Expanding the Horizon: An Empirical Study of Sustainable Supply Chain Management and Firm Performance

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As global competition is getting more and more intense, there is an increasing trend manifesting the increasing interest in sustainable supply chain management. This study introduces four sustainable supply chain indicators from the upstream (supplier), middle stream (focal firm) and downstream (customer) of a supply chain to empirically examine the relationship between sustainable supply chain performance and firm performance (ROA), as well as the relationship between environmental efficiency and other three indicators. It focuses on the Energy and Utilities industries. In this study we use global firm dataset from Bloomberg professional service, and the number of observation is 86 during 2005 to 2013. We find an inversely U-shaped curve relationship between environmental efficiency in supply chain and firm's profitability (ROA); and a U-shaped relationship between investments in operational sustainability and firm's profitability. Also a negative relationship is found between having a new product and ROA. We provide implications obtained from our analysis of regression results for managers. We contribute to the literature by responding to the call for more empirical research in this filed, providing the evidence that sustainable supply chain performance can bring actual benefits for the firm, as long as firms identify their own position accurately and take the right action.

Key Words : *sustainable supply chain, environmental efficiency, new product, firm performance*

1. INTRODUCTION

(1) Purpose of this study

Academic and corporate interest in sustainable supply chain management has risen considerably in recent years[1)]. Globally dispersed suppliers and customers have called for improved management strategies in order to match the production and reputation of the focal firm. Rising awareness of sustainability has led to actions by firms to manage their suppliers and products in terms of sustainability. However, a comprehensive understanding of what sustainability is and how to create a business case for it is still missing, creating barriers that inhibit managers from pursuing sustainability in the supply chain.

The energy and utilities industry is vital to the normal function of a society. It is also a controversial industry for generating greenhouse gases (GHGs) through power generation and distribution. Many organizations in this industry have started pursuing sustainable activities proactively, and sustainable supply chain management is definitely an important topics of considerations. Tate et al.'s (2009) study compared and contrasted the influential words in the Corporate Social Responsibility (CSR) reports of firms from a range of industries and found that the utilities industry emphasizes the energy conservation the most in CSR reports compared to other industries[2)]. Zhu and Sarkis (2005) identified drivers and pressures for adoption of green supply chain management practices in their inter-sector study in China, including the thermal power plants industry[3)].

Despite the importance of this topic, to the best of our knowledge little research has been done to examine what roles the sustainable supply chain management plays in the area of financial perfor-

mance and environmental efficiency in the energy and utilities industry. Therefore, in this study, the authors introduced four indicators to investigate the relationship between sustainable supply chain performance and firm performance in the context of the energy and utilities industry.

(2) Backgrounds and Research Questions

According to Walley and Whitehead (1994), responding to environmental challenges has sometimes been a costly and complicated proposition for managers, and win-win situations are very rare[4]. Colby (1995) agreed by arguing that: "easy problems have mostly been fixed – the remaining obstinate challenges are becoming increasingly expensive to resolve"[5]. Carter and Rogers (2008) identified several challengers to implementing sustainability[6]. They argued that there are always environmental and social activities that harm or at least do not help the economic bottom line. The key is to learn from all these failures and to develop workarounds for the most common failures.

On the contrary, according to Lankoski (2000), an inversely U-shaped curve is often cited as the "best" possible relationship between environmental and economic performance[7]. In his theory, marginal environmental profit is a decreasing curve because of the decreasing marginal benefits and increasing marginal costs, resulting in a non-linear relationship where both the first and second order derivatives are negative. Researchers have disputed this while little empirical research has tested this relationship so far[8]. Wagner and Schaltegger (2004) investigated this issue by examining whether a non-linear effect of corporate environmental performance on competitiveness and economic performance can be shown and what effect strategy choice has on this. They found that for firms with an Environmental Shareholder Value-oriented corporate environmental strategy, the environmental activities had a significant and positive influence on environmental competitiveness. Following their step, we develop this model to test if there is an inversely U-shaped relationship between environmental performance and firm's profitability in the context of the supply chain.

Following on the previous research, we try to fill some gaps and further investigate this relationship. We found a lack of global samples to test the relationship between sustainable supply chain performance and a firm's financial performance. Also, most of the studies were conducted a single supply chain dimension, focusing on either the upstream (more) or the downstream (less). In addition, we found almost no studies were conducted in the context of the energy and utilities industry.

To fill these gaps, we pose the following question in our study: Are sustainable supply chain management practices related to firm performance? We selected four indicators, representing the sustainable performance of the upstream, middle stream and downstream supply chain, to examine their relationships with firm performance.

a) Environmental Efficiency in the Supply Chain

Firms are required to employ sustainable supply chain practices because of pressures from their stakeholders such as customers, regulators and NGOs[9]. In the context of sustainability, green purchasing, sustainable supplier management and relevant topics have attracted more attention from managers. Not only should they focus on internal operations, but they must also extend their green practices to other parts of supply chain. Regarding the role of the supply chain management in the literature, Green et al.'s (1998) study[10] suggests environmental pressures are "leading to a much more significant, and central, role for purchasing and supply management than the function has experienced before". Reuter et al. (2010)[11] introduced case studies and proposed that profound sustainable global supplier management (SGSM) capabilities are a source of competitive advantage. Regarding supplier management and green purchase issues, another set of literature examines the downstream side of the supply chain, focusing on logistics, reverse supply chain, and the use impact of products[12),13),14),15)]. In addition, as stated by Srivastava (2007), "it is not just about being environmentally friendly; it is about good business sense and higher profits". Studies in this area suggest many benefits of implementing sustainable supply chain practices, and the relationship could be non-linear between environmental performance and economic performance, according to Lankoski's[7] model.

H1: Environmental efficiency of the supply chain has a non-linear relationship with firm's financial performance.

b) Operational Sustainability

Operational sustainability is closely related with the production process, new product design and pollution prevention. Manufacturing firms adopt cleaner process techniques to both respond to the external pressures and improve competitiveness. Managers are more willing to implement such practices than to cooperate with other entities to achieve sustainability in the supply chain because it costs less and is less risky. This study hypothesizes that investing to implement sustainable operational practices will enhance environmental performance

and financial performance. Specifically, we make the following hypothesis:

H2a: Investments in operational sustainability is positively related to firm's financial performance.

H2b: Investments in operational sustainability is positively related to firm's environmental efficiency.

c) Sustainable Products and Services

With all the possibilities and benefits a new product or service could offer to improve sustainability, it is reasonable to say that a firm that cares about its corporate responsibility will put effort into the development of sustainable products and services. However it is not certain whether these products have achieved any market success[16]. According to Peattie and Crane (2005)[17], although in the early 1990s "survey evidence from reputable research bodies was cited as identifying heightened environmental awareness, a growing consumer interest in green products, and a pronounced willingness to pay for green features, … by the mid-1990s new market research evidence began to emerge which was less unequivocal about the growth of green consumerism." They concluded that green marketing has been significantly unsuccessful. In addition, even if the function of the green product is not compromised it is difficult for it to replace the existing one and penetrate the market in a short time. Customers tend to be price-sensitive and are reluctant to try new things because of the usually higher price and information asymmetry. A business case for sustainable products and services is badly needed. This logic results in the following proposition:

H3a: Adopting a new product that addresses the future climate impact is positively related to a firm's financial performance.

H3b: Adopting a new product that addresses the future climate impact is positively related to a firm's environmental efficiency.

d) Environmental Supply Chain Management Initiatives

Intuitively we suggest that environmental efficiency, or environmental performance could to some extent be enhanced by the implementation of sustainable practices. Marketing of green products develops the customers' awareness of environmental problems and encourages them to contribute to the environment by purchasing green products[18),19)]. Other initiatives that aim to reduce the environmental footprint in the supply chain also contribute to environmental efficiency, thus, we have the following hypothesis:

H4a: Implementation of environmental supply chain management initiatives is positively related to the firm's financial performance

H4b: Implementation of environmental supply chain management initiatives is positively related to firm's environmental efficiency.

2. METHODOLOGY

(1) Model

In our first regression model, we examine the relationship between sustainable supply chain performance and firm performance. We use environmental inefficiency scores, investments in operational sustainability, new environmentally friendly products and environmental supply chain management (SCM) as indicators covering the upstream and downstream supply chain. The environmental inefficiency score refers to the environmental performance of the focal firm and the related supply chain. The other three indicators refer to the initiatives or investments that the firm utilizes to improve their sustainable supply chain performance. ROA is an indicator of the firm's profitability.

In our second regression model, we examine the relationship between the environmental inefficiency score and the other three independent variables in the first model. We assume that the efforts that firms make will improve their sustainable supply chain performance.

$$ROA = \beta_1 \cdot lnScoSales^2 + \beta_2 \cdot lnScoSales + \beta_3 \cdot lnSuslnv^2 + \beta_4 \cdot lnSuslnv + \beta_5 \cdot NewPrd + \beta_6 \cdot EnvSCM + \beta_7 \cdot Controls + \alpha_i + \alpha_t + e \quad (1)$$

$$lnScoSales = \beta_8 \cdot lnSuslnv^2 + \beta_9 \cdot lnSuslnv + \beta_{10} \cdot NewPrd + \beta_{11} \cdot EnvSCM + \beta_{12} \cdot Controls + \alpha_i + e \quad (2)$$

where *i* and *t* denote firm and year, respectively. ROA denotes the return on assets of a firm. lnScoSales denotes the ratio of the natural log value of Scope1, Scope2 and Scope3 GHG emissions of the company divided by revenue. In other words, it reflects the emissions level, or environmental inefficiency, of the supply chain for every unit of revenue. Whereas previous studies have used only Scope1 in the calculation, we extend it to obtain an environmental inefficiency score for the entire supply chain. lnSusInv denotes the natural log value of the amount of money spent by the company on operational environmental and social compliance and other internal environmental and social initiatives,

Table 1 Descriptive statistics

variable	obs	mean	s.d	min	max
Dependent variable					
ROA	86	0.076	0.037	−0.071	0.208
Independent variable					
lnScoSales	86	−14.816	2.228	−20.381	−12.399
lnSusInv	86	17.793	2.171	13.217	23.916
NewPrd	86	0.116	0.322	0.000	1.000
EnvSCM	86	0.709	0.456	0.000	1.000
Control variable					
SIZE	86	23.857	1.327	21.180	26.497
lnKL	86	14.050	1.289	8.711	16.126
lnLEFF	86	13.837	0.612	11.884	15.318

Table 2 Correlation table

	ROA	*lnScoSales*	*lnSusInv*	*NewPrd*	*EnvSCM*
ROA	1				
lnScoSales	−0.0041	1			
lnSusInv	−0.0885	0.5355	1		
NewPrd	0.0873	0.1236	0.2380	1	
EnvSCM	−0.2380	0.2087	−0.0625	−0.1672	1

Table 3 Regression result

	(1) *ROA*	(2) *ROA*	(3) *ROA*	(4) *ROA*	(5) *lnScoSales*	(6) *lnScoSales*
lnScoSales	0.0346***	0.0673	0.0284	−0.3550**		
	(0.0114)	(0.1532)	(0.0217)	(0.1621)		
lnScoSalesSq		.0010		−0.0113**		
		(0.0047)		(0.0049)		
lnSusInv	0.0090	−0.0144	−0.0003	−0.0733*	−0.0126	−0.4985*
	(0.0146)	(0.1235)	(0.0040)	(0.0364)	(0.0297)	(0.2772)
lnSusInvSq		0.0006		0.0020**		0.0135*
		(0.0033)		(0.0010)		(0.0076)
NewPrd	0.0724	0.0715	−0.0361	−0.0401*	0.0641	.0715
	(0.0653)	(0.0668)	(0.0225)	(0.0207)	(0.1671)	(0.1627)
EnvSCM	− 0.1269***	−0.1230**	−0.0015	0.0166	0.1894	0.2454
	(0.0475)	(0.0498)	(0.0279)	(0.0262)	(0.2054)	(0.2025)
lnKL	−0.1490***	−0.1475***	−0.0266	−0.0254***	0.0114	0.0316
	(0.0195)	(0.0204)	(.0181)	(0.0166)	(0.1347)	(0.1316)
SIZE	−0.0257	0.0228	−0.2177***	−0.2207	−0.0950	−0.0538
	(0.0224)	(06.0338)	(0.0439)	(0.0403)	(0.3266)	(0.3188)
lnLEFF	0.2247***	0.2169***	0.3096***	0.2672***	0.5172	−0.6926
	(0.0382)	(0.0461)	(0.0751)	(0.0705)	(0.5530)	(0.5475)
Constant	0.4351	0.9813	2.1190	0.2727	-5.5159	-0.1501
	(0.7116)	(1.8888)	(1.5358)	(1.8051)	(11.3944)	(11.5022)
Firm fixed effects	No	No	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
obs	86	86	86	86	86	86
year	2005-2013	2005-2013	2005-2013	2005-2013	2005-2013	2005-2013
R-squared	0.63	0.71				
Within R-squared			0.72	0.78	0.21	0.27
Overall R-squared			0.01	0.00	0.08	0.05

Notes: Columns 1 to 4 shows results of regression model. ***, **, and * denote significances at the 1%, 5%, and 10% level, respectively. Coefficients are without parentheses, and standard errors are in parentheses.

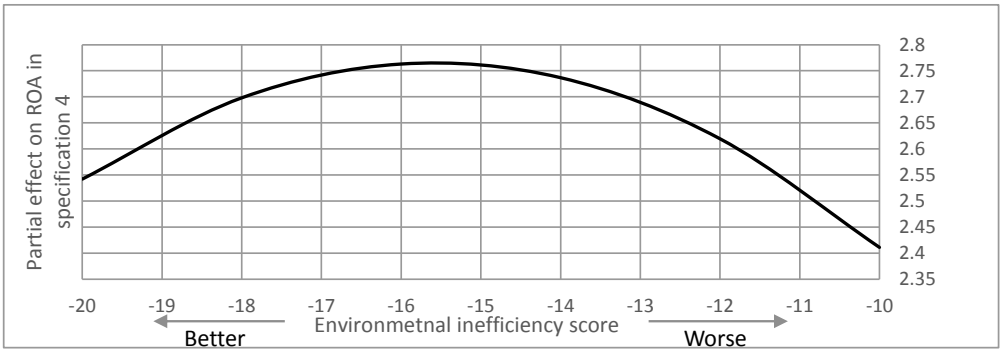

Fig.1 Relationship between environmental inefficiency score and ROA

as defined by the company. NewPrd is a dummy variable that indicates whether the company has developed and/or launched products during the current period designed specifically to address future impacts of climate change and/or mitigate customers' contributions to climate change through reduced GHG emissions. The products may or may not be new to the market. EnvSCM is a dummy variable that indicates whether the company has implemented any initiatives to reduce the environmental footprint of its supply chain. Environmental footprint reductions could be achieved by reducing waste, resource use, or environmental emissions, or by insisting on the introduction of environmental management systems or other sustainability initiatives in the supply chain. Control variables includes SIZE, lnKL and lnLEFF. SIZE denotes the natural log value of the firm's total assets. lnKL denotes the natural log value of the capital-labor ratio, calculated by net fixed assets/ number of employees, and lnLEFF denotes the natural log value of labor productivity, calculated by Revenue/ # of employees.

(2) Data

We use a dataset of global firms compiled by Bloomberg professional service. The number of observations was 86 between 2005 and 2013, which is relatively small compared to the original dataset. As this is an industry-specific study, and due to the particularity of our independent variable, we consider this number of observation as valid. **Tables 1** and **2** show the descriptive statistics and correlation table respectively in this study.

3. RESULTS

Table 3 shows the regression results of equations (1) and (2). In specification (4), the coefficients of lnScoSales and lnScoSalesSq are statistically significantly from zero and both are negative, indicating that the relationship between the environmental inefficiency score and the firm's profitability is an inversely U-shaped curve, supporting H1. On the other hand, the coefficients of InSusInv and InSusInvSq are significantly negative and positive, respectively. This is also a U-shaped curve, partially supporting H2a, indicating the complexity of investing in sustainability. Opposed to our H3a, the coefficient of NewPrd is significantly negative; that is, the development of a new product that mitigates the future climate impact is found to have a negative relationship with the firm's profitability at a 10% significance level. Regarding H4a, environmental initiatives in the supply chain turn out to have no significant impact on the firm's performance according to our regression results.

The statistically significant negative and positive coefficients of InSusInv and InSusInvSq, respectively, are found in specification (6), supporting H2b. There is no significant relationship regarding NewPrd and EnvSCM, thus H3b and H4b are not supported.

The results of our two regression models are surprising, but at the same time indicate that the task to achieve higher profitability through a sustainable supply chain is not easy. This situation differs from firm to firm and no single solution or framework fits all firms.

(1) The Relationship Between Supply Chain Management and Financial Performance

The pattern we found that links the environmental inefficiency score and the firm's profitability is consistent with the findings in Wagner and Schaltegger's (2004)[12] and Lankoski's[7] studies. In contrast to the traditional view that there is a trade-off between environmental performance and economic performance[20], we found an encouraging inversely U-shaped curve between the two variables (**Fig.1**). At firs firms can obtain higher profitability

by increasing enviromental efficiency in the supply chain. Following Colby's (1995) logic[5], firms will start by solving the easier problems, and as the problems become more and more challenging, it is also increasingly more difficult to obtain profits by improving environmental performance. Hence, the growth rate of ROA decreases all the way to the left in **Fig. 1**. At some point, the firm reaches its highest ROA. Because the firm has solved most of the easy problems, after this breakeven point it becomes too costly to improve its environmental performance, and it will suffer from a drop in profitability if it continues to invest in sustainable supply chain management. The environmental inefficiency score can also reflect the business position of a firm. The higher this score is, the more suppliers it may have. It is reasonable to say that the highest ROA is enjoyed by moderately sized firms, ones with neither too small nor too large number of suppliers.

Another non-linear relationship is found between investments in operational sustainability and ROA. The shape of the curve here is a U-shaped quadratic function curve. It indicates that firms will suffer from a drop in ROA when they first implement operational sustainability strategies, but as these strategies become more sophisticated, the firm can finally enjoy an increase in ROA.

The new product variable has a significantly negative relationship with ROA. This is not consistent with our hypothesis, but it is consistent with some evidence shown in some previous studies. Mintel's (1995) report[21] recorded only a slight increase in green consumers in 1990. Wong et al. (1996) stated that green products have achieved limited success[22].

(2) The Relationship Between Supply Chain Management and Environmental Efficiency

In specification (6), a U-shaped relationship between the environmental inefficiency score and investments in operational sustainability is found. The reason is similar to the one mentioned above. At first, investments in operational sustainability are utilized to solve some easier problems, and rewards are enjoyed in the short term, so the environmental efficiency is improved. However, as the situation becomes increasingly complicated and the number of environmental problems that can be solved with the same amount of money decreases, so do the rewards. At some point the money spent and the rewards received are at breakeven, and this is the lowest point of the environmental inefficiency score. Continuing to invest in operational sustainability may bring no further rewards because it becomes too costly and inefficient. The reward margin of every unit of investment in operational sustainability is smaller than that in other types of investment (e.g., green purchasing, etc.). Continuing to invest in operational sustainability will only lead to a higher opportunity cost and drag down the firm's environmental performance.

4. CONCLUSIONS

Sustainable supply chain management has attracted more attention from both researchers and managers. Despite the fact that the significance of this issue is well understood in the field, it remains unclear whether sustainable supply chain management could bring firms extra profits. The results of this study are encouraging for managers because they show the linkages between sustainable supply chain management and firm performance. Successful sustainable supply chain management could lead to an increase in firms' profitability in the long term, but only if organizations implement sustainable practices in a coordinated manner. Organizations should precisely position themselves in the industry and employ the right strategy to allocate resources to the appropriate place.

According to the results, regarding firm's financial performance as the dependent variable, H1 is supported, and a win-win situation is found in environmental efficiency and the firm's ROA. H2a is partially supported, implying that investing in operational sustainability is challenging and risky. We also found an opposite result to H3a, indicating that the development and launch of a new green product compromises the firm's ROA. No significant relationship is found to support H4a. Regarding environmental efficiency as the dependent variable, a U-shaped relationship is found between investments in operational sustainability and environmental efficiency, supporting H2b. No significant relationship is found to support H3b or H4b. The results suggest that it is not enough to only implement practices successfully, but that it is necessary to also evaluate the results carefully. The launch of a new product may not bring an increase in ROA immediately. Appropriate objectives and time to achieve these goals should be set correctly to obtain the outcomes they may bring.

There are some implications for managers from our analysis. First, as superior environmental performance in the supply chain could lead to a higher ROA, it is worth implementing sustainable supply chain practices. Note that the more devoted a firm is to sustainable supply chain management the more difficult it may be for it to benefit from this effort. Thus, firms that wish to continue to improve their sustainability in the supply chain will need to

evolve in an innovative way. Both incremental and radical innovation are needed in order to make money from sustainability.

Second, it is important to make preparations before launching a new environmentally friendly product or service. Market research is needed to identify the response of customers towards this kind of new product, and the part they find the most attractive. Employees need to be mentally prepared for the change in the company's culture, and sales and service staff should have the knowledge to market this new product. Also, a long term perspective is necessary to obtain the rewards from the new product. Kahnemann and Lovallo (1993)[23] found that people tend to underestimate the difficulty of tasks and expect results sooner than is reasonable or realistic[23]. Insufficient time to achieve the goals may create a false impression that sustainable supply chain management does not work, and that the traditional way of dealing with suppliers brings higher profitability.

Third, investment in operational sustainability is also necessary for firms that want to grow faster. It not only reduces costs through innovations, but also expands the firm's competitive advantage as it differentiates itself from its competitors. The difficulties should be precisely identified and overcome to successfully lead the firm toward operational sustainability. Allocating resources to improve the sustainable supply chain performance as a whole, instead of focusing on only one or two dimensions is likely to yield better results.

Future research is needed to extend the findings of this study to other industries, and additional indicators are needed to conduct a more comprehensive study. Also, further studies are needed to understand how to successfully implement sustainable supply chain practices through partnerships with other entities in the same chain. We believe that in the future when sustainability of the supply chain becomes more important, Scope 1, 2 and 3 or other similar indicators of environmental performance of the firm and its supply chain will be a critical criterion to judge a firm in terms of sustainability. Finally, we did not examine social responsibility in the supply chain, and this is an area that future researchers can study.

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