (ROS) growth. The ROS is calculated as earnings after tax (EAT) divided by sales. The adjusted decoupling formula can be seen as follows:

$$\gamma(CO_2, ROS) = \frac{\dfrac{\dfrac{CO_{2,t}}{Sales_t} - \dfrac{CO_{2,t-1}}{Sales_{t-1}}}{\dfrac{CO_{2,t-1}}{Sales_{t-1}}}}{\dfrac{\dfrac{EAT_t}{Sales_t} - \dfrac{EAT_{t-1}}{Sales_{t-1}}}{\dfrac{EAT_{t-1}}{Sales_{t-1}}}} \quad (2)$$

Tapio (2005) decoupling model is basically a method of elasticity analysis. Tapio introduces the theory of elasticity into decoupling indicators that are divided into eight categories: Expansionary negative decoupling, strong negative decoupling, weak negative decoupling, weak decoupling, strong decoupling, recession decoupling growing link, and recession link. Eight different possibilities of firm status can be shown in Table 1.

A firm will have a status as expansionary negative decoupling when its elasticity is on a range from 1.2 to an unlimited positive number; besides that, CO_2 intensity growth of the firm must be between zero and unlimited positive number, and its growth is between zero to an unlimited-positive number. Furthermore, a firm will have a status as strong decoupling when its elasticity is laid from an unlimited negative number until zero; besides that, CO_2 intensity growth of the firm must be laid between zero to an unlimited positive number, and its growth is between an unlimited-negative number to zero. The same way to read is applicable for other statuses.

As the main objective of the Government Regulation PP No 70/2009 is to reduce firms' carbon emissions without reducing their competitiveness known as a win-win solution (Ministry of Finance, 2009); therefore, strong decoupling is the status to for the objective of the regulation. Firms are able to reduce their carbon emissions and they are also able to increase their competitiveness.

2.2. Firm Competitiveness

Competitiveness is a frequently used term, but not clearly defined. In general, competitiveness refers to the policy on the ability of an entity to compete in international markets (Dechezleprêtre and Sato, 2014). This effect can be felt at various levels: Firm level, industrial level, and country level.

At a firm level, a firm is acknowledged to be competitive if it can produce better or cheaper products or services than domestic and international competitors. This competitiveness is identical to the firm's long-term earnings and refers to its ability to compensate

Table 1: Eight different status of decoupling according to Tapio with an adjustment

Decoupling status	Environmental pressure (CO_2 intensity growth)	Firms' ROS growth	Environmental pressure ROS growth	Decoupling ındex (elasticity, γ)
Decoupling negative				
Expansionary negative decoupling	(0, + ~)	(0, + ~)	Positive growth of CO_2 Positive growth of ROS	(1.2, + ~)
Strong negative decoupling	(0, + ~)	(- ~, 0)	Positive growth of CO_2, Negative growth of ROS	(- ~, 0)
Weak negative decoupling	(- ~, 0)	(- ~, 0)	Positive growth of CO_2 Negative growth of ROS	(0, 0.8)
Decoupling				
Weak decoupling	(0,+ ~)	(0, + ~)	Positive growth of CO_2 Positive growth of ROS	(0, 0.8)
Strong decoupling	(- ~, 0)	(0, + ~)	Negative growth of CO_2 Positive growth of ROS	(- ~, 0)
Recession decoupling	(- ~, 0)	(- ~, 0)	Negative growth of CO_2 Negative growth of ROS	(1.2, + ~)
Link				
Growing link	(0,+ ~)	(0,+ ~)	Positive growth of CO_2 Positive growth of ROS	(0.8, 1.2)
Recession link	(- ~, 0)	(- ~, 0)	Negative growth of CO_2 Negative growth of ROS	(0.8, 1.2)

Source: Wan et al. (2016). ROS: Return on sales

employees and provide sufficient returns to its owners. This can then be interpreted as a firm's ability to sell, as reflected in its ability to increase market share and can be measured by trading volume or domestic market share (Reinaud, 2008). Or it can be seen as a firm's ability to earn revenue, improve its capacity to increase profits as measured by increased firm turnover, added value or market value.

To measure firm competitiveness, this research uses the growth of EAT per sales that known as the growth of ROS. The growth reflects the ability of a firm to increase its return for each sale.

$$Growth_{ROS} = \frac{\frac{EAT_t}{Sales_t} - \frac{EAT_{t-1}}{Sales_{t-1}}}{\frac{EAT_{t-1}}{Sales_{t-1}}} \quad (3)$$

2.3. Carbon Emissions

The manufacturing industry in Indonesia is a major energy consumer responsible for 40% of Indonesia's national energy needs and is a major contributor to carbon emissions in Indonesia. This industry consumes fuel, for example, coal, coke, gasoline, diesel, oil, natural gas, and electricity. The energy consumption produces carbon dioxide. Therefore, this study selects carbon emissions produced by manufacturing firms to represent the environmental pressure index of each firm's energy consumption.

In calculating carbon emissions generated by individual firms, this study uses the guidance provided by DEFRA (2011). This study only included scope 1, namely emissions resulting from the burning activities of fossil fuels and scope 2 of the electricity trading activities in the production by the firm or purchased from the electricity provider. This study does not include scope 3 because scope 3 is carbon emissions produced by outsiders (suppliers or contractors) where the firm is unable to control it. The end result of the calculation is equivalent to the CO_2 equivalent tones denoted by C; where, C is the sum of the multiplication between each type of fuel multiplied by the emission coefficient of each type of fuel, resulting from the activity of scope 1 and the multiplication of the electrical energy generated and the electrical energy sold with the respective emission coefficients of the activity scope 2, formulated as follows:

$$C = \sum_{i=1}^{n} C_i = \sum_{i=1}^{n} H_i . \delta_i \quad (4)$$

Where
C: Carbon emissions from each manufacturing firm
C_i: All types of carbon emissions
H_i: Energy consumption of energy i
δ_i: Coefficient of carbon emission from energy i
n: Type of fuel or electricity.

Then, to avoid the heterogeneity issue, we divide the nominal value of CO_2 by sales.

2.4. Carbon Emission and Firms' Competitiveness

Competitive advantage theory (Porter and van der Linde, 1995a) states that effective government policies can stimulate firms to abide by the rules. An effective policy will help the firms avoid threats; even they will get the benefit by complying with the regulation. An effective policy can stimulate firms to be more creative in developing its potential to respond to the mandate of PP 70/2009 carbon emission reduction. This policy basically encourages firms to be more innovative and creative as well as to work more efficiently with regard to fuel consumption. Accordingly, the reduction of carbon emissions should lead firms to decrease their costs from being efficient and allow firms to increase their revenues from being innovative and creative. Having mentioned that, it can be concluded that the reduction of carbon emissions can improve firms' competitiveness. Hence, if the regulation is effectively implemented, carbon emissions from the firms' operations will decline followed by the increase in firms' competitiveness. To test the statement, the research hypothesis can be drawn as follows:

H1: Firms with negative growth of carbon emissions are more competitive than firms with positive growth of carbon emissions.

In relation to government policies for lowering carbon emissions, Porter and Van Der Linde (1995a) argued that if a firm wants to be sustainable the firm must be able to work efficiently in consuming energy. Efficiently consuming energy means lowering carbon emissions and reducing costs. The inevitability of firms to work efficiently will negatively affect its competitiveness. According to Tapio Decoupling Model, firms that are able to reduce emissions without losing their competitiveness are characterized as firms that have a negative growth of carbon emissions and have a positive growth of ROS. This kind of firm is classified as strong decoupling. In contrast, firms that do not have the characteristics are grouped as non-strong decoupling. Accordingly, if the competitive advantage theory is confirmed, then strong decoupling firms should have a higher competitiveness than non-strong decoupling.

H2: Strong decoupling firms are more competitive than non-strong decoupling firms.

3. METHODOLOGY AND DATA

The population of this study is all Indonesian manufacturing firms. While the sample of this study is selected manufacturing firms with a high consumption level of energy more than or equal to 6,000 TOE. The data used in this research are data in 2014 about firm consumption of fossil fuels and electricity, firm costs or expenses for fuel fuels and electricity, firm revenue, firm total costs, firm net income, and investment data. The data were collected by İndonesıa Statistics through a survey. The data year 2014 has been chosen because PP 70/2009 was introduced in 2009 hence the five lag period gives time for firms to adjust to the regulation. Besides that reason, the new government removed fossil fuel subsidies for household consumption. Although fossil fuels for the industry have not been subsidized, the subsidy removal may affect the industry because there was a misappropriation of the implementation of subsidy policy. There was 10–15% fossil fuel subsidy leaking from household consumption to industry (Fadillah and Samboh, 2011). Hence, using both the data from before 2015 and after 2015 may cause bias because of the significant difference in the data characteristics.

3.1. Sample

The sample of the research is selected based on the firm consumption level of energy. Those who consumed more than 6,000 ton equivalent oil (TOE) are included in the sample, otherwise is excluded. The number of firms included in the sample is 645 firms which consume more than or equal to 6,000 TOE.

3.2. Variables

There are two hypotheses in this research. In the first hypothesis, two independent variables that are used, namely: Competitiveness of firms with negative growth of carbon emissions and competitiveness of firms with positive growth of carbon emissions. In the second hypothesis, two independent variables that are employed, i.e competitiveness of strong decoupling firms and competitiveness of non-strong decoupling firms.

3.3. Analysis Technique

To examine the two hypotheses, this research uses a comparison study employing two independent sample t-test. Before that, two assumption tests must be conducted to examine normality and homogeneity that are required for two-independent-sample t-test. If the normality assumption is not met, then two independent sample t-test cannot be done. Alternatively, Mann–Whitney test for two-independent-samples will be conducted.

To test the first hypothesis, this study classified firms into two groups. The first group is the firms which experience a decreasing growth in carbon emissions, and the second group is those firms that do not experience a decreased growth of carbon emissions. Then, we compare the growth of the competitiveness between those two groups of firms. This comparison is to examine whether firms that have a decreasing growth of carbon emissions are more competitive than firms that have an increasing growth in carbon emissions. It means that the government regulation "PP No 70/2009" has been effectively implemented.

To test the second hypothesis, this study classifies firms into two groups; firms that classified as strong decoupling firms, and non-strong decoupling firms. Then, we compared the competitiveness between those two groups of firms. This comparison is to confirm whether the hypothesis of Porter's competitive advantage is confirmed or not. The hypothesis is confirmed if strong decoupling firms are more competitive than those non-strong decoupling firms. Group of firms with a decreased carbon emission growth that have an increase in earning will have higher competitiveness than another classified group of firms.

4. RESULTS AND ANALYSIS

4.1. Descriptive Statistics

By following Tapio decoupling model, we classified firms into eight classifications that can be seen in Table 2.

From Table 2, it can be seen that there are 297 firms out of 642 firms that have reduced their CO_2. These firms are in the groups of strong decoupling, weak negative decoupling, recession decoupling, and recession link. However, only 165 firms are classified as strong decoupling that the firms have reduced their carbon emissions and they also have a positive growth of ROS. Moreover, excluding strong decoupling firms (165 firms) there are 184 firms that experience positive growth of ROS that is in the groups of Expansionary Negative Decoupling, Weak Decoupling, and Growing Link. The rest (293 firms) has a negative growth of ROS that is assigned into groups of Strong Negative Decoupling, Weak Negative Decoupling, Recession Decoupling, and Recession Link.

More detail for the descriptive statistic of the data can be seen in Table 3.

Table 3 presents that the minimum value of ROS growth is −6.5%, the maximum value of 3.7%, and the standard deviation is 0.93. Furthermore, the skewness is −1.069. It means that the value of Z-skewness is equal to −11.06 calculated as skewness/SQRT(6/N). Then the result is −1.069/SQRT(6/642) that is equal to −11.06. This statistic of skewness shows that the data is not normal since Z skewness is less than −1.96. Meanwhile, the kurtosis is 8.046 hence the value of Z-kurtosis can be calculated as kurtosis/SQRT(24/N). The result of Z-kurtosis is 8.046/SQRT(24/264) that is equal to 41.61. Hence, it can be concluded that the data is not normal because the value of Z-kurtosis (41.61) is more than +1.96.

4.2. The Result of Mann–Whitney U-test

As the data is not normal, this research does not use two independent sample t-test to compare the competitiveness between one group of firms and another group. This research employs the Mann-Whitney U test to examine the difference and the result can be seen as follows.

Table 4 shows that there are 297 firms reducing their carbon emissions and 345 firms do not reduce their carbon emissions. The table also provides a Z value of −2.240 with a significant value of 0.025 that is < 0.05. Therefore, it can be concluded that firms that reduce their carbon emissions have higher competitiveness than firms that do not reduce their carbon emissions since the mean rank of ROS growth for firms with negative growth of CO_2 (339.17) more than the mean rank of ROS growth for firms with positive growth of CO_2 (306.29).

Whereas Table 5 shows that there are 165 firms with strong decoupling status and 477 firms are classified as non-strong decoupling status. The Table 5 provides a Z value of −12.610 with a significant value of 0.000 that is <0.05. Therefore, it can be concluded that firms with strong decoupling firms are more competitive than those non-strong decoupling firms. This is because of the mean rank of ROS growth of strong decoupling firms (478.44) more than the mean rank of ROS growth for firms with non-strong decoupling status (267.21). Table 6 shows the number of firms with various kinds of decoupling status.

4.3. How Effective is Carbon Emission Regulation to İmprove Firms' Competitiveness?

The statistical comparative result of firms' competitiveness between firms with carbon emission reduction and firms with a carbon emission increase provides us that firms with carbon emission reduction are more competitive than firms without a carbon emission reduction. The result implies that carbon emission reduction has a positive effect on firms' competitiveness. In other words, carbon emission reduction allows firms to be more competitive.

The result is in contrast with the prior research that has been conducted by Rokhmawati and Gunardi (2017) that the research samples were Indonesian listed manufacturing firms in which not all the firms consumed energy more than or equal to 6,000 TOE. Moreover, the data from prior research used data from 2011. There was a 2-year lag. Conversely, this research uses the data in 2014 with a 5-year lag. It means that after five years of introducing the regulation in 2009, the effect of the regulation has been beginning to take place. The result implies that the regulation has been effective to encourage firms to reduce their carbon emissions. There are 297 firms out of 642 firms have been able to reduce their carbon emissions and the 297 firms have a mean rank of ROS growth at 339.17 higher than the mean rank of ROS growth of firms (306.29) that are unable to reduce their carbon emissions. Although reducing carbon emissions allows firms to achieve competitiveness, there are only 297 firms out of 642 firms that reduce their carbon emissions, the rest (345) firms fail to reduce their carbon emissions. In fact, the firms are the subject that is obligated to reduce carbon emissions.

Table 2: The number of firms with various kinds of decoupling status

Decoupling status	Average CO_2 growth	Average ROS growth	Decoupling ındex (elasticity, γ)	The number of firms
Strong decoupling	−0.38199	0.63556	−0.60104	165
Non strong decoupling				
Expansionary negative decoupling	3.10629	0.25110	12.37052	71
Strong negative decoupling	3.34479	−0.78296	−4.27199	161
Weak negative decoupling	−0.22539	−0.78977	0.28538	62
Weak decoupling	0.17504	0.55162	0.31733	89
Recession decoupling	−0.33435	−0.09386	3.56209	55
Growing link	0.35623	0.35785	0.99549	24
Recession link	−0.357689	−0.37948	0.94257	15
Total				642

Source: Calculated data, based on statistics Indonesia, 2015. ROS: Return on sales

Table 3: Descriptive statistics

Discription	N	Minimum	Maximum	Mean	SD	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. error	Statistic	Std. error
EAT growth	642	−6.5137	3.6998	−0.00857	0.92997	−1.069	0.096	8.046	0.193
Valid N (listwise)	642								

Source: Calculated data, based on Statistics Indonesia, 2015. SD: Standard deviation

Table 4: The result of comparing ROS growth of firms with negative growth of CO2 emissions and of firms with positive growth of CO_2

Ranks				
	Group	**N**	**Mean rank**	**Sum of ranks**
ROS growth	Firms with negative growth of CO_2	297	339.17	100733.50
	Firms with positive growth of CO_2	345	306.29	105669.50
	Total	642		
Test statistics[a]				
		ROS growth		
Mann–Whitney U		45984.500		
Wilcoxon W		105669.500		
Z		−2.240		
Asymp. Sig. (2-tailed)		0.025		

[a]Grouping variable: Group. Source: Calculated data, based on Statistics Indonesia, 2015. ROS: Return on sales

Table 5: The result of comparing ROS growth of firms with strong decoupling status and firms with non-strong decoupling status

Ranks				
	Group	**N**	**Mean rank**	**Sum of ranks**
ROS growth	Firms with strong decoupling status	165	478.44	78942.50
	Firms with non strong decoupling status	477	267.21	127460.50
	Total	642		
Test statistics[a]				
		ROS growth		
Mann–Whitney U		13457.500		
Wilcoxon W		127460.500		
Z		−12.610		
Asymp. Sig. (2-tailed)		0.000		

[a]Grouping variable: Group. Source: Calculated data, based on Statistics Indonesia, 2015. ROS: Return on sales

Table 6: The number of firms with various kinds of decoupling status

Decoupling status	Environmental pressure (CO2 intensity growth)	Decoupling ındex (elasticity, γ)	The number of firms
Strong decoupling	Negative growth of CO_2 Positive growth of ROS	(- ~, 0)	165
Non strong decoupling			
Expansionary negative decoupling	Positive growth of CO_2 Positive growth of ROS	(1.2, + ~)	65
Strong negative decoupling	Positive growth of CO_2, Negative growth of ROS	(- ~0)	161
Weak negative decoupling	Positive growth of CO_2 Negative growth of ROS	(0, 0.8)	54
Weak decoupling	Positive growth of CO_2 Positive growth of ROS	(0, 0.8)	106
Recession decoupling	Negative growth of CO_2 Negative growth of ROS	(1.2, + ~)	60
Growing link	Positive Growth of CO_2 Positive growth of ROS	(0.8, 1.2)	13
Recession link	Negative growth of CO_2 Negative growth of ROS	(0.8, 1.2)	18
Total			642

Source: Calculated data, based on Statistics Indonesia, 2015. ROS: Return on sales

The failure of the firms to reduce their carbon emissions may be because they have not perceived the benefits of reducing their carbon emissions, although there are fiscal incentives for firms that succeed to reduce their emissions. The fiscal incentives are such as tax reduction or exemption for energy-saving products and low-interest financing for investment in energy conservation in accordance with existing laws and regulations (APEC, 2012). This kind of incentives may not be sufficient to attract the firms to reduce their carbon emissions. It is known that the implication of the regulation is that firms should make an expensive investment in energy efficient and environmentally friendly machinery. Indeed, the expensive investment hinders firms to get the incentive opportunities. Many firms' owners may think that investment in new machinery has not been needed yet since the existing machines may still have a long economic life so that replacing the existing machines with a new one will elevate costly; especially, if the government does not allow companies to accelerate depreciation for the machines. Moreover, firms' owners may consider the source of funding for the investment. Since Indonesian firms have limited internal source of funding, loans become an alternative to the external source of funding. However, loan utilization will increase default risk and insolvency risk. Furthermore, to get loans firms must provide collaterals. Providing collateral is the big problem for many Indonesian firms (APEC, 2012). Hence, it may be helpful for firms if besides providing low-interest financing the government may provide up-front financing so that firms are able to access external funds without providing collaterals.

4.4. The Effect of Carbon Emissions Reduction on Firms' Competitiveness

Based on the argument of Porter and van der Linde (1995a; 1995b), it can be concluded that energy efficiency results in reducing carbon emissions that this can reduce the costs of energy and ultimately this improves firms' competitiveness. In brief, it can be stated that firms that reduce their carbon emissions should have higher competitiveness than companies that have not reduced their carbon emissions.

The statistical comparative result of firms' competitiveness between strong decoupling firms and non-strong decoupling firms gives us an empirical evidence that strong decoupling firms are more competitive than non-strong decoupling firms. The result implies that carbon emission reduction has a positive effect on firms' competitiveness. In other words, carbon emission reduction allows firms to be more competitive.

The number of firms that gain the competitiveness by reducing their carbon emissions is only 165 firms out of 297 firms that are able to reduce their carbon emissions. 132 firms that are able to reduce their carbon emissions have lost their competitiveness. Or only 165 firms out of 642 firms consuming energy more than or equal to 6,000 TOE that affords the competitiveness. Those 165 firms that are classified as strong decoupling firms contribute to the mean rank of ROS growth at 478.44 higher than the mean rank of ROS growth (267.21) of non-strong decoupling firms (477 firms). Hence, it can be concluded that based on the mean rank of ROS growth of those two groups, strong decoupling firms provide higher competitiveness. The number of firms that are able to gain the competitiveness by reducing their carbon emissions is also more than the number of firms losing their competitiveness. It means that the competitive advantage hypothesis has been confirmed. However, when the number of strong decoupling firms is compared to the number of firms consuming energy more than or equal to 6,000 TOE, the number of strong decoupling firms is much fewer.

The reason for this can be explained from the perspective of fiscal and financial incentives gained, which has been explained above. The second reason is from the perspective of disincentives. It seems that the disincentives for not complying with the regulation have been perceived fearless because there are no direct costs such as penalties or fines for those not complying firms.

There are 293 firms that have negative ROS growth. This means that there are many firms that still struggle with their economic sustainability since in 2013 and 2014 Indonesia experienced a financial crisis due to the issue of quantitative easing regulation in the USA (Hussein, 2013). This regulation leads to capital outflows from Indonesia to abroad that trigger a depreciation of the Indonesian Rupiah. Accordingly, reducing carbon emissions may not become their priority.

5. CONCLUSION

The objective of this research is to examine whether carbon regulation is effectively implemented to develop Indonesian Manufacturing firms. The Tapio decoupling model generally is employed by previous studies by using macro data at country level and they analyze the elasticity of economic growth due to environmental pressures without involving a statistical test. This research also uses Tapio decoupling model to classify firms based on their ability to reduce their carbon emission growth and their ability to increase their ROS growth based on microdata at the individual firm level. Then, based on the classification, this research employs a statistical test to compare firms' competitiveness between firms that reduce their carbon emissions and firms that do not reduce their carbon emissions. Using microdata allows researchers to compare between groups of firms' decoupling status. This is the conceptual contribution of this research to the theory of competitive advantage hypothesis of Porter.

This research found that firms that are able to reduce their carbon emissions are more competitive than those firms that are not able to reduce their carbon emissions. It implies that carbon emission reduction will increase firms' competitiveness. It means that carbon regulation has been effectively implemented to reduce carbon emissions while improving firms' competitiveness. Nevertheless, there are only 297 firms out of 642 firms that able to reduce their CO_2 emissions and 345 firms are not able to reduce their CO_2 emissions.

This research also found that strong decoupling firms are more competitive than non-decoupling firms. It means that decoupling firms, firms with negative CO_2 growth and with positive-competitiveness growth provide higher ROS growth than non-decoupling firms. It implies that the competitive advantage theory has been confirmed.

Besides the conceptual contribution to the competitive advantage theory, the finding of this research has implications for policy. The Indonesian government needs to consider to allow firms to accelerate their depreciation so that firms may be attracted to replace their existing machines into efficient and environmentally friendly machines as depreciation is non-cash costs but the costs will reduce firms' tax expenses. Furthermore, the government also needs to think about the possibility to provide firms with up-front funding that do not require collaterals. Finally, the government still needs to review whether fine or penalty need to enforce to non-complying firms to the regulation.

Future studies may like to examine whether investment in efficient and environmentally friendly machines will increase firms' competitiveness or decrease.

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