Complementary Assets and the Use of Leading Practices to Positively Contribute to Company's Cost Advantage

Christine S. Miranda
Master in Engineering Management
Héctor J. Cruzado, PhD
Graduate School
Polytechnic University of Puerto Rico

Abstract *— Research has shown that a firm's performance has disregarded the existing resources and capabilities to apply environmental management leading practices. The leading practices concept refers to that of protecting the environment while minimizing costs. The aim of this paper is to analyze the importance of complementary assets and whether they are required to generate a cost advantage as a result of implementing leading practices. Results from 88 chemical companies have shown that creating a relationship between leading practices and cost advantage is achievable through the application of process innovation and implementation as complementary assets.*

Key Terms *— leading practices, complementary assets, cost advantage, environmental management*

INTRODUCTION

Since 1970, the cost of environmental protection for firms in the United States has increased drastically and is expected to continue to rise in the future [1]. Although this increase is inevitable, feasible options exist to improve a firm's competitive position while reducing the negative effects on the environment as a result of its various activities. Studies have shown that companies such as 3M and Dow have successfully created a competitive advantage by identifying their leading practices while developing environmental strategies [2-3]. However, research has yet to provide standards on how these firms have successfully implemented leading practices of environmental management while achieving their financial goals. Therefore, it is important to have a clear understanding of the process of implementing these leading practices to determine if its applicability exists to all firms, or if it is specific to firms that possess certain complementary assets that allow them to have a competitive advantage.

In this paper, the strategic management approach is employed to understand the implementation of leading practices. Although, there is limited literature associating environmental strategies with strategic management perspectives, recent studies, specifically Reinhardt, argue that more attention is needed in understanding the circumstances that lead to identifying the specific environmental strategies that contribute to a competitive advantage [4]. Reinhardt explains that competitive advantage, while being environmentally responsible, mainly depends on the industry structure and the product market in which the industry competes. Critically, these views are essential in analyzing how internal factors of the firm can affect the relationship between a competitive advantage and environmental practices.

The research for this paper employs a resource-based view of the firm current complementary assets and how they can affect the relationship between leading practices of environmental management and competitive cost advantage of a firm. Complementary assets are associated with resources such as the organizational strategy, technology, or innovation. Teece argues that complementary assets are essential to gain the firm's competitive advantage from the implementation of leading practices of environmental management [5]. He used data collected from the chemical industry in the United States to explore the following two issues: (1) Is the relationship between the leading practices of environmental management as a means of assisting in a firm's competitive advantage; (2) Are complementary assets essential to the relationship between leading practices of environmental management and cost advantage. Finally, the

research explains why the successful implementation of leading practices for environmental management does not always provide a positive economic benefit for the firm.

LITERATURE REVIEW

This section introduces the three process-focused leading practices of environmental management used in the pragmatic analysis. For this study, two set of hypotheses were generated. The first set is based on the environmental management literature on the effects of environmental leading practices on cost advantage. The second set explores the effect of specific complementary assets on the company's cost advantage based on the implementation of these three leading practices.

Direct Effects of the Three Leading Practices on Cost Advantage

- **Hypotheses 1**: Directly proportional relationship between a company's pollution-prevention technologies and its cost advantage in regard to the firm's environmental strategies [6].
- **Hypotheses 2**: Directly proportional relationship between a company's innovation of exclusive pollution-prevention technologies and its cost advantage in regard to the firm's environmental strategies [7].
- **Hypotheses 3**: Directly proportional relationship between a company's early timing on cost advantage in regard to the firm's environmental strategies.

Firm's Outcomes of Complementary Assets

- **Hypotheses 4**: Directly proportional relationship between a company's capabilities on process innovation and implementation its cost advantage in regard to the firm's environmental strategies.
- **Hypotheses 5**: Directly proportional relationship between a company's capabilities on process innovation and implementation its cost advantage concerning the firm's innovation of exclusive pollution-prevention technologies.
- **Hypotheses 6**: Directly proportional relationship between a company's capabilities on process innovation and implementation its cost advantage concerning the firm's innovation of exclusive pollution-prevention technologies.

ANALYSIS APPROACH

Level of Analysis and Choice of Industry

For multidivisional firms, the concept of competitive advantage is developed at the business-unit level. Research shows that firms' performance is determined at a business-unit level [8]. Consequently, the more appropriate level for the analysis of this study is the business unit. In order to effectively analyze the effect of environmental strategies on cost advantage, an individual level of environmental issues was chosen over an overall level of environmental issues.

The choice of an industry was determined based on the industries with the highest costs for environmental protection. The chemical industry was found to be one that spent the highest capital in the remediation and protection of environmental issues.

Data Collection and Construction of Measures

A questionnaire for the study was developed using the "Total Design Method" [9]. This survey was designed to ask respondents to identify one environmental issue that greatly affected their business unit. This approach was far more appropriate because different environmental issues can affect different areas of the chemical industry. As a result, the data collected had a higher quality and a faster response rate.

On this questionnaire, many of these items were adopted from literature research; others were originally developed. Through prior research, existing measurement scales were identified and adjusted to fit the following variables included in this study.

- **Cost Advantage**. The cost advantage variable is the dependent variable for this study, and it is based on the company's rough estimation of cost savings from environmental practices relative to its competitors.
- **Leading Practices of Environmental Management**. Key points generated in the survey aid in the development of leading practices of environmental management measures. These key points were mainly focused on the company's approach to pollution-prevention technologies and their exclusive innovation, as well as their timing regarding their own environmental strategies.
- **Complementary Assets.** The complementary assets were measured in the survey by asking the respondents to identify any tendencies or to implement new production technologies and equipment to their company. Also, respondents were asked about the company's innovativeness in relation to their competitors.
- **Control Variables.** Environmental issues were classified in six categories: air pollution, water pollution, waste, product issues, issues related to the Superfund regulation, and others (where others include issues that did not fit any category).

Data Analysis and Quality Checks

Before testing the hypotheses generated for this study, two quality checks were performed on the collected data. The first quality check evaluates the extent of multicollinearity among the independent variables [10]. The second quality check was used to test the common-method variance. Table 1 shows the correlations between independent variables reviewed for multicollinearity.

The data shows that the level of complementary assets has a direct correlation with early timing, indicating that firms who main focus on innovation are inclined to address environmental issues faster than others. Furthermore, that data reveals a positive and significant relationship between innovation of exclusive pollution-prevention technologies and the product issue. This relationship indicates that firms are more active when it comes to addressing environmental issues with a higher level of pollution-prevention innovation than other issues. The presence of multicollinearity in the data indicates that is not a problem based on the variance inflation factors and examinations of condition indices.

To avoid common method variance or to have an estimation of its extent, several procedures were applied [11]. Regarding the survey to avoid or reduce the effects of consistent items, the dependent variables were placed after the independent variables. Next, Harman's single-factor test was performed [12]. The results from both procedures show that common method variance is not issued in this study.

Table 1

Means, Standard Deviations, and Spearman Coefficient

		N	MEANS	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Cost Advantage	88	0.00	0.86	1.00														
2	Pollution Prevention	88	0.00	0.84	-0.01	1.00													
3	Innovation	88	0.00	0.88	0.21^{r}	0.01	1.00												
4	Early Timing	88	0.00	0.90	0.10	-0.01	0.02	1.00											
5	Complementary Assets	88	0.00	0.90	0.09	0.20^{r}	0.10	0.42***	1.00										
6	Complementary Assets*Pollution Prevention	88	0.15	0.94	0.20^{r}	-0.19^{r}	0.17	-0.13	-0.18^{r}	1.00									
7	Complementary Assets*Innovation	88	0.08	0.78	0.12	0.22*	-0.12	0.16	0.08	-0.29**	1.00								
8	Complementary Assets*Early Timing	88	0.34	0.89	0.22*	-0.16	0.13	0.16	0.03	0.34**	-0.15	1.00							
9	Firm Size (log)	88	9.00	2.01	0.00	0.06	0.01	0.03	0.01	0.01	0.10	0.00	1.00						
10	Water	88	0.14	0.35	-0.01	-0.03	0.01	-0.06	-0.09	0.02	0.04	0.10	-0.13	1.00					
11	Waste	88	0.22	0.41	0.05	0.04	0.00	0.04	0.05	-0.16	0.05	-0.07	-0.06	-0.21^{r}	1.00				
12	Product	88	0.09	0.29	-0.10	-0.21*	0.35***	-0.17	-0.15	0.25*	-0.23*	0.25*	0.06	-0.13	-0.17	1.00			
13	Superfund	88	0.05	0.21	-0.37***	0.13	-0.22*	-0.04	0.07	-0.01	-0.08	-0.14	0.08	-0.09	-0.11	-0.07	1.00		
14	Other	88	0.11	0.32	0.18^{r}	0.20^{r}	0.08	0.04	0.05	0.00	0.05	-0.05	0.06	-0.14	-0.19^{r}	-0.11	-0.08	1.00	
15	3-year stock returns (1192-1994)	49	0.22	0.42	0.28^{r}	-0.08	-0.06	0.11	0.08	0.08	-0.21	0.19	0.00	-0.34*	0.08	-0.09	-0.05	0.26^{r}	1.00

^{r}p<.10 *p<.05 **p<.01 ***p<.001

To test the hypotheses of this study, the used of ordinary least square regression was employed [13]. Moderated regression analysis was tested on the possible relationship suggested on hypotheses 4 through hypotheses 6.

The three leading practices of environmental management measures and the complementary assets variable were multiplied to generate interaction terms. To minimize multicollinearity among the independent variables analyzed in this study, each interaction had their own separate regression equation. The hypotheses regarding the moderating effects support both interaction terms of significant regression coefficients and increases in the descriptive power of the model through inclusion. To assess the significance of regression coefficients, T-tests were performed on the data. In addition, F-tests were applied to the data that assess the significance of the increase in the descriptive power of the models.

RESULTS

Regression analysis results are presented in Table 2. On the first equation, only the control variables are included to be able to later compare against other equations. The second equation tests the hypotheses on the direct effects of the leading practices on cost advantage by adding the three leading practices to the control variables. The third equation adds to the control variables the three leading practices and the complementary assets. The reasoning behind this approach is to have a point of comparison for the models with interaction effects. The results of this study showed that the hypotheses were tested concerning the moderating effects of complementary assets. Moreover, each of the last three equations includes one of the interaction effects.

Table 2
Results of Regression Analysis

	Dependent Variable: Cost Advantage					
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-0.01	0.02	0.01	-0.03	0.18	-0.04
	0.42	**0.42**	**0.42**	**0.41**	**0.41**	**0.42**
"Leading Practices" of Environmental Management						
Pollution Prevention		-0.03	-0.04	-0.01	0.04	-0.02
		0.11	**0.11**	**0.11**	**0.12**	**0.11**
Innovation		0.19†	0.18	0.14	0.15	0.18†
		0.11	**0.11**	**0.11**	**0.11**	**0.11**
Early Timing		0.04	0.01	0.03	0.06	-0.02
		0.10	**0.11**	**0.11**	**0.11**	**0.10**
Complementary Assets and Interactions						
Complementary Assets			0.06	0.09	0.11	0.06
			0.11	**0.11**	**0.11**	**0.11**
*Complementary Assets*Pollution Prevention*				0.23*		
				0.09		
*Complementary Assets*Innovation*					0.24†	
					0.13	
						0.22*
						0.10
Control Variables						
Firm Size (log)	0.01	0.01	0.01	0.01	0.01	0.01
	0.04	**0.04**	**0.04**	**0.04**	**0.04**	**0.04**
Water	-0.08	-0.11	-0.10	-0.09	-0.08	-0.18
	0.27	**0.27**	**0.28**	**0.27**	**0.26**	**0.27**
Waste	0.01	-0.02	-0.02	0.04	-0.03	-0.01
	0.23	**0.23**	**0.23**	**0.23**	**0.22**	**0.23**
Product	-0.35	-0.56	-0.54	0.63†	0.65†	0.73*
	0.32	**0.36**	**0.36**	**0.35**	**0.34**	**0.36**
Superfund	-1.51***	-1.35***	-1.37***	-1.43***	-1.37***	-1.29***
	0.43	**0.44**	**0.44**	**0.43**	**0.43**	**0.44**
Other Issue	0.35	0.30	0.30	0.29	0.26	0.30
	0.29	**0.30**	**0.30**	**0.29**	**0.29**	**0.29**
R^2	0.17	0.20	0.21	0.26	0.27	0.25
Delta R^2				0.05	0.06	0.04
F-Test for Delta R^2				5.73*	7.11*	4.61*

Standard errors are in bold
$^{\dagger}p<.10$ $^{*}p<.05$ $^{**}p<.01$ $^{***}p<.001$

Direct Effects of Leading Practices on Cost Advantage

The second equation shows the data does not support hypotheses 1 and 3 on the initiative of environmental strategies on the firm's cost advantage. Most specifically, hypotheses 1 suggests that pollution-prevention technologies have a negative impact on the firm's cost advantage. Hypotheses 3, although it suggests a positive impact on early timing of its effect, is not significant. Nevertheless, the second equation does support the data for hypotheses 2 on the innovation of exclusive pollution-prevention technologies on the firm's cost advantage. The coefficient for hypotheses 2 is positive and meaningful at the 10 percent level.

Firm's Outcomes of Complementary Assets

The fourth equation indicates that the data support hypotheses 4 on the firm's cost advantage as a result of higher levels of complementary assets in the use of pollution prevention technologies. The coefficient for hypotheses 4 is positive and meaningful at the 5 percent level. The results of the regression analysis model show an increase of 0.05 with the interaction term. An F-test was performed on the data and it indicates that the 0.05 increase in the R_2 is substantial at the 5 percent level.

The fifth equation indicates that the data support hypotheses 5 on the firm's cost advantage as a result

of higher levels of complementary assets in the use of innovation of exclusive pollution prevention technologies. The coefficient for hypotheses 5 is positive and meaningful at the 10 percent level. The results of the regression analysis model show an increase of 0.06 with the interaction term. An F-test was performed on the data and it indicates that the 0.06 increase in the R_2 is substantial at the 5 percent level. An F-test was performed on the data and it indicates that the 0.06 increase in the R_2 is substantial at the 5 percent level.

The sixth equation indicates that the data support hypotheses 6 on the firm's cost advantage as a result of the early timing of environmental strategies. The coefficient for hypotheses 5 is positive and meaningful at the 5 percent level. The results of the regression analysis model show an increase of 0.04 with the interaction term. An F-test was performed on the data and it indicates that the 0.04 increase in the R_2 is substantial at the 5 percent level. An F-test was performed on the data and it indicates that the 0.06 increase in the R_2 is substantial at the 5 percent level.

CONCLUSION

In this study, the concept of the firm's complementary assets was applied to the analysis of the competitive effects of environmental practices. Results indicate that leading practices of environmental management did not positively affect firm's cost advantage. Nevertheless, in order to create cost advantage from the implementation of leading practices of environmental management, it is necessary that firms acquire complementary assets.

The outcomes on this study show a differentiation among firms that possess certain characteristics in their approach on environmental strategies. Such outcomes suggest that future research is necessary to understand the firm's existing resources and capabilities to effectively develop environmental strategies that would lead to firm's cost advantage. Additionally, future research would be needed in the detail identification of complementary assets and their specific role on the competitive advantage. The reasoning behind this approach is to have a better understanding of the several environmental practices and their significant importance and impact to the environment.

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