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Is there a link between environmental expenditure, innovation, and revenue in Malaysian manufacturing industry?

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Abstract

This paper provides new evidence on the relationship between environmental expenditure, innovation, and revenue in Malaysian manufacturing industry. This study employed a panel data analysis involving 22 manufacturing sectors from 2008 to 2012. Apart from the panel data regression analysis, the Granger causality test was also performed to examine a causal relationship based on the Porter hypothesis. The results showed that both environmental expenditure and innovation undoubtedly influenced the revenue of firms across manufacturing sectors. The results also revealed the existence of a bilateral relationship between innovation and environmental expenditure. Furthermore, this result was in line with the Porter hypothesis, which asserts that stringent policy will induce innovation activities. However, a more comprehensive and structured environmental policy, particularly involving taxation and financing mechanisms, is also crucial to encourage a strong commitment from the industries. In general, it can be concluded that for a firm in the manufacturing sector, a high commitment to environmental protection expenditure and innovation will directly influence its performance.

Introduction

The continuing emission from modern societies' activities of a number of gases into the atmosphere, including chlorofluorocarbons, methane, nitrous oxide and most importantly carbon dioxide (CO_2), has been linked as a main factor affecting terrestrial ecosystems and causing changes in the global environment. In Malaysia, the growth of manufacturing sectors, which rapidly increased in the late 1980's, has exacerbated the environmental situation. A recent report indicated that manufacturing sectors emitted around 30 percent of the CO_2 from the total CO_2 emitted in Malaysia (Department of Statistics, 2014).

Given the tenuous impacts of a 'free market' approach to environmental law, another recognized alternative solution to overcome environmental externalities is via the implementation of the 'command-and-control approach'. Nevertheless, Jorgenson and Wilcoxen (1990) argued that such a stringent policy could retard economic growth as a result of high production costs. However, Porter and Van der Linde (1995) were of the opinion that environmental policy that mainly aims to overcome externalities would also pave the way for innovation and encouraging improvement in firms' competitiveness and efficiency levels, which eventually would allow firms to maximize their profitability. In general, innovation may not only involves the firms' product and its process but it also comprises marketing and organizational settings (Malaysian Science and Technology Information Centre, 2012).

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In Malaysia, despite the fact that the manufacturing sector contributes nearly one-third of the country's CO_2 emissions, it is important to note that this sector also records the highest number of establishments for environmental expenditure (Figure 1), accounting for approximately 63 percent (Department of Statistics, 2014). In fact, the manufacturing sector is one of the highest sectors that encourages innovation, while on the other hand, it plays a critical role in reducing the impact of environmental pollution. Figure 2, shows the distribution of innovating firms across manufacturing industries from 2009 to 2011. Therefore, this study attempted to provide evidence of empirical relationships between pollution control (environmental expenditure), innovation activities, and firms' performance (revenue) across Malaysian manufacturing sectors based on the Porter hypothesis.

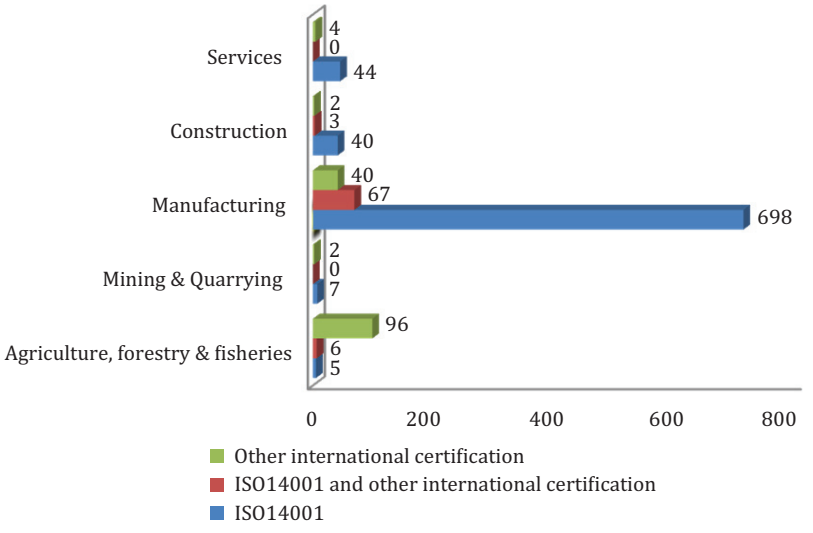

Figure 1 Number of establishments for environmental protection expenditure, 2012
Source: Department of Statistics (2014)

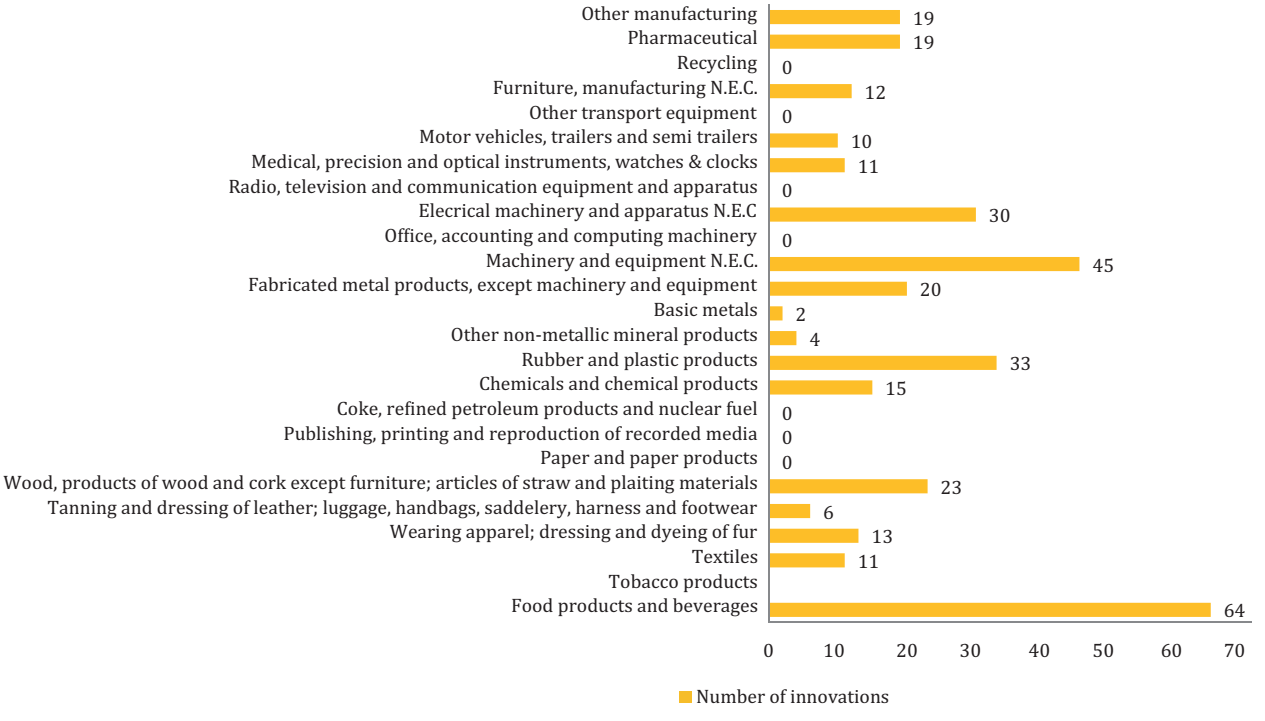

Figure 2 Number of innovations across manufacturing industries, 2009–2011
Source: Malaysian Science and Technology Information Centre (2012)

Literature Review

The Porter hypothesis is a well-known hypothesis and has been applied to study the relationship between regulation and innovation. According to the hypothesis, strict environmental regulations are believed to encourage commercial competitiveness by inducing efficiency and innovation. The hypothesis asserts that environmental expenditure borne by the company is a constraint from which a firm barely benefits. Therefore, firms are normally facing a dilemma in making a decision on whether to abate or to pay in the form of taxes or fines (Bruneau, 2004). A number of studies by scholars such as Triebswetter and Wackerbauer (2008), Chiou, Chan, Lettice, and Chung (2011), Yang, Tseng, and Chen (2012) have employed the Porter hypothesis to examine the effects of exogenous environmental regulations that stimulate innovation. The studies found that such regulations would offer a win-win situation. In Taiwan for instance, Chiou et al. (2011) found that exogenous environmental regulations that stimulate innovation are able to reduce pollution and improve productivity.

A study by Brunnermeier and Cohen (2003) proved that abatement pressures could increase innovation activities, while Costantini and Mazzanti (2012) found that abatement does not affect a firm's competitiveness since the cost of protection eventually benefits the firm. However, there will be innovation barriers, such as training and education, the size of domestic market and the level of security (Alinaitwe, Widén, Mwakali, & Hansson, 2007). A recent study by Antonioli, Mancinelli, and Mazzanti (2013) implied that even though firms are in advanced and competitive industrial settings, it is difficult for them to attain full integration involving environmental innovation given their internal capabilities (in terms of high performance work practices and human resource management) and the assets that they owned. This is further supported by the fact that the level of maturity in environmental management plays a crucial factor in determining innovation (Inoue, Arimura, & Nakano, 2013). Furthermore, studies by De Marchi (2012) and Liu, Hodgkinson, and Chuang (2014) found that cooperation between suppliers and external partners is an important factor to induce innovation activities.

Lin, Tan, and Geng (2013) revealed that market demand is positively correlated to both firm performance and green product innovation, while green product innovation performance is positively correlated to firm performance. Similarly, a study by Ahmed (2012) found that there is a slow pattern in productivity growth, when he internalized CO_2 intensity in the Total Factor Productivity model. On the other hand, a study by Johnston (2005) concluded that the consequences of regulation and voluntary capital expenditure led to negative earning among the firms studied.

In general, most of the studies focused on the macroeconomic elements and perspectives. Likewise, this study also focused on the context based on aggregate responses. Therefore, any differences due to market characteristics and the type of policies implemented were not taken into account. Given the fact that most of the previous studies in Malaysia focused on the factors that influence innovation, this study attempted to extend the scope by investigating what are the implications of innovation and environmental expenditure (policy stringency) towards the revenue of firms across manufacturing sectors in Malaysia.

Methods

Most researchers have applied a panel data analysis that is based on secondary data (Brunnermeier & Cohen, 2003; Jaffe & Palmer, 1997), while others have employed a Structural Equation Modeling (SEM) analysis, which relies on primary data. In this study, a panel data analysis has been employed, which is shown by Equation 1:

$$R_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 I_{it} + \varepsilon \quad (1)$$

where R is the revenue that is used to measure the performance in 22 manufacturing sectors in year t, X denotes environmental expenditure, which is a proxy for regulation compliance, and I represents innovation. According to Lin (2008), correlation does not reflect any causality. Thus, in order to examine a causal relationship, the Granger causality test was undertaken, which is shown in Equation 2, where E denotes the conditional expectation. The causal relationship is important especially for the policy makers, so that they are well informed regarding any consequences from the execution of various actions. Nevertheless, testing causality among variables is difficult, particularly due to the non-experimental nature of social science research. Equation 2 explained innovation (I_{t-K}) does not Granger-cause revenue (R_{t-K}) with respect to information of environmental expenditure (E_{t-K}) if:

$$\mathrm{E}\left(R \mid R_{t-k}, X_{t-k}, I_{t-k}\right) \neq R\left(R \mid R_{t-k}\right) \quad (2)$$

The panel data in this study cover from 2008 to 2012. Data on the firm's revenue across 22 manufacturing sectors in Malaysia (based on two and three digit Standard Industrial Codes at the industry level) was compiled from the Monthly Manufacturing Statistic Report and the Report on the Survey of Environmental Protection Expenditure by the Department of Statistics. The data for innovation was collected from the National Survey of Innovation Report published by the Ministry of Science, Technology and Innovation. The data consist of patents and grants information, which has been used as a proxy for the innovation variable. Such data would provide rich information particularly on the level of research and developmental activity since the dates of applications for patents (Marinova & McAleer, 2003; Popp, 2006). Even though the data do not explicitly represent environmental innovation, it can still be adopted in the model given that the environmental element is actually within the interpretation of innovation (Henry Goh & Co. Sdn. Bhd., 2015). In this study, the number of establishments for environmental expenditure were used, which follows the approach used by Jaffe and Palmer (1997). In general, the data would also represent the level of stringency of environmental policy in Malaysia.

Since the model contains 22 various manufacturing sectors, it was expected that heterogeneity and individuality might exist among those sectors. In order to confirm whether

the fixed effects or random effects suit the model, the Hausman test was performed. Since the result from this test rejected the null hypothesis (chi-squared = 36.305125, p = .0000), it is expected that the fixed effects model would produce a robust and consistent estimation as opposed to the random effects given the nature of the data characteristics. By using the fixed effects model, which allows each sector to have its own intercept value, any heterogeneity effects would implicitly be accounted for in the model. Another advantage offered by a fixed effects model is the ability of the model to eliminate omitted variable bias effects (Boreinstein, Hedges, Higgins, & Rothstein, 2009).

Based on the descriptive statistics shown in Table 1, the distribution of revenue data is highly skewed to the left. Nevertheless, the standard deviation around the mean indicates that the data possessed good statistical characteristics. Even though the data for environmental expenditure is skewed to the right the standard deviation indicated that the data were reliable. The mean value for innovation was close to the median, which means that there was a symmetrical distribution. Therefore, it is expected that the model with its variation of variables around the mean (Exp*ct, Inv*ct, and Rev*ct) would allow the regression analysis to avoid any potential omitted variable bias effects such as the size of the sectors and differences in management qualities.

Results and Discussion

The regression results based on the panel data analysis are shown in Equation 3. The R^2 value of .878 reflects that almost 88 percent of Malaysian manufacturing sectors' revenue can be explained by the explanatory variables in the model.

$$Rev = 14119090 + 62501.55\ Exp^{***} + 95260.70\ Inv^{**} + \varepsilon \quad (3)$$

*Note: significant at ***99 percent, **95 percent with R^2 = .878*

The results implied that both environmental expenditure and innovation hold a positive and significant relationship with revenue across 22 Malaysian manufacturing sectors. Therefore, an increase in environmental expenditure and innovation is expected to expedite firms in the manufacturing sectors in Malaysia to attain higher revenues. The result corresponds to the finding by Brunnermeier and Cohen (2003), Triebswetter and Wackerbauer (2008), Chiou et al. (2011), Yang et al. (2012), and Hung and Chou (2013). These studies also found that a firm could reduce its cost of environmental abatement if it established an allocation for environmental protection. Therefore, undeniably, innovation is a crucial element for a firm to boost its revenue, particularly in the Malaysian manufacturing sectors studied.

Based on the results in Table 2 and illustrated in Figure 3, the Granger causality test showed that there is a bilateral relationship between innovation and environmental expenditure. Moreover, the simultaneous relationships between these variables do influence the revenue via a one-way relationship. This finding was in line with the Porter hypothesis, which states that regulation will trigger innovation, where technological innovation would concomitantly drive a firm toward reducing its cost of pollution abatement. The findings however, require further research, particularly on the depth of the implication for each policy that applies to specific market competitiveness.

Table 3 demonstrates in greater detail the list of sectors that were affected due to the lack of or non-involvement in innovative activities and environmental expenditure. The results show that, out of 22, 15 of the sectors experienced an adverse effect on profitability. This indicated that it is crucial for a firm in this sector to integrate environmental protection in its production as well as innovation activities since both factors would likely improve the firm's productivity and also evade fines due to non-compliance with Malaysia's regulatory environment.

Conclusion

From a macro perspective, this study showed that there is a link between environmental control, innovation, and revenue among firms in Malaysian manufacturing industries. Even though Robinson (1995) found that enforcement by the Environmental Protection Agency and the Occupational Safety and Health Administration regulations would divert economic resources and managerial attention away from productivity, nevertheless, such a situation does not occur in Malaysian manufacturing sectors. In Malaysia, regulatory stringency is associated with innovative activities and it contributes positively towards firms' revenue in the manufacturing sectors. Thus, commitment from firms in manufacturing toward green manufacturing or environmentally sustainable responsibility for instance, will not only produce economic benefits but will also give them a competitive edge as well as establishing a reputable public image. By and large, the commitment may require a firm to reconcile the economic, social, and environmental needs in its operational practice. Nevertheless, a more comprehensive environmental policy, especially involving taxation and financing mechanisms, is also crucial to encourage a strong commitment by the local industries due to the fact that efforts to improve environmental business practices among local businesses are still low (Organisation for Economic Co-operation and Development, 2013).

Table 1
Descriptive statistics

Variable	Mean	Median	Standard Deviation	Minimum	Maximum
Revenue (RM'000)	20,391,256	4,860,736	26,740,840	293,767	128,811,773
Expenditure (number of establishments)	79.56	45.00	96.40	2.00	522.00
Innovation	13.64	9.00	15.70	0.00	110.00

Table 2
Granger causality test results

Dependent Variable	Independent Variable			
	R	E	I	ECT1, t-1
R	*7.0443	*0.3997	*2.3116	*-2.1741
E	0.1290	*3.3108	**2.2243	*-2.3847
I	0.1089	*6.1803	0.1418	*2.7387

Note: significant at **95 percent, *90 percent.

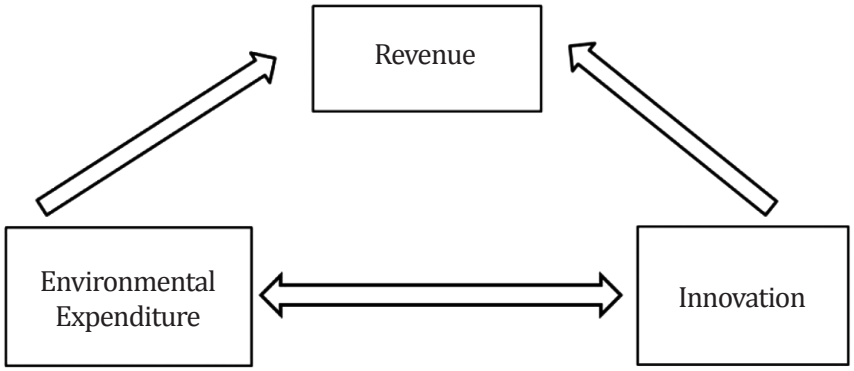

Figure 3 Causal relationship between revenue, environmental expenditure, and innovation
Source: Authors' simulation

Table 3
Results of pooled least square (cross section fixed)

Sectors	Constant	Exp	Inv
Food Products and Beverages	**-17681001**	62501.6	95261
Tobacco Products	**-13064804**		
Textiles	**-13396415**		
Wearing Apparel; Dressing and Dyeing of Fur	**-11063429**		
Tanning and Dressing of Leather; Luggage, Handbags, Saddlery, Harness and Footwear	**-14766169**		
Wood; Products of Wood and Cork Except Furniture; Articles of Straw and Plaiting Materials	**-16877366**		
Paper and Paper Products	**-13349652**		
Publishing, Printing and Reproduction of Recorded Media	**-14337680**		
Coke, Refined Petroleum Products and Nuclear Fuel	84542106		
Chemicals and Chemical Products	15451733		
Rubber and Plastic Products	3592541		
Other Non-Metallic Mineral Products	**-19015745**		
Basic Metals	6702169		
Fabricated Metal Products, Except Machinery and Equipment	**-11807684**		
Machinery and Equipment N.E.C.	48321624		
Office, Accounting and Computing Machinery	**-7386612**		
Electrical Machinery and Apparatus N.E.C	2844076		
Radio, Television and Communication Equipment and Apparatus	25950402		
Medical, Precision and Optical Instruments, Watches and Clocks	**-6401309**		
Motor Vehicles, Trailers and Semi-Trailers	**-1341349**		
Other Transport Equipment	**-11558230**		
Furniture; Manufacturing N.E.C.	**-17970166**		

Note: Bold values show firms with negative revenue.

References

Ahmed, E. M. (2012). Green TFP intensity impact on sustainable East Asian productivity growth. *Economic Analysis and Policy, 42*(1), 67–78.

Alinaitwe, H. M., Widén, K., Mwakali, J., & Hansson, B. (2007). Innovation barriers and enablers that affect productivity in Uganda building industry. *Journal of Construction in Developing Countries, 12*(1), 59–75.

Antonioli, D., Mancinelli, S., & Mazzanti, M. (2013). Is environmental innovation embedded within high- performance organisational changes? The role of human resource management and complementarity in green business strategies. *Research Policy 42*(4), 975–988.

Boreinstein, M., Hedges, L. V., Higgins, J. P., & Rothstein, H. R. (2009). Chapter 11: Fixed-effect versus random-effects models. In *Introduction to Meta-Analysis* (1st ed.). Chichester, UK: John Wiley & Sons.

Bruneau, J. F. (2004). A note on permits, standards, and technological innovation. *Journal of Environmental Economics and Management, 48*(3), 1192–1199.

Brunnermeier, S. B., & Cohen, M. A. (2003). Determinants of environmental innovation in US manufacturing industries. *Journal of Environmental Economics and Management, 45*, 278–293.

Chiou, T. Y., Chan, H. K., Lettice, F., & Chung, S. H. (2011). The influence of greening the suppliers and green innovation on environmental performance and competitive advantage in Taiwan. *Transportation Research Part E: Logistics and Transportation Review, 47*(6), 822–836.

Costantini, V., & Mazzanti, M. (2012). On the green and innovative side of trade competitiveness? The impact of environmental policies and innovation on EU exports. *Research Policy*, *41*(1), 132–153.

De Marchi, V. (2012). Environmental innovation and R&D cooperation: Empirical evidence from Spanish manufacturing firms. *Research Policy, 41*(3), 614–623.

Department of Statistics. (2014). *Report on the survey of environmental protection expenditure, Malaysia 2013*. Putrajaya, Malaysia: Author.

Hung, K. P., & Chou, C. (2013). The impact of open innovation on firm performance: The moderating effects of internal R&D and environmental turbulence. *Technovation, 33*(10–11), 368–380.

Henry Goh & Co. Sdn. Bhd. (2015). *A guide to the Malaysian IP system*. Kuala Lumpur, Malasia: Author. Retrieved from http://henrygoh.com/downloads/ip-guide-en.pdf

Inoue, E., Arimura, T. H., & Nakano, M. (2013). A new insight into environmental innovation: Does the maturity of environmental management systems matter? *Ecological Economics*, *94*, 156–163.

Jaffe, A., & Palmer, K. (1997). Environmental regulation and innovation: A panel study. *The Review of Economics and Statistics, 79*(4), 610–619.

Johnston, D. (2005). An investigation of regulatory and voluntary environmental capital expenditures. *Journal of Accounting and Public Policy, 24*(3), 175–206.

Jorgenson, D. W., & Wilcoxen, P. J. (1990). Environmental regulation and U.S. economic growth. *The RAND Journal of Economics, 21*(2), 314–340.

Lin, J. L. (2008). *Notes on testing causality*. Taipei: Department of Economics, National Chengchi University. Retrieved from http://faculty.ndhu.edu.tw/~jlin/ files/causality.pdf

Lin, R. J., Tan, K. H., & Geng, Y. (2013). Market demand, green product innovation, and firm performance: Evidence from Vietnam motorcycle industry. *Journal of Cleaner Production, 40*, 101–107.

Liu, X., Hodgkinson, I. R., & Chuang, F. M. (2014). Foreign competition, domestic knowledge base and innovation activities: Evidence from Chinese high-tech industries. *Research Policy, 43*(2), 414–422.

Malaysian Science and Technology Information Centre. (2012). *National survey of innovation 2012*. Putrajaya, Malaysia: Ministry of Science, Technology and Innovation.

Marinova, D., & McAleer, M. (2003). Modelling trends and volatility in ecological patents in the USA. *Environmental Modelling and Software, 18*(2), 195–203.

Organisation for Economic Co-operation and Development. (2013). *OECD investment policy reviews: Malaysia 2013*. Paris, France: Author.

Popp, D. (2006). International innovation and diffusion of air pollution control technologies: The effects of NOX and SO_2 regulation in the U.S, Japan and Germany. *Journal of Environmental Economics and Management, 51*(1), 46–71.

Porter, M., & Van der Linde, C. (1995). Toward a new conception of environment-competitiveness relationship. *Journal of Economic Perspectives, 9*(4), 107–118.

Robinson, J. C. (1995). The impact of environmental and occupational health regulation on productivity growth in US manufacturing. *Yale Journal on Regulation, 12*, 387–434.

Triebswetter, U., & Wackerbauer, J. (2008). Integrated environmental product innovation in the region of Munich and its impact on company competitiveness. *Journal of Cleaner Production, 16*(14), 1484–1493.

Yang, C. H., Tseng, Y. H., & Chen, C. P. (2012). Environmental regulations, induced R&D, and productivity: Evidence from Taiwan's manufacturing industries. *Resource and Energy Economics, 34*(4), 514–532.