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The Impact of Supply Chain and Network Structure on the Environmental Performance of Sustainability-Focused Companies

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The Impact of Supply Chain and Network Structure on the Environmental Performance of Sustainability-Focused Companies

by

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DEDICATION

To my mother Canan Ozcan, and my son Ediz Yigit Ozcan.

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ABSTRACT

The goal of this dissertation was to contribute to our understanding of the relationship between supply chain structure and the pursuit of a sustainability-driven corporate strategy. The literature indicates that in order to pursue a sustainability-focused strategy, an increased level of integration across the supply chain is required. However, there are also industry-level dynamics that impact observed levels of vertical integration. That is, some industries are naturally more integrated than others based on the maturity level of the industry. Thus, some firms may experience opposing forces regarding their sourcing strategies once they choose to pursue a sustainability-focused strategy.

To explore this potential tension, it is first necessary to objectively measure vertical integration. Several methods for measuring vertical integration exist; however, all of these methods rely exclusively on economic data. These measures might overlook other forms of integration that might be enacted, such as the development of stronger social ties. Thus, this research will seek to utilize a novel method that makes use of social network analysis to assess integration among firms in a supply chain along social dimensions.

This dissertation 1) determined the correlation between having a vertically-integrated organizational structure and pursuing a sustainable supply chain strategy by identifying if sustainability-focused companies (SFCs) have a more vertically-integrated organizational structure than their counterparts that are not pursuing such strategies, 2) examined the evolution of supply chain structure as a company becomes more

environmentally, economically, and socially sustainable over time, and 3) defined the social ties between SFCs and their first- and second-tier suppliers to understand if they develop stronger social ties as a potential substitute for pure vertical integration.

This dissertation is comprised of four main parts. In the first part of the dissertation, I compared three recently developed vertical integration indices based on consistency and ease of measurement. The three vertical integration indices studied were empirically tested on companies in the U.S. Medical Devices Industry and the limitations of each are discussed. Our analysis suggested adoption of the Fan and Lang's method.

In the second part, I examined the vertical integration level of environmentally sustainable and non-sustainable companies. I empirically examined the vertical integration level of 144 sustainability-focused companies in 9 different industries. The results demonstrate that sustainability-focused companies in the Medical Devices Industry and the Industrials Industry tend to have more vertically integrated organizational structures than their industry competitors that are not pursuing such a strategy since these two industries are production oriented and they have closer relationships with their suppliers.

In the third part, the objective was to understand how the organizational structure of sustainability-focused companies changes over time as the companies become more environmentally, economically, and socially sustainable. I applied trend analysis to the sustainability and vertical integration level of the companies. Our sample consisted of 10 sustainability-focused companies from the industrials industry. I used the content analysis of annual reports to calculate sustainability development scores, and applied the Fan and Lang's method to determine the vertical integration level of the companies. The study results demonstrated an increasing trend in both vertical integration and

sustainability development of industrial industry companies over a 15-year of period. Furthermore, the companies became more vertically integrated as their environmental, economical, and social sustainability increased.

Finally, in the fourth part, I developed and empirically tested a theoretical model that examines the supplier relationships of sustainability-focused companies (SFCs) to understand if these relationships are substitute to a vertically integrated organizational structure. Furthermore, I tested if SFCs are more socially connected to their suppliers compared to non-sustainable companies (non-SFCs). An online survey instrument was utilized for data collection. The empirical findings of path analysis demonstrated that SFCs establish long term relationships, collaborate, transfer know-how and experience, and create strong-ties with their first and second-tier suppliers to have an organizational structure that is substitute to a pure vertical integration. Findings further revealed that SFCs are connected to their first and second tier suppliers with stronger social ties compared to non-SFCs. Results support the natural transaction cost economics and natural resource based perspectives. Our study results should be useful to researchers and managers who are interested in corporate sustainability behavior.

CHAPTER 1:

INTRODUCTION

1.1. The Problem

Examining the relationship between organizational structure and corporate strategy is drawing renewed interest among organization, finance, and management researchers as well as practitioners (Hutzschenreuter and Gröne, 2009). Historic academic literature points to this relationship in classic research that demonstrates the relative presence of bureaucratic versus organic organizational structures in stable versus dynamic product environments (Adelman, 1955). A more contemporary issue involving the relationship between organizational structure and corporate strategy involves the social trend toward sustainability.

The literature indicates that an increased level of integration across the supply chain is necessary in order to pursue a sustainability-focused strategy (Hart, 1995, Russo and Fouts, 1997). However, under some industry (Fine and Whitney, 1996), product (Christensen, 1994), and market conditions (Arya et al., 2008), having a vertically-integrated organizational structure is not feasible. Thus, there appears to be the potential for theoretical tension within some companies that set out to pursue a sustainability-focused strategy. That is, while firm capabilities, firm culture, and industry dynamics may make outsourcing the preferred solution, there is an added pressure to vertically integrate simply as a result of the pursuit of a sustainability-focused strategy.

A firm is classified as vertically integrated if one of its subsidiaries can, rather than outsourcing, use another of its subsidiary's products or services as input for its own production (Fan and Lang, 2000). There have been previous attempts to develop vertical integration indices to measure organizational structure. Since these various models provide contradictory results, none of the introduced models is an entirely accepted measurement index. Moreover, all of these models rely exclusively on economic data and, thus, might overlook other forms of integration that might be enacted such as the development of stronger social ties. Thus, there is a need to develop a more widely accepted index.

Additionally, there has been criticism about institutional theory's failure to adequately address the concept of change (Brint and Karabel, 1991, DiMaggio, 1988). An organization's supply chain structure must evolve in conjunction with its corporate strategy as it becomes more socially and environmentally aware. Although it is very crucial, the impact of sustainability-focused strategy on the sourcing decision has not been addressed satisfactorily in the literature.

1.2. Proposed Solution

Vertical integration measurement index analysis and development is the first solution. Traditionally, the appropriateness of an index is defined by two characteristics. First, the index should be accurate. Second, the index should be applicable and make use of easily accessible data sets. One of the aims of this research is to investigate the accuracy and ease of use of recently developed indices and to explore the development of a new index that incorporates the measurement of social ties.

Understanding the impact of a sustainability-focused strategy on firm vertical integration level is another solution in my dissertation. This research examined the relationship

between the pursuit of a sustainability-focused corporate strategy and the level of vertical integration observed in organizations. This part of the research made two contributions. First, it developed the theoretical foundation for linking sustainability strategies to organizational structure. Second, it empirically examined the vertical integration level of sustainability-focused companies (SFCs) in different industries to understand if SFCs are more vertically integrated than their non-sustainable competitors.

Examining the "evolution of supply chain structure as firms become more socially and environmentally aware" is another solution in my dissertation. This study builds a framework for understanding how organizational structure and corporate environmental strategies coevolve. Through a longitudinal analysis, I empirically measured changes in the organizational structure of a firm in correlation with the evolution of its corporate environmental strategy.

Determining the relationship between of SFCs and their suppliers under vertical integration constraints is the final solution in my dissertation. Companies may prefer to be vertically integrated due to the availability of strategic resources (Barney, 1991) or high transactions costs (Williamson, 1985) of negotiating and safeguarding their contracts. When vertical integration is not reasonable, ensuring the trust (Dyer and Chu, 2003) and collaboration (Carson et al., 2003), guaranteeing supplies by establishing long-term relationships (Paulraj and Chen, 2007), improving coordination of activities (Vachon and Klassen, 2008), and manufacturing irreplicable products by transferring tacit knowledge (Lee, 2001) are necessary to preserve the effect of integration. Defining the relationship between SFCs and their first- and second-tier suppliers, to understand if they have an organizational structure that is a substitute to vertically integrated organizational structure, is necessary to develop effective environmental management strategies.

CHAPTER 2:

COMPARISON OF VERTICAL INTEGRATION INDICES FOR ACCURATE AND EASY MEASUREMENT

2.1. Abstract

Research regarding vertical integration is difficult due to the existence of several competing methods of measurement. This paper compares three recently developed vertical integration indices based on consistency and ease of measurement. The three vertical integration indices studied were empirically tested on companies in the U.S. Medical Devices Industry and the limitations of each are discussed. Our analysis suggests adoption of the Fan and Lang's method. These results should be useful to researchers and managers who are interested in vertical integration decisions.

Keywords: Vertical Integration Measurement, Input-output, Relatedness, Medical Devices Industry

2.2. Introduction

Measurement of vertical integration is drawing increasing interest among organization, finance, and management researchers as well as practitioners. Such measurement tools are of use to managers because they can be used to assess a firm's diversification level and aid in the development of appropriate competitive strategies. Such measurement tools are of use to academic researchers because they can be used in empirical studies. In the literature there are mainly two types of vertical integration measurement indices: those that are calculated by using an economic ratio, such as value-added-over-sales

ratio or work in process ratio; and those that are calculated by using input-output tables. Traditionally, the appropriateness of an index is defined by two characteristics. First, the index should be accurate. Second, the index should be applicable and make use of easily accessible data sets. The aim of this paper is to investigate the accuracy and ease of use of three recently developed indices.

There have been previous attempts to develop vertical integration indices, but all have been criticized as inadequate. For example, value-added-over-sales ratio were developed by Adelman (1955) and used by Gort (1962), Nelson (1963), Laffer (1969), and Tucker and Wilder (1977) with small variations. Maddigan (1981) demonstrates that, although Adelman's method is easy to calculate, it is affected by other economic factors that are not of interest. In another effort, Maddigan (1981) developed the vertical integration connection index and used input-output tables in her calculations. She surveyed the vertical integration trends of US firms. A third methodology, the work-in-process ratio (ratio of inventory to sales) method, was originally created by Adelman (1955) and assumes that "the longer the production line and the more successive processes are operated by one firm, the higher the ratio." Lindstrom and Rozell (1993) discussed and compared these three methods. After applying each of the methods to the same set of firms within a common industry no consistency was found among the methods; all of the measures suggested different levels of vertical integration for the same set of firms (Lindstrom and Rozell, 1993).

In response to these criticisms, Davies and Morris (1995) and Fan and Lang (2000) further discuss the problems with these previous methods and generate their own indices. Davies and Morris (1995) used the market shares of companies and Fan and Lang (2000) used the sales of firms in different industries. Both of them used input–output tables in their calculations. Davies and Morris (1995) analyzed the vertical

integration level of 79 UK industries and their leading firms. Fan and Lang (2000) developed their indices following the work of Lemelin (1982) and surveyed the vertical integration level of the firms between 1979 and 1997. Recently, researchers applied these two methods in their empirical studies and explored the results and impacts of vertical integration. In addition, Hortacsu and Syverson (2007) introduced a new method that uses input-output tables and examines the economic exchanges between industries in which the firms operate.

In this dissertation, I will apply these three new methods to the medical device industry. Because industry type is one of the factors that affect the vertical integration level, I have focused on a single industry to avoid potentially misleading results. I selected companies that are specifically focused to avoid the problems associated with measuring firms that are operating in vastly different industries in accordance with the methodology of (Lindstrom and Rozell, 1993). I will explore the correlation between these most recently developed vertical integration measurement indices and discuss the advantages and disadvantages of their application in terms of ease of use and accessibility of the required data sets. The result of this study will assess the validity of the existing measures and contribute to the identification of a common vertical integration measurement index to be used by both researchers and practitioners.

The remainder of this paper proceeds as follows. Section 2 briefly surveys inconsistencies and problems in traditional measures. Section 3 surveys the recently developed measures and their implementations in the literature. Section 4 describes the data and sample used for the study. Section 5 explains the step by step applications of the three vertical integration measures to our sample. Section 6 presents the results of analysis. Section 7 discusses the results with a focus on the advantages and

disadvantages of the methods and databases. Finally, section 8 provides concluding thoughts.

2.3. Survey of the Literature on Traditional Vertical Integration Measures

2.3.1. Implementation of Traditional Measures and Decision Making

One of the most important decisions for managers is determining the strategy regarding the diversification level of the organization. The market conditions, company policies, changes in product and process structures, market conditions, and other economic factors influence this decision. The definitions in Table 1 exhibit the role of vertical integration on decision making and strategy determination of companies. Numerous researchers searched the impact of vertical integration on several characteristics of organizations and industries. As illustrated in Table 2, researchers got varying results because of using different types of measurement indices. Maddigan and Zaima (1985) and Lindstrom and Rozell (1993) proved the inconsistencies among these measures. For example, both Buzzell (1983) and Maddigan and Zaima (1985) explored if there is any impact of vertical integration on profitability. Buzzell (1983) used Adelman's value-added-over-sales (VA/S) ratio and observed a positive correlation; however, Maddigan and Zaima (1985) observed no impact with Maddigan's vertical industry connection (VIC) index. This inconsistency is a problem and indicates a need for an accepted measure of VI for researchers going forward.

Table 1. Definitions of Vertical Integration

Author(s), Year	Definitions of Vertical Integration
Porter (1980)	“the combination of technologically distinct production, distribution, selling and/or other economic processes within the confines of a single firm. As such, it represents a decision by the firm to utilize internal or administrative transactions rather than market transaction to accomplish its economic purposes.”
Maddigan (1981)	“describes the firm’s strategy of exercising ownership control in the production of products that are used as inputs to each other.”
Buzzell (1983)	“the combination of two or more stages of production or distribution (or both) under a single ownership.”
Riordan (1990)	“the organization of two successive production processes by a single firm.”
Chatterjee, Lubatkin, and Schoenecker (1992)	“puts more of one's eggs in the same basket, it makes the basket stronger, i.e., more able to deal with the economic and competitive forces that threaten it.”
Davies and Morris (1995)	“the decision by the individual firm on whether to organize exchanges internally (within the firm) or externally (in the marketplace)”
Reed, Lajoux, and Marsalese (1995)	“occurs when a company buys a supplier (vertical backward integration) or customer (vertical forward integration) to achieve economies in purchasing or sales/distribution”
Fan and Lang (2000)	“Two businesses are vertically related if one can employ the other's products or services as input for its own production or supply output as the other's input.”

Table 2. Area of Study and Results with Different Measures

Research Question	Author(s), Year	Methods	Major findings
Trends in VI over a time period	(Adelman, 1955); (Laffer, 1969); (Nelson, 1963); (Tucker and Wilder, 1977); (Hutzschenreuter and Gröne, 2009)	Adelman's Value-added-over-sales ratio (VA/S) and adjusted versions	VI level remained about the same or indicated little variation over the decades
	(Maddigan, 1981)	Maddigan's VIC;	An upward trend in the vertical integration index
	(Fan and Lang, 2000)	Fan and Lang	
Profitability	(Maddigan and Zaima, 1985)	Maddigan's VIC and VA/S	Depends on which VI measure used; positive relation with VA/S and negative relation with VIC
	(Levin, 1981)	Self sufficient ratio	No impact on profitability
	(Bhuyan, 2002)	Davies and Morris	Negative impact on profitability
	(Buzzell, 1983); (Bamiro et al., 2009)	VA/S	Vertical integration is profitable
Performance	(Fernández-Olmos, 2010)	Fan and Lang	No impact of vertical integration on firm's performance
	(Claessens et al., 2003)	Fan and Lang;	Effects vary according to types of businesses and the levels of economic development of countries
	(Buzzell, 1983)	(VA/S)	
	(D'Aveni and Ravenscraft, 1994);	Herfindahl index first used by (Berry, 1974);	Positive correlation: the more vertically integrated the better at administrative, selling, advertising, R&D expenditures, and profitability.
	(Palepu, 1985)	Jacquemin-Bermy entropy measure	

Table 2. (Continued)

Market Competition	(Aghion et al., 2006)	Fan and Lang	U-shaped relationship: a moderate competition reduces but too much competition increases the producer's incentive to integrate
	(Porter, 1980); (Harrigan, 1983); (Matsubayashi, 2007)	Harrigan	Positively affects both backward and forward integration
	(Fronmueller and Reed, 1996)	Harrigan	Strongly supports the connection of market competition with forward integration but do not support with backward vertical integration

2.3.2. Problems with Traditional Methods

Adelman (1955) created the first vertical integration measurement method which is considered a seminal work and one of the most widely used measures in the vertical integration literature. After Adelman, several researchers followed him by developing new methods through discussing pros and cons of previous methods. None of these methods were accepted as a general method because of the problems in their applications. In this section, I will discuss these traditional methods and their limitations.

Adelman (1955), Gort (1962), Nelson (1963), Laffer (1969), and Tucker and Wilder (1977) used value-added-over-sales ratio (VA/S) with some variations. Although this method uses readily available data and is easy to calculate, it has significant problems. For example, other economic factors such as taxation or profitability affect the VA/S (Lindstrom and Rozell, 1993). Tucker and Wilder (1977) developed an adjusted VA/S method to decrease the effect of these economic factors. Davies and Morris (1995)

explain two additional important limitations of VA/S ratio. First, VA/S is sensitive for a firm's position, being at the end or beginning of the supply chain. The value of the index becomes lower as the stage of the firm posits near to the end of the supply chain. Second, there is ambiguity about whether the type of integration described is intra- or inter-industry. Researchers also criticize the employment or sales ratio used by Gort (1962) and Rumelt (1984) because of difficulties with data collection and usage procedures. Therefore, most of the researchers do not evaluate the VA/S and its variations as reliable methods to determine the level of vertical integration.

Maddigan (1981) developed the vertical industry connection (VIC) index that utilizes I-O tables. If a firm's one industry is a supplier to another then the index yields a higher value. The advantage of this method is that one can access the necessary data easily. However, Davies and Morris (1995) criticize this method because it ignores firm size. The index gives the same results for firms that operate in the same subset of industries regardless of their output across those industries. Moreover, Maddigan's VIC was developed for the firm level and cannot be applied at the industry level.

Hutzschenreuter and Gröne (2009) assessed the influence of foreign competition on vertical integration strategies of US and German companies. They used VA/S approach of Adelman (1955), adjusted VA/S ratios developed by Buzzell (1983) and Tucker and Wilder (1977), and Fan and Lang (2000) methods in their analyses. They compared these methods and concluded that input-output based Fan and Lang's method is more advantageous than the VA/S based methods because, beside the disadvantages of VA/S, input-output based methods clearly determine vertical integration level in multi-business firms.

Adelman (1955), Laffer (1969), Nelson (1963), and Tucker and Wilder (1977) found that the vertical integration level of companies remained about the same or indicated little variation over the decades. On the other hand, Maddigan (1981) concluded an upward trend in the index which is contrary to results of VA/S and its variations. Lindstrom and Rozell (1993) explained the contradiction between VA/S and VIC by demonstrating a weak correlation between the two methods. There is not a widely accepted VI measurement index in the literature because such inconsistent results were obtained.

Researchers summarize the features of economic-based measures as follows: A widely accepted measure should

- be based on the theoretical concept of vertical integration
- be completed without demanding technical knowledge or additional information about the business in consideration
- use easily accessible and reliable data sources
- be applicable to large data sets
- be computed automatically with using formulations or computer codes
- be valid at both the industry and firm levels.

2.4. Survey of the Literature on Recently Developed Vertical Integration Measures

Recent developments have occurred to address this need for a new vertical integration measure. In this section, three of the more recently developed measures were discussed.

2.4.1. Davies and Morris's Method

Davies and Morris (1995) generated a vertical integration index that uses intra-industry flows and market shares of companies across industries that the firm operates. They took both intra-firm and inter-industry flows into consideration and analyzed the 79 manufacturing industries and their leading firms in the UK. The aim of their paper was to suggest a method that is simple to use and to avoid the need for specialist technical knowledge or subjective assessment. They define the ultimate aim as using this method to report and analyze the causes and effects of vertical integration. Explicit example will be presented in Section 5.

Using national I–O tables and profitability indicator data sets, Bhuyan (2002) constructs a forward vertical integration index, which is based on Davies and Morris (1995), to understand the impact of vertical mergers on profitability for a sample of U.S. food manufacturing industries. He found that vertical mergers negatively impact profitability of food manufacturing industries.

2.4.2. Fan and Lang's Method

Fan and Lang (2000) build their method on the work of Lemelin (1982) who used input-output tables for measuring industry relatedness to consider patterns of diversification. Fan and Lang (2000) extended this study to construct alternative measures of relatedness. Fan and Lang's (2000) method provides us detailed information on vertical integration calculation at both the industry and firm levels. They state that two industries are vertically related if one industry uses the other's output as its input. Fan and Lang (2000) developed vertical relatedness and complementarity variables as inter-industry and intersegment measures based on I-O tables. At the industry level, they show that the proposed input-output-based vertical relatedness and complementarity measures provide better description of firms' relatedness than previously generated SIC-based

measures[1]. Fan and Lang (2000) examine the relatedness patterns of U.S. firms between 1979 and 1997 and report an increasing trend at the vertical integration level of firms over time.[2]

Early studies of Fan and Lang's method include Claessens et al. (2001), who employed Fan and Lang's (2000) vertical relatedness and complementarity variable measures to a sample of over 10,000 firms in nine East Asian economies to examine the patterns of vertical relatedness and complementarity of diversified firms' business segments[3]. This study sheds light on the differences and changes in the diversification of the eight East Asian countries, Japan, and the United States besides examining the influence of diversification types on corporate value. Additionally, in Claessens et al. (2003), they examine the impact of corporate diversification on productivity and performance. Schildt et al. (2005) used Fan and Lang's (2000) method to examine the effect of downstream vertical integration on explorative versus exploitative learning outcomes from external corporate ventures. Rondi and Vannoni (2005) used forward and backward integration measures and Italian I-O tables to test the effects of competitive pressure on product diversification and refocus on core business strategies of 108 diversified European Union (EU) manufacturing leaders that faced the EU integration shock.

Recent studies using the method include Fan and Goyal (2006), who measure vertical relations in a large sample of mergers between 1962 and 1996. Also, Fukui and

[1] The use of SIC based measures has been widely criticized by Nayyar (1992), Farjoun (1994), Robins & Wiersema (1995), Silverman (1999), Fan and Lang (2000)

[2] The data set of Fan and Lang (2000) is available from Prof. Joseph P.H. Fan's personal website: http://ihome.cuhk.edu.hk/~b109671/relatedness.htm. Various researchers used Fan and Lang's IO-SIC conversion tables in their analyses (e.g. see Kale and Shahrur (2007); Raman and Shahrur (2008))

[3] A segment is defined by the Financial Accounting Standards Board (FASB) Statement No. 14 as: "a component of an enterprise engaged in providing a product or service or a group of related products and services primarily to unaffiliated customers (i.e. customers outside the enterprise) for a profit."

Ushijima (2007) investigate the industry diversification of the largest Japanese manufacturers. Acemoglu et al. (2009) explored the main effects of financial development and contracting costs on the vertical integration level across 750,000 firms in 93 countries. Hendricks et al. (2009) examine whether business diversification and vertical relatedness influence the stock market reaction to supply chain disruptions. Hutzschenreuter and Guenther (2008) analyzed the expansion steps of firms and the way of reaching their level of diversity. Hutzschenreuter and Guenther (2009) examine the factors that have impacts on a firm's rate of expansion and the major sources of complexity that are associated with managing and expanding assets. Hutzschenreuter and Gröne (2009) assessed the influence of foreign competition on vertical integration strategies of U.S. and German companies. They used the value-added-to-sales approach of Adelman (1955), adjusted value-added-to-sales ratios developed by Buzzell (1983) and Tucker and Wilder (1977), and Fan and Lang (2000) methods in their analyses. They compared these methods and concluded that, besides being more advantageous than VA/S, input-output based methods have some shortcomings. For example, input-output based methods assume that national I-O tables are applicable to individual firms and I-O based methods cannot calculate vertical integration level for single-business firms.

2.4.3. Hortacsu and Syverson's Method

Hortacsu and Syverson (2007) proposed a method for measuring vertical integration which is based on intra-industry flows. The method uses establishment-level data (owning-firm indicators) from the U.S. Economic Census, shipments data from the Commodity Flow Survey, and intra-industry-flows data from I-O tables to investigate the reasons for vertical ownership. Hortacsu and Syverson (2007) used a data set of cement and ready-mixed concrete plants to empirically investigate the possible market power effects of vertical integration. They concluded that the productivity of plants does not only depend on the vertical integration structure of the companies but also the size of the operations. Using two unique data sets, Hortacsu and Syverson (2007) document the production differences between vertically integrated and non-vertically integrated firms in the U.S. manufacturing industries from 1977 to 1997. They found that vertical integration was stable during 1977-1997 and declined somewhat after 1987. Furthermore, they found a positive correlation between vertical integration and productivity, size, and capital intensity. Hortacsu and Syverson (2009) investigated if vertical integration is related to unusually high growth in productivity, scale, or factor intensities and found that shipments from firms' upstream units to their downstream units are surprisingly low.

2.5. Data and Sample

2.5.1. Data

All the three methods I evaluate in this paper utilize I-O tables to calculate vertical integration indices. The Bureau of Economic Analysis (BEA), which is an agency of the Department of Commerce, publishes the benchmark I-O tables every five years. BEA estimates industry and commodity outputs for the I-O make and use tables. The input-output tables report the dollar value of each input used to produce the output of more than 400 different industries in the U.S. economy. Make-use tables provide a comprehensive picture of economy and show the relationships between industries and commodities. Many economists, analysts, and policymakers use I-O tables in their analyses. These tables mimic the 6 digit NAICS (North American Industry Classification System) codes; however, there are aggregations of some NAICS codes. This research will use 2002 I-O tables which are the latest available data set, because data for 2007 was not publicly available at the time this paper was written. Stewart, Stone, and Streitwieser (2007) discusses the preparation of the 2002 I-O tables. They explain the utilization and the concepts of make-use tables and illustrate the methods underlying the I-O tables in detail.

I used the Corporate Affiliations database, which is compiled by the LexisNexis Business Data Group, to find subsidiaries of the firms in our sample. Corporate Affiliations is a source that provides insight on nearly 210,000 parent and subsidiary businesses worldwide. This database provides the names of the subsidiaries and their related industry SIC (Standard Industrial Classification) codes. I then transform these SIC codes to NAICS codes to utilize from I-O tables.

Wards Business Directory of U.S. Private and Public Companies database was used for firms' market share in industries that is needed in the Davies and Morris's method.

Companies are ranked by sales within 6-Digit NAICS codes. The market share of the company will be calculated by dividing company sales to total industry sales. If a company's subsidiary is not ranked in this directory, we can assume that it is small enough (close to zero) to be negligible.

Standard & Poor's Compustat Industry Segment database provides financial, statistical, and marketing information of companies that represent at least 10 percent of a firm's sales, assets, or profits. Disclosure of data in this database is required by the Securities and Exchange Commission of the United States Government. This database is used extensively by the researchers who apply Fan and Lang's method. Compustat database compiles the industry information from firms' annual reports and 10-K reports that are reported to the Securities and Exchange Commission. In addition to a firm's financial data, Compustat assigns a 4 digit SIC code and a 6 digit NAICS code according to the industry in which that segment operates.

Beginning from December 15, 1977, public firms are required to disclose the industry segment information if the segment's account is more than 10% of their total sales, profits, or assets, because of the Financial Accounting Standards Board's (FASB) statement number 14. For some companies, this may cause a problem of disclosing segment-level information for over 10 segments (i.e. a limitation of Compustat stated in (Villalonga, 2004)). In our study, the maximum number of segments is 6; therefore, this problem does not affect our study. I utilized the Hoover and Mergent Online databases to determine our sample. I constructed our sample with the industry leaders. The Hoover and Mergent Online databases report the industry leaders for each NAICS code. Additionally, Hoover database provide product, operation, and industry information of companies which is familiar to Compustat's information. Therefore, missing information

in Compustat was completed with the Hoover database. Table 3 summarizes the utilization of databases by each vertical integration index.

Table 3. Summary of Database Utilization

	Davies and Morris	Fan and Lang	Hortacsu and Syverson
BEA Input-Output Tables	✓	✓	✓
Corporate Affiliations	✓		✓
Wards Business Directory of U.S. Private and Public Companies	✓		
Standard & Poor's Compustat Industry Segment		✓	
Hoover		✓	✓
Mergent Online			✓

2.5.2. Sample

In this study, I have examined 20 different industries that can be categorized under medical industry. NAICS codes[4] used in this study that correspond to medical industries were gathered by University of South Florida's Center for Economic Development Research report, "Medical Product Industries Cluster in Tampa Bay" which was developed in October, 2002. Medical industry was randomly selected but I focused on only one industry because the industry type may affect the comparison of measurement results (Fine and Whitney, 1996). Generally, the NAICS code of segments falls within one of the major medical categories; medical device manufacturing starts with 33911

[4] Bhojraj (2003) discusses the historical development, intent, and basic philosophy behind the SIC and NAICS codes.

and 33451 and pharmaceuticals starts with 32541. The other selected NAICS codes belong to industries that supply inputs to these industries.[5]

From Mergent Online and Hoover databases I obtained the names of 5 industry leader U.S. companies for each NAICS code and with the overlaps we had 65 industry leader companies in total as a sample. I especially selected the industry-leader companies to make sure that they are not operating in very broad and different environments. However, missing information prevents applying all three methods; therefore, only 29 of them were used in our analysis. This problem was also experienced in Lindstrom and Rozell (1993). I need the segment names and sales of all companies to calculate the vertical integration level with each method.

GE Healthcare and Siemens Medical Solutions are the industry leaders of 334517 NAICS but these are not in our sample because GE and Siemens are very big families and their other companies may provide inputs to these two firms. The next section explains step-by-step how to apply all three methods to calculate vertical integration level of companies. I used the same notation with the original papers to avoid confusing readers.

[5] The description and detailed information about NAICS codes are available at http://www.census.gov/epcd/www/naics.html and http://www.census.gov/epcd/naics/naicscod.txt.

2.6. Application of the Methods

This section illustrates the implementation of three methods step by step using an example firm.

2.6.1. Measuring Vertical Integration with the Davies and Morris's Method

Davies and Morris (1995) define the integration of firm k which exists in R industries as "the proportion of its aggregate sales accounted for by flows between its plants across industries":

$$VI^k = \sum_{i=1}^{R} \sum_{i \neq k}^{R} X_{ij}^k \, / \, X^k \tag{1}$$

where X^k_{ij} is the flow of output within firm k from its plants in industry i to its plants in industry j, and X^k is the total sales of firm k. However, X^k_{ij} is very hard to reach, publicly unavailable, or even nonexistent. After their assumptions of "fixed technical and sales destination coefficients" and "internal transactions are preferred to using the market", the formula turns into:

$$VI^k = \sum_{i=1}^{R} \sum_{i \neq j}^{R} X_{ij} m_{ij}^k \, / \, X^k \tag{2}$$

where $m_{ij}^k = \min(s_i^k, s_j^k)$ and $s_i^k = X_i^k \, / \, X_i$ is firm k's market share in industry i.

As an example of how integration status is determined, consider Dresser Inc. which is one of the medical device producer firms in our sample. As we can find from Corporate Affiliations and Ward's Business Directory databases, Dresser Inc. has subsidiaries in 332910, 333618, 333913, and 335312 I-O industries. To calculate VI level:

- divide the company sales in these industries to the total sales of these industries to find the market shares (s_i^k and s_j^k) and m^k_{ij}.
- multiply industry i to industry j sales (X_{ij}) with m^k_{ij}, and
- divide this value to firm's total sale and we can find vertical integration of firm as 0.0094.

The mean value of 306 firms that were examined by Davies and Morris is 1.38 and the mean value of our sample is 0.01485. Therefore, we can say Dresser Inc. is a less vertically integrated firm when we compare it to our and Davies and Morris's sample.

2.6.2. Measuring Vertical Integration with the Fan and Lang's Method

The benchmark input-output tables[6] report the dollar value of industry i's output used to produce the output of industry j and this is denoted by Fan and Lang as a_{ij}. We divide a_{ij} to the industry j's total output to get v_{ij}, interpreted as "the dollar value of industry i's output required to produce 1 dollar's worth of industry j's output". In an opposite manner, we find the values of a_{ji} and v_{ji}. Moreover, we find the V_{ij} (relatedness coefficient) which is the average of v_{ij} and v_{ji} and represents "the proxy for the opportunity for vertical integration between industries i and j" ((Fan and Lang, 2000), p. 633).

The vertical integration level is defined as:

$$V = \sum_j (w_j V_{ij}) \tag{3}$$

where w_j is the ratio of j th secondary segment sales to the total sales of all secondary segments (sales weight of secondary industries). This formulation tells how and to what degree the primary and secondary firm segments are related.

[6] The complete sets of Bureau of Economic Analysis Benchmark Input-Output 2002 tables are accessible from: http://www.bea.gov/industry/io_benchmark.htm#2002data

Table 4 illustrates the data and calculation for Dresser Inc. which has subsidiaries at flow control, measurements systems, and compression and power systems. Primary segment of this company is Flow Control because of the highest amount of sale in this industry. For Measurement Systems segment:

- NAICS code is 333912,
- sale of Dresser Inc. in this segment is 310.9M$,
- total sale of Measurement Systems segment is 5745.7M$,
- the output of "Flow Control" industry required to produce the output of "Measurement Systems" industry, a_{ij} is 170.5 M$
- the output of industry "Measurement Systems" required to produce the output of "Flow Control" industry, a_{ji} is 131.3 M$
- v_{ij}, v_{ji}, and their averages V_{ij} are 0.03, 0.006, and 0.018047 respectively, and
- finally, 0.0118 is the vertical integration level V which is obtained by the multiplication of V_{ij} value of secondary industry with its corresponding sale weight, w_j

Table 4. Measuring Vertical Integration Level with Fan and Lang's Method

Company	Segment Name	NAICS	Sale in NAICS	W_j	Total Sales of NAICS	a_{ij}	a_{ji}	v_{ij}	v_{ji}	V_{ij}	V
Dresser Inc	Flow Control	332911	1005.1		20452.6						0.0118
	Measurements Systems	333912	310.9	0.529	5745.7	170.5	131.3	0.030	0.006	0.0181	
	Compression and Power Systems	333618	277.1	0.471	21702.2	206.6	0.000	0.010	0.000	0.0048	

2.6.3. Measuring Vertical Integration with the Hortacsu and Syverson's Method

As a first step, we use the Corporate Affiliations database to determine firms' NAICS codes (i.e. industries) for each establishment. Hortacsu and Syverson define establishments as "unique locations where economic activity takes place, like stores in the retail sector, warehouses in wholesale, offices in business services, and factories in manufacturing". An establishment may belong to more than one industry (NAICS code) but, Hortacsu and Syverson use just the primary NAICS of the establishments.

The next step is to determine the establishments that are connected by a "substantial link." Hortacsu and Syverson state that "a substantial link exists between one industry and another based on the relative volume of trade flows between those two industries." A substantial link exists between industry i and industry j if i buys at least five percent of its intermediate materials from j or j sells at least five percent of its own output to i. BEA's benchmark input-output tables are used to determine substantial links between industry pairs.

At the final step, all establishments the firm owns that are connected with substantial links are classified as vertically integrated. As an example, according to Corporate Affiliations database, Dresser Inc. has subsidiaries in 15 different industries. After calculating X_{ij} values from I-O tables, we identify a substantial link between 333618, 332991, 335312, and 811300 (Figure 1). I have ranked the vertical integration level of all companies according to the number of substantial links over the number of possible links ratio. This is true because the vertical integration increases as the number of links increases. This ratio gives us the result of the Hortacsu and Syverson's VI method as 0.0238.

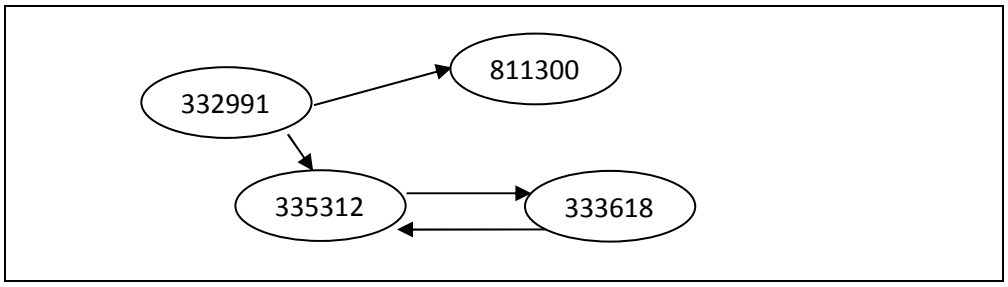

Figure 1. Depiction of Substantial Links Between Subsidiaries of Dresser Inc.

2.7. Results

Table 5 demonstrates the correlation matrix that was used to determine the congruence between the three VI measurements. Because there is not an absolutely accepted VI measurement method in the literature, we cannot determine the "most accurate" method among these new measures. Instead, we determine the ones that give similar results.

The correlation between the Fan and Lang's and Davies and Morris's methods is 0.76771 which reflects a strong correlation. However, the correlation between Hortacsu and Syverson's mode and other models is pretty low, even a negative value. This negative correlation demonstrates that at least one of the methods is not measuring properly.

We gave a ranking to each company and put the companies in an order according to their vertical integration level. These rankings were examined for each method and the correlation of these rankings was demonstrated in Table 6. The order of these companies with the Fan and Lang's and Davies and Morris's methods has the correlation coefficient of 0.67242. This is higher than the correlation between Hortacsu and Syverson and other methods. As displayed in Figure 2, the Fan and Lang's and Davies and Morris's methods rate the companies in the similar or close order.

Table 7 illustrates some descriptive statistics about the methods and compares these statistics with the example company. As depicted in the table, both results of the Fan and Lang's and Davies and Morris's methods for Dresser Inc. are below the average of measure and they are reflecting similar ranking (i.e. 14^{th} and 16^{th}, respectively, among the 29 companies studied) of vertical integration. On the other hand, the Hortacsu and Syverson's method provided results above the average and reflected a different ranking than the other two measures. Additionally, variability in the measures was tested and we found that the standard deviation in the Hortacsu and Syverson's method is higher than the other two measures. The other two methods have similar values of standard deviation.

Table 5. Correlation Matrix for Comparison of VI Measurement Results

	Fan and Lang	Davies and Morris	Hortacsu and Syverson
Fan and Lang	1		
Davies and Morris	0.76771	1	
Hortacsu and Syverson	-0.22816	-0.19658	1

Table 6. Correlation Matrix for Comparison of VI Measurement Rankings

	Fan and Lang	Davies and Morris	Hortacsu and Syverson
Fan and Lang	1		
Davies and Morris	0.67242	1	
Hortacsu and Syverson	-0.16453	-0.14532	1

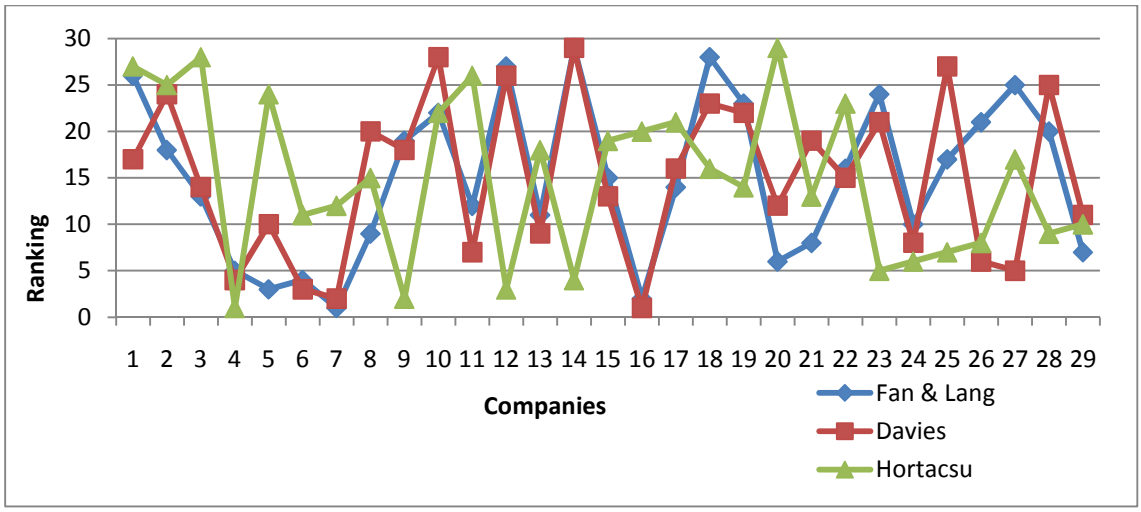

Figure 2. Rankings of Companies According to Three VI Measurement Methods

Table 7. Descriptive Statistics for VI Measures

	Average	Std Dev.	Dresser Inc.	Ranking of Dresser Inc.
Fan and Lang	0.01448	0.01256	0.0118	14
Davies and Morris	0.01485	0.01503	0.0094	16
Hortacsu and Syverson	0.02098	0.03191	0.0238	21

2.8. Discussion

In this paper, we wanted to examine the similarity of the vertical integration measurement methods. Since researchers gave contradictory results with their models, none of the introduced models are an entirely accepted measurement index. Our study exhibits a similar contradiction in recently developed indices as (Lindstrom and Rozell, 1993) and (Hutzschenreuter and Gröne, 2009) did for the traditional methods. This section discusses the limitations of the databases and the advantages and disadvantages of application of these methods.

The Compustat database is widely used by researchers who apply Fan and Lang's method in their analysis. However, the Compustat database is not always consistent with the other databases (e.g. Hoover or Mergent Online) or annual reports of the companies because the companies do not announce all the industries in which they operate. This limitation makes it impossible to calculate vertical integration for undeclared subsidiaries.

Another inadequacy of the I-O based VI measurement methods is excluding wholesale and retail trade industries. All I-O based methods exclude these industries because I-O tables do not define these industries appropriate enough for VI calculation. Several NAICS codes of wholesale, which starts with 4, are combined into inadequate amount of NAICS codes.

The Fan and Lang's method measures the relationship between the primary and the other segments of the company. The primary segment is defined as the segment which has the highest sales; the relationship between the primary segment and others is weighted according to the sales of other segments. (Acemoglu, Johnson and Mitton, 2009) modified Fan and Lang's method, used equal weights for each segment, and examined the relationship between all segments. Because of FASB Statement No. 14, firms declare limited number segments. Therefore, modification of (Acemoglu, Johnson and Mitton, 2009) may give more accurate results due to the consideration of all relationships.

As explained in the data section, the Compustat data is limited to 10 segments and this causes inaccurate vertical integration calculation for companies which are operating in more than 10 different segments.

Other concerns about the Compustat database are related to the definition of a "segment" itself. Because of the ambiguity in definition, some firms may disclose the segments as an aggregation of a couple of unrelated segments (Davis and Duhaime, 1992). Furthermore, they may change the segments and number of segments in their disclosed reports even if there is no change in their operations (Denis et al., 1997). This may cause incorrect allocation of industries to firms. The Compustat database compiles the segment information on public companies traded on NYSE, ASE, NASDAQ, and OTC. Therefore, we can say that Compustat limits the sample to publicly traded companies. Additional concerns about the Compustat database can be found in (Davis and Duhaime, 1992), (Denis, Denis and Sarin, 1997), and (Villalonga, 2004).

While examining large data sets and using computer programs, researchers should be careful about using accumulated NAICS codes. Because I-O tables combine some of the NAICS codes under a main code, this main code should be used in the calculations. For example, 33329A should be used instead of the NAICS codes from 333291 through 333294.

Hortacsu and Syverson's method has another limitation besides the limitations in the databases. (Hortacsu and Syverson, 2007) define the establishments as the production places of the companies and use only one NAICS code for each establishment. However, the establishments may operate in more than one industry and Hortacsu and Syverson use only the one that has the highest sale value which may cause miscalculation.

Davies and Morris use market share data in their calculations. However, because of FASB Statement No. 14, companies may not report all necessary market information and this may cause miscalculation with this method. Additionally, (Fan and Lang, 2000)

criticizes this method because of using market share and states that additional market share data limits methods' application to large samples.

2.9. Conclusion

In order to test the impact of the vertical integration level on economic indicators such as business profitability, performance, market competitiveness, and trends in the industries, it is necessary to develop a reliable and easily measurable method. This type of method helps managers to determine the most accurate vertical integration strategy. Management may benefit from vertical integration strategies to increase the profit and decrease the risk in the market. For example, Acemoglu et al. [2009] proved that the firms in developing countries have more vertically integrated structure than firms in developed countries because vertical integration mitigates the contracting risks.

The aim of this paper is to compare the recently developed Davies and Morris's, Fan and Lang's, and Hortacsu and Syverson's indices. The results provide information that there is an inconsistency between the results Hortacsu and Syverson and the other two indices. For that reason, it is not known whether or not these indices accurately measure the vertical integration. (Buzzell, 1983) examined the impact of vertical integration on profitability with using VA/S and stated that vertically integration has a strong impact on the profitability of the companies. On the other hand, (Maddigan and Zaima, 1985) could not find a relation between VI and profitability with using VIC method. These inconsistencies among the measurements are no doubt the reason for the contradictory results and lack of a generally accepted VI measurement. The researchers may select one of these methods by utilizing the discussions about methods and databases. Our analysis suggests adoption of the Fan and Lang's method because of the easiness and accuracy in the application of this method.

Future studies should compare the recent methods with traditional methods and provide more detailed evidence for the causes of errors. Additionally, using these indices, simulation models can be created to assess the effect of vertical integration on economic, social or environmental performances of vertical mergers.

CHAPTER 3:

THE FIRM BOUNDARY DECISION FOR SUSTAINABILITY-FOCUSED COMPANIES

3.1. Abstract

This paper examines the vertical integration level of environmentally sustainable and non-sustainable companies. In the first part, we developed the theoretical foundation for linking sustainability strategies to organizational structure. In the second part, we empirically examined the vertical integration level of 144 sustainability-focused companies in 9 different industries. The results demonstrate that sustainability-focused companies in the Health Care Industry and the Industrials Industry tend to have more vertically integrated organizational structures than their industry competitors that are not pursuing such a strategy since these two industries are production oriented and they have more close relationships with their suppliers. There was no significant difference in the vertical integration level of sustainability-focused versus non-sustainability-focused companies for the other seven industries studied. In the literature, the linkage between environmental strategies and vertical integration has not been thoroughly examined. Our study results should be useful to researchers and managers who are interested in corporate sustainability behavior.

Keywords: Sustainable supply chain, vertical integration measurement, natural-resource-based view, transaction cost economics

3.2. Introduction

This study contributes to our understanding of the relationship between supply chain structure and the pursuit of sustainability-focused corporate strategies. A company's strategic plan provides guidance for the decisions it makes regarding its products, processes, and its supply chain. An example of a decision that is greatly influenced by company strategy is the make-buy decision. The make-buy decision is particularly critical for firms pursuing a sustainability-focused strategy because such companies require that every aspect of the supply chain have a similar focus (i.e. such firms view sustainability holistically). This requirement introduces an additional constraint that is unique to firms pursuing such a strategy. For example, while a sustainability-focused firm may want to outsource a particular product or service, if there are no sustainability-focused suppliers of the product or service they may opt to develop the capability internally. As a result, sustainability-focused companies may tend to be more vertically integrated relative to their non-sustainability-focused counterparts, particularly in the early stages of the sustainability movement life cycle when there are a limited number of suppliers committed to this strategy. In this paper, we examine this hypothesized trend toward vertical integration in make-buy decisions for sustainability-focused companies. Vertical integration may enhance performance, profitability, and market competitiveness because of better supply chain coordination. The literature indicates that an increased level of integration across the supply chain is necessary in order to pursue a sustainability-focused strategy (e.g. see Hart, 1995, Russo and Fouts, 1997). However, under some industry, product, and market conditions, having a vertically-integrated organization structure is not reasonable. These conditions will be discussed in later sections.

Thus, there appears to be a potential for tension for some companies that set out to pursue a sustainability-focused strategy. That is, while firm capabilities, firm culture, and industry dynamics may make outsourcing the preferred solution, there is dual pressure to vertically integrate simply as a result of the pursuit of a sustainability-focused strategy. This paper will explore this issue and determine if sustainability-focused companies tend to be more vertically integrated regardless of industry. As an empirical study, we will analyze the vertical integration level of 116 sustainability-focused companies in the United States Dow Jones Sustainability Index. Unlike previous studies that employed surveys, we use objective economic data and employ the measurement method of Fan and Lang (2000), which is a widely used and accepted index in recent literature. Fan and Lang use the sales of companies in primary and secondary industries and benchmark input-output (I-O) tables. We utilize the Compustat database to collect the sales information of companies. The Bureau of Economic Analysis (BEA) publishes the input-output tables every five years. We use the 2002 I-O table, which is the most recently published table at the six digit NAICS code level. Following Fan and Lang (2002), we also analyze the relationship between the integration level and their industry types to provide insight regarding the make-buy decision for sustainability-focused companies versus their counterparts pursuing other strategies.

The rest of the paper is organized as follows. Background section provides information on vertical integration, make-buy decisions, transaction cost economics, resource based view, and collaboration in sustainability-focused-organizational structures. The methodology of Fan and Lang (2000) section will provide some literature review for the measurement of vertical integration. We will document the sample and data sources; implement our vertical integration measure after methodology. Results section presents

the main analysis. Discussion section explains the results and, finally, last section concludes.

3.3. Background

Theoretical and empirical work dedicated to illuminating make-buy or firm-boundary decision, has taken a number of different approaches. Two important perspectives are transaction cost economics and the resource-based view. Both theories focus on different factors to explain make-buy decisions. In this section we will introduce the concepts of vertical integration, transaction cost economics, and the resource-based-view and their implementations on sustainability-focused strategies. Then we will explain how these concepts may be useful in thinking about environmental strategies; we will point out mainly the studies of Coase (1937), Williamson (1985), and Barney (1991).

3.3.1. Vertical Integration

Both vertical integration and its absence may cause significant problems for companies. Several researchers have investigated the efficiency and inadequacy of vertical integration compared with contractual relations since the 1970s. We propose the definition of vertical integration as follows: A firm is classified as vertically integrated if its segments are operating in two or more different industries and the output of one industry segment is used as input by succeeding industry segments. A segment is defined by the Financial Accounting Standards Board (FASB) Statement No. 14 as: “a component of an enterprise engaged in providing a product or service or a group of related products and services primarily to unaffiliated customers (i.e. customers outside the enterprise) for a profit.” As the input-output utilization relationship intensifies, the firm becomes more vertically integrated; in other words, the vertical integration level increases. At the ultimate vertical integration level, the companies perform nearly 100 percent of their

activities in their own facilities. We can define the segments as unique locations where the activities take place, such as factory, warehouse, distribution place, and stores.

3.3.2. Reasons for Vertical Integration or Diversification

The literature has noted five main reasons concerning sourcing decisions, in other words, why companies may prefer to purchase a product or service via the market. Firstly, the nature of the product may affect the vertical integration level since some products require a broad range of knowledge and capabilities to design and produce the sub-components.

Secondly, organizational culture may affect the vertical integration level. There is some evidence that competitive forces may change the organizational culture over a long period of time. Two examples of evidence can be given from the computer industry. As a first example, Fine and Whitney (1996) discuss the integration level differences between Japanese and American companies due to the differences in their organization cultures. At the second example, Christensen (1994) finds that disintegration will occur with component and design standardization in the disk drive industry. The integration level of an industry may change as a result of the affects of technology on the degree of modularity in design. The reduction in unit cost as the size of a facility or scale increases is another driving force of vertical integration of industries.

Thirdly, several theoretical studies have shown that macroeconomic factors affect make-buy decisions of companies. Advanced economies have a variety of intermediating institutions in place to address imperfections in the product, labor, and capital markets such as information asymmetries, imperfect contract enforcement, and the inability to enforce property rights. Because these problems are very costly, firms are expected to

be more vertically integrated in less developed countries (Khanna and Palepu, 1997). Moreover, the instability of certain industries may affect the diversification of companies.

In addition to these first three reasons, the make-buy decisions are also determined by market conditions. Researchers showed that the vertical integration level can also be stimulated by fluctuations in demand by assuming the existence of market imperfections (Lieberman, 1991).

Finally, the dynamics of the company also influence vertical integration policy. The model developed by Balakrishnan (1994) demonstrates that “changes in profitability, technological innovation, and costs for assets regarding to these changes” shape the make-buy decisions in the company.

3.3.3. Resource-Based View

The resource-based view (RBV) theory explores the firms’ performance from the resources and their implementation side rather than in terms of the products side. Barney (1991, p. 101), referring to Daft (1983), defines firm resources as “all assets, capabilities, organizational processes, firm attributes, organizational processes, firm attributes, information, and knowledge.” According to Barney (1991), the firm resources that hold the potential advantage of sustained competitive advantage must be valuable, rare, inimitable, and non-substitutable. These attributes are the requirements for a firm resource to be a source of sustained competitive advantage. The resource-based view provides insights on both organizational and strategic side of the firm. Within the field of sustainability studies, natural-resource-based-view researchers categorize the resources and capabilities that yield competitive advantage will be discussed in the next section.

3.3.4. Natural-Resource-Based View

It is usually expected that companies buy an input if its price is lower than its in-house production cost. However, the make-buy decisions can be more difficult under some conditions. One of these conditions is having a vertically-integrated corporate strategy. Concerns of Sustainability Focused Companies (SFCs) about strategic competitiveness may revoke these customary commerce habits. The vertical-integration-level analysis for SFCs contributes to both the vertical integration and sustainability literatures, which is mainly related to answering the following question: “Do the sustainability-focused companies have a higher vertical integration level than their counterparts which are not pursuing a sustainability-focused strategy?” A tremendous amount of research has been accomplished about the connection between firm strategies and the vertical integration level. Unfortunately, none of the scholars examined the vertical integration level of sustainability-focused companies with any developed vertical integration measures.

There is literature that discusses the benefits of integration, particularly for sustainability-focused companies. Hart (1995) makes natural-resource-based view arguments for vertical integration and proposes that corporate environmental management is a strategic resource that can produce competitive advantage and progress towards more sustainable production which takes place in three phases: pollution prevention, product stewardship, and sustainable development. These three phases are interconnected and support each other. Especially, the firms that demonstrate capability in tacit skills (e.g. TQM), socially complex skills (e.g. cross-functional management), and rare skills (e.g. shared vision) will be successful in pollution prevention, product stewardship, and sustainable development respectively. The natural resources that contribute to the competitive advantage are assumed to be difficult to replicate because they are rare and/or specific to a given firm, tacit (causally ambiguous) or socially complex. Carter and

Rogers (2008) concluded in their literature review study that the product of SFCs may be more difficult to imitate. From a resource-based view perspective, these arguments point toward vertical integration.

The natural-resource-based view arguments of Hart (1995) were tested by Menguc and Ozanne (2005) as to whether firm performance is related with the capabilities of corporate social responsibility and commitment to the natural environment. They argued that these capabilities are rare, valuable, and difficult to imitate. Thus, successful implementation should lead to higher profit and market share.

Also, sustainable development will extend beyond the firm with collaboration skills (such as technology cooperation) among the public and private companies. Russo and Fouts (1997) provided an empirical test of resource-based view theory and applied to environmental social responsibility using firm-level data on environmental performance and profits. The authors found that companies reporting superior environmental performance also had superior financial performance, a result that can be interpreted as being consistent with the resource-based view theory.

Harrigan (1983) states that vertical integration assures irreplicable differentiation advantages such as superior service levels, coordination of raw material qualities, and customized development of special products. Additionally, Carter and Rogers (2008) concluded in their literature review that the product of SFCs may be more difficult to imitate.

Chan (2005) proposes a model that illustrates the antecedents and results of natural-resource-based-view approach by conducting a survey to foreign invested companies located in China. His analysis demonstrates; firstly, resource-based-view approach leads company to develop higher organizational capabilities, secondly, companies that have

these capabilities are more likely to adopt sustainability-focused strategies, and consequently, the adoption of sustainability-focused strategies leads to achieve higher environmental and financial performance.

3.3.5. Transaction Cost Economics

During the early 1970s, the economists began to promote the theory of transaction cost economics from the earlier work of 1991 Economy Nobel Prize winner Ronald H. Coase. Especially, Oliver Williamson fully developed this theory with his remarkable contributions over the last four decades and he was also awarded with the Economy Nobel Prize in 2009.

Coase (1937) noted that the transaction cost economics forms the boundary of the firm. Some transaction costs may not be handled in the market; therefore, firms may need to increase vertical integration level to undertake these transaction costs. Hence, these types of costs have influence on outsourcing decisions and the success of outsourcing depends on the managing outsourcing relationships. Transaction cost economics assumes that people may not be truthful and honest about their contracts to take advantage of some circumstances in the market (i.e. opportunism assumption – limitations on information and restriction to process) and may not foresee all possible results due to existence of uncertainties (i.e. bounded rationality assumption) in transactions (Williamson, 1985).

Asset specificity is the also another important concept in TCE theory and refers to "durable investments that are undertaken in support of particular transactions'' (Williamson, 1985, p. 55). According to TCE theory, asset specificity is one of the fundamental factors that determine the vertical integration strategy of the firm (Williamson, 1985).

3.3.6. Natural Transaction Cost Economics

There have been limited number of studies conducted on the intersection of sustainability-focused strategies and transaction cost analysis. For example, the empirical study of Rosen et al. (2000) confirms that, in computer industry, SFCs were more likely to specify a role for third parties to help with conflict resolution in contracting and recognize and express concern about potential “expropriation and shirking” risks. The problem in contracts may be a reason for internationalization of production. In other words, SFCs will tend to reduce transaction costs of contracting by vertical integration (Rao, 2003).

Carter and Carter (1998) examined the effect of vertical coordination between buyers and suppliers to environmental purchasing activities with conducting a survey to managers and they observed that the greater the vertical coordination between suppliers and buyers supports the environmental purchasing activities. Additionally, they detected that as manufacturers use environmentally friendly input they become more vertically integrated with their suppliers.

Finon and Perez (2007) explore the efficiency of the regulatory instruments used to encourage renewable energy sources in electricity generation. They argued that governments coordinate renewable energy sources more effectively with long-term contracting and explained the main goal of this contractual format as supplying long-term guaranteed support to encourage investors. Using transaction costs economics,

Natural-resource-based view and natural-transaction-cost-economics theories propose sustainability-focused companies to increase vertical integration level. On the other hand, collaboration in sustainable supply chains is another way that leads company to successfully pursuing sustainability practices.

3.3.7. Collaboration in Sustainable Supply Chain

Firms may prefer buying outside or producing in house. Literature indicates that collaboration is very important in sustainable supply chains as an alternative to the vertical integration. Collaboration with suppliers may facilitate the implementing and managing sustainable supply chains (Vachon and Klassen, 2008). In cooperative customer-supplier relationships, companies plan and design their products and processes for the purpose of reducing the impact to the environment (Noci, 1997). Environmental collaboration is defined by Vachon and Klassen (2008) as follows:

"the direct involvement of an organization with its suppliers and customers in planning jointly for environmental management and environmental solutions" (p. 301).

Noci (1997) developed a green vendor rating system that includes supplier selection procedure to help developing proactive sustainable strategies. Bowen et al. (2001) concluded that capabilities in sustainable supply chains are developed by a proactive corporate-environmental approach and collaboration is one of the important capabilities that predict the green supply behavior. Managers can develop these capabilities to help fostering sustainability practices. Klassen and Vachon (2003) assessed the customer- and plant-initiated collaboration in Canadian sustainable businesses. They found that as the companies increase customer-initiated collaboration, managers prefer to make investments towards preventing environmental pollution. In other words, collaboration in sustainable supply chain affects both the level and form of investment in environmental technologies.

The summary of the literature review was illustrated in Figure 3. In the next section, we will continue with introducing Fan and Lang's vertical integration measurement method and its implementations.

3.4. Vertical Integration Measurement with Fan and Lang Method

Lemelin (1982) uses input-output tables for measuring industry relatedness to consider patterns of diversification. Fan and Lang (2000) extended this study to construct alternative measures of relatedness. In this study, we will follow Fan and Lang's (2000) method which provides us detailed information of vertical integration calculation at both the industry and firm levels. They state that two industries are vertically related if one industry uses the other's output as its input. Fan and Lang (2000) developed vertical relatedness and complementarity variables as interindustry and intersegment measures based on I-O tables. At the industry level, they show that the proposed input-output-based vertical relatedness and complementarity measures provide better description of firms' relatedness than previously generated SIC-based measures. Fan and Lang (2000) examine the relatedness patterns of U.S. firms between 1979 and 1997 and report an increasing trend at the vertical integration level of firms over time.

Early application of Fan and Lang's method include Claessens et al. (2003) This study employed Fan and Lang's (2000) vertical relatedness and complementarity variable measures to a sample of over 10,000 firms in nine East Asian economies to examine the patterns of vertical relatedness and complementarity of diversified firms' business segments. This study sheds light on the differences and changes in the diversification of the eight East Asian countries, Japan, and the United States besides examining the influence of diversification types on corporate value. Additionally, in Claessens et al. (2003), they examine the impact of corporate diversification on productivity and performance. Schildt et al. (2005) used Fan and Lang's (2000) method to examine the effect of downstream vertical integration on explorative versus exploitative learning outcomes from external corporate ventures. Rondi and Vannoni (2005) used forward and backward integration measures and Italian I-O tables to test the effects of

competitive pressure on product diversification and refocus on core business strategies of 108 diversified European Union (E.U.) manufacturing leaders that faced the E.U. integration shock.

Recent studies using the method include Fan and Goyal (2006), who measured vertical relations in a large sample of mergers between 1962 and 1996. Fukui and Ushijima (2007) investigate the industry diversification of the largest Japanese manufacturers. Hutzschenreuter and Guenther (2009) analyzed the expansion steps of firms and the way of reaching their level of diversity. Moreover, they examined the factors that have impacts on a firm's rate of expansion and the major sources of complexity that are associated with managing and expanding assets. Hutzschenreuter and Gröne (2009) assessed the influence of foreign competition on vertical integration strategies of U.S. and German companies. They used the value-added-to-sales approach, adjusted value-added-to-sales ratios, and Fan and Lang (2000) methods in their analyses. They compared these methods and concluded that input-output based method of Fan and Lang is more advantageous than the other value-added-to-sales based methods. Acemoglu, Johnson, and Mitton (2009) explore the main effects of financial development and contracting costs on the vertical integration level across 750,000 firms in 93 countries.

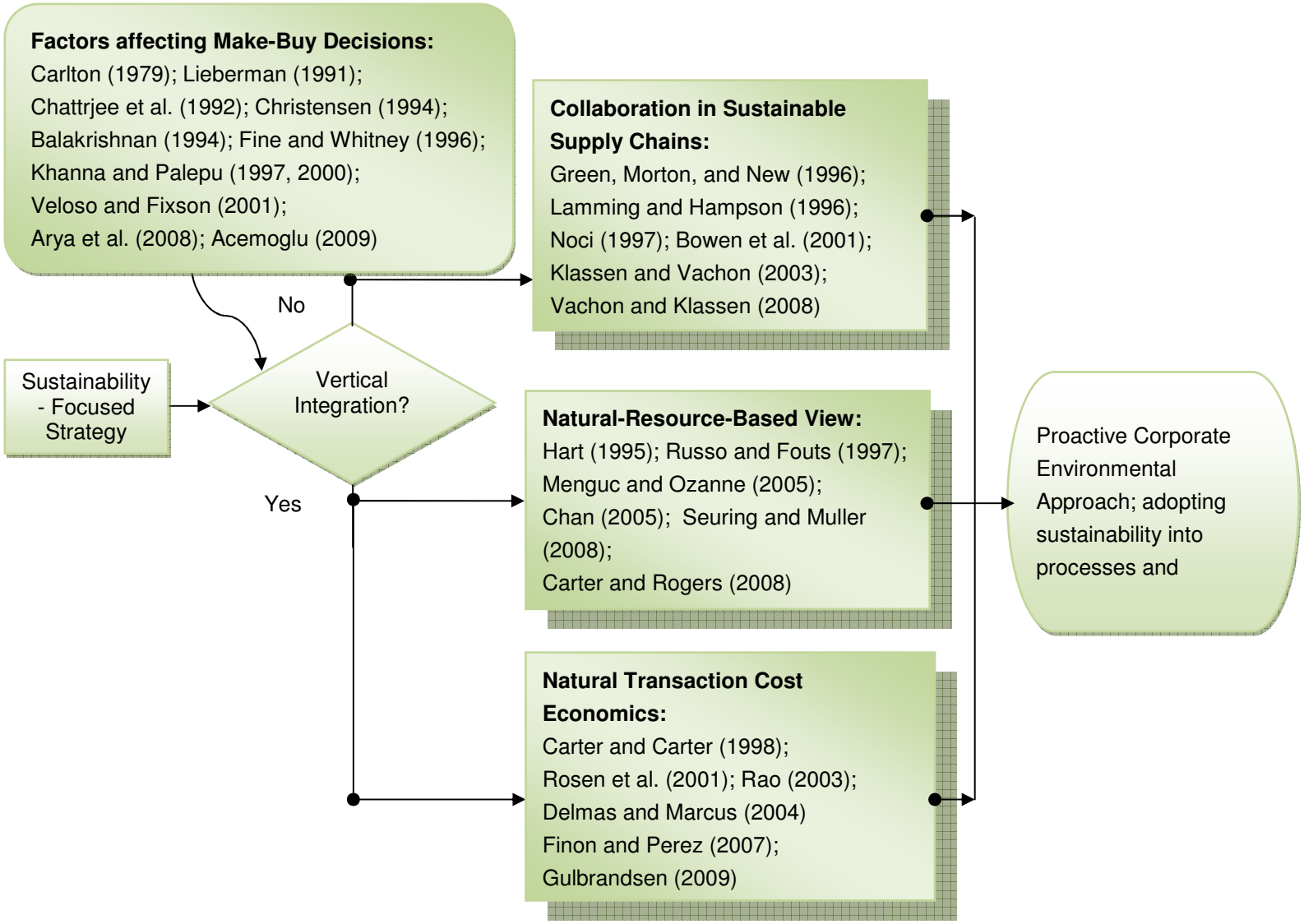

Figure 3. The Summary of the Literature Review

3.5. Sample, Data Collection, and Measurement

3.5.1. Sample

Our sample of SFCs was drawn from the union of three firm sets. The first set is the "Dow Jones Sustainability United States Index" and consists of 116 U.S. firms. These firms integrate long-term economic, environmental, and social aspects into their business strategies. A sustainability-focused strategy increases long-term shareholder value and sustainable companies show superior financial performance (Russo and Fouts, 1997); consequently, Dow Jones Indexes, STOXX Limited, and SAM Group launched the Dow Jones Sustainability Index (DJSI) to quantify the firms' economic, environmental and social developments to assess their strategic and management performance. This index is reviewed with a questionnaire annually to ensure that it represents the leading sustainable companies. This index also utilizes information from the company documents, such as, sustainability, environmental, social, financial, and health-safety reports. Appendix A presents the set of criteria and weightings that is used to assess the economic, environmental, and social aspects of the companies.

The second set is the "The Global 100 Most Sustainable Corporations" list which has been compiled by the Corporate Knights magazine since 2005. After eliminating overlaps, we obtained 38 companies by combining 2005-2009 lists. The aim of this list is to emphasize the global firms which are successful in managing environmental, social, and governance issues. The annual list of Global 100 is announced each year during the World Economic Forum in Davos. The performance indicators that are developed by Corporate Knights Research Group are given in Appendix B. Corporate Knights examine the 300 companies, which are the top 10% of 3000 developed and emerging market stocks, based on these indicators. The Global Sustainability Research Alliance compiles the economic, social, and governance performance indicators from ASSET4, a Thomson

Reuters business, The Bloomberg Professional, and FactSet Research Systems databases.

The third set, “SB20: The World's Top Sustainable Business Stocks,” has been created by Progressive Investor for 9 years. We eliminated the overlapping companies and obtained 23 sustainable businesses in the combined list. Progressive Investor is a monthly and online investing newsletter that provides financial information about leading green companies and instructs investors about all green funds. The newsletter works with a group of judges, who are stock analysts, to select, nominate, and discuss companies. The SB20 list includes various sizes of companies and these companies must be competitive based on both the sustainability and financial strategies to be in the set. The criteria for the list are not announced in detail; however, they are accumulated under two main categories, environmental and financial criteria. Companies should make announcements and progress in meeting objectives, have advanced green technologies, and lead society to a sustainable future. Financial criteria evaluate the profitability of the companies and expect strong management skills and balance sheet.

We compiled our sample from U.S. companies. There are two main reasons; first, we eliminated the country effect (Acemoglu, Johnson and Mitton, 2009) on vertical integration, second, we used only the I-O tables for the U.S. Since all three lists have similar criteria, we combined these lists and finally get 144 companies. However, information for some companies is not available in our databases (see Appendix C for the list of the sustainable firms). Additionally, the vertical integration level of companies, which are operating mainly in retail, transportation, and warehousing industries, cannot be calculated because I-O tables do not provide detailed information for these industries. We assume that the companies that are listed in these sets are successful in pursuing and/or monitoring sustainability activities. The list of non-sustainable companies is not

available; hence, we assume that the companies that are not listed in these sets are not pursuing and/or monitoring sustainability activities as much successful as listed companies.

In this study, a non-sustainability company comparison set was generated by looking at the competitors that are similar to sustainable companies with regards to financial indicators, products, and operations. We utilized Hoover and Mergent Online databases to obtain these "so-called" non-sustainable companies as these databases report the competitors for each North American Industry Classification System (NAICS) code. Bhojraj et al. (2003) discusses the historical development, intent, and basic philosophy behind the SIC and NAICS codes. DJSI United States categorizes companies under 10 industries. After excluding Telecommunications industry, which has only one company, we categorize all sustainable companies and their competitors within nine industries. In the next section, we will mention other data sources in detail.

3.5.2. Data Collection

The Fan and Lang (2000) method utilizes input-output (I-O) tables to calculate vertical integration level. The Bureau of Economic Analysis (BEA), which is an agency of the Department of Commerce, publishes the benchmark I-O tables every five years. BEA estimates industry and commodity outputs for the I-O make and use tables. The input-output tables report the dollar value of each input used to produce the output of more than 400 different industries in the U.S. economy. Make-use tables provide a comprehensive picture of economy and show the relationships between industries and commodities. Many economists, analysts, and policymakers use I-O tables in their analyses. These tables mimic the 6 digit NAICS codes; however, there are aggregations of some NAICS codes.

This research will use 2002 I-O tables which are the latest available data set, because data for 2007 was not publicly available at the time this paper was written. Stewart et al. (2007) discusses the preparation of the 2002 I-O tables. They explain the utilization and the concepts of make-use tables and illustrate the methods underlying the I-O tables in detail.

Standard & Poor's Compustat Industry Segment database provides financial, statistical, and marketing information of companies that represent at least 10 percent of a firm's sales, assets, or profits. Disclosure of data in this database is required by the Securities and Exchange Commission of the United States Government. This database is used extensively by the researchers who apply Fan and Lang's method. Compustat database compiles the industry information from firms' annual reports and 10-K reports that are reported to the Securities and Exchange Commission. In addition to a firm's financial data, Compustat assigns a 4 digit SIC code and 6 digit NAICS code according to the industry in which that segment operates.

Beginning from December 15, 1977, public firms are required to disclose the industry segment information if the segment's account is more than 10% of their total sales, profits, or assets, because of the Financial Accounting Standards Board's (FASB) statement number 14. For some companies, this may cause a problem of disclosing segment-level information for over 10 segments (i.e. a limitation of Compustat stated in Villalonga (2004)). In our study, the maximum number of segments is 6; therefore, this problem does not affect our study. Next section explains step-by-step how to apply Fan and Lang's method to calculate vertical integration level of companies. We used same the same notation with Fan and Lang (2000) to not to confuse reader.

3.5.3. Measuring Step-by-Step Vertical Integration with Fan and Lang Method

The benchmark input-output tables report the dollar value of industry i's output used to produce the output of industry j and this is denoted by Fan and Lang as a_{ij}. We divide a_{ij} to the industry j's total output to get v_{ij}, interpreted as "the dollar value of industry i's output required to produce 1 dollar's worth of industry j's output". In an opposite manner, we find the values of a_{ji} and v_{ji}. Moreover, we find the V_{ij} (relatedness coefficient) which is the average of v_{ij} and v_{ji} and represents "the proxy for the opportunity for vertical integration between industries i and j" (Fan and Lang, 2000, p. 633).

The vertical integration level is defined as;

$$V = \sum_{j} (w_j V_{ij}) \tag{4}$$

where w_j is the ratio of j th secondary segment sales to the total sales of all secondary segments (sales weight of secondary industries). This formulation tells how and to what degree the primary and secondary firm segments are related.

Appendix D illustrates the data and calculation of vertical integration index for H&R Block, Inc., which has subsidiaries at Tax Services, Mortgage Services, Business Services, and Investment Services. Primary segment of this company is "Tax Services" because it has the highest amount of sale for H&R Block, Inc. For "Mortgage Services" segment

- NAICS code is 522292, which is shown as 522A00 in 2002 I-O table
- sale of H&R Block, Inc. in this industry is 1,150 M$
- total sale of "Mortgage Services" industry is 206,138 M$
- the output of "Tax Services" industry required to produce the output of "Mortgage Services" industry, a_{ij} is 208 M$

- the output of industry “Mortgage Services” required to produce the output of “Tax Services” industry, a_{ji} is 279.9 M$
- v_{ij}, v_{ji}, and their averages V_{ij} are 0.001, 0.003, and 0.00189 respectively
- finally, 0.0019 is the vertical integration level V which is obtained by the multiplication of V_{ij} value of secondary industry with its corresponding sale weight, w_j

3.6. Results

We have used Wilcoxon Rank Sum Test (a.k.a Mann-Whitney U test) for comparing sustainable companies and their competitors that are not listed as sustainable companies. The residual analysis does not confirm the normality assumption; therefore, we preferred to use this nonparametric test. In our analysis, vertical integration level is considered as the dependent, response or outcome variable, and the “strategy” is the independent or factor variable.

According to our analysis, we observed significant differences in vertical integration levels for Health Care and Industrials industries. For $\alpha = 0.05$, sustainable companies in Health Care and Industrials industries present higher vertical integration level than their non-sustainable counterparts do. On the other hand, we could not state a significant difference in the vertical integration level for other seven industries. Table 8 presents the p-values associated to each industry with descriptive statistics that are calculated with Wilcoxon Rank Sum Test.

Both Basic Materials and Oil and Gas industries present higher level of vertical integration for sustainable and non-sustainable companies. On the contrary, the vertical integration level of Consumer Goods and Consumer Services industries are quite low for both sustainable and non-sustainable companies. Most of the companies have zero

vertical integration level because they operate generally in only one industry. Because I-O tables do not provide information for these industries, we have to omit retail, transportation, and warehousing industries in our calculations. This is also another reason for obtaining zero vertical integration level. In Consumer Goods and Consumer Services industries, most of the companies have distribution and transportation segments that we cannot consider in our calculations.

The vertical integration level in Technology industry is low for both sustainable and non-sustainable companies. As noted in Fine and Whitney (1996), these computer and software companies started to be disintegrated starting from mid 1980s because of the product and industry conditions. Therefore, this low vertical integration level is due to industry and product effects. Fan and Lang (2000) also observed a high vertical integration level in Chemical industry (i.e. Basic Materials industry). Therefore, the high vertical integration level of sustainable and non-sustainable companies in Basic Materials industry may be because of the industry effect as well.

At first glance, since we were expecting higher vertical integration level for sustainable companies in more industries, the result of the study is surprising given that the literature hypothesize a higher level of vertical integration for sustainable companies. However we understand that the difference of vertical integration is significant especially in production industries since they have more interaction with their suppliers. The results of this study do not conflict with literature; but support both the scholars that emphasize the factors affecting make-buy decisions and the scholars that propose higher integration for sustainable companies. In the next section, we present more discussion on the Fan and Lang's method and data sources.

Table 8. Summary of Results

	Industry / Strategy	Basic Materials	Consumer Goods	Consumer Services	Financials	Health Care	Industrials	Oil and Gas	Technology	Utilities
Sample Size (n)	Sus	6	15	19	13	15	18	9	15	11
	Non-Sus	6	15	19	13	15	18	9	15	11
Mean	Sus	0.0393	0.0099	0.0322	0.0579	0.0296	0.0190	0.1177	0.0148	0.0041
	Non-Sus	0.0501	0.0077	0.0378	0.0611	0.0044	0.0065	0.0805	0.0068	0.0102
Median	Sus	0.0168	0.0005	0	0.0505	0.0199	0.0125	0.0230	0.0099	0.0022
	Non-Sus	0.0084	0.0051	0	0.0505	0.0023	0.0023	0.0370	0	0.0005
Standard Deviation	Sus	0.0464	0.0172	0.0932	0.0581	0.0351	0.0197	0.1740	0.0186	0.0043
	Non-Sus	0.0746	0.0119	0.1024	0.0660	0.0050	0.0083	0.1308	0.0134	0.0230
Sample Variance	Sus	0.0027	0.0003	0.0087	0.0034	0.0012	0.0004	0.0303	0.0004	1.87-05
	Non-Sus	0.0056	0.0002	0.0105	0.0044	0.00002	6.82E-05	0.0171	0.0002	0.0005
Range	Sus	0.1177	0.0497	0.3144	0.2236	0.1022	0.06411	0.4088	0.0625	0.0137
	Non-Sus	0.1812	0.0465	0.3935	0.1965	0.0204	0.0222	0.4097	0.0403	0.0721
Minimum	Sus	0.0030	0	0	0	0	0	0.0010	0	0
	Non-Sus	0	0	0	0	0	0	0	0	0
Maximum	Sus	0.1207	0.0497	0.3144	0.2236	0.1022	0.0641	0.4097	0.0625	0.0137
	Non-Sus	0.1812	0.0465	0.3935	0.1965	0.0204	0.0222	0.4097	0.0403	0.0721
Count	Sus	6	15	19	13	15	18	9	15	11
	Non-Sus	6	15	19	13	15	18	9	15	11
P value		0.423	0.800	0.728	0.426	0.042*	0.029*	0.894	0.101	0.148

3.7. Discussion

Our analysis has some limitations that deserve further research. Fan and Lang's method is an I-O based vertical measurement index. Because of limited information in I-O tables, this method could not calculate the vertical integration level of some companies that are operating mainly in retail, transportation, and warehousing industries. In a parallel study we evaluated the I-O based vertical integration measures and concluded that Fan and Lang's method is a preferable method compared to other methods, Davies and Morris (1995) and Hortacsu and Syverson (2009).

The Compustat database is widely used by researchers who apply Fan and Lang's method in their analysis. However, Compustat database is not always consistent with the other databases (e.g. Hoover or Mergent Online) or annual reports of the companies because the companies do not announce all the industries in which they operate. This limitation makes it impossible to calculate vertical integration for undeclared subsidiaries. On the other hand, only public companies have to declare the segments and segment sales correctly. The data about the private companies may not be accurate and this limitation may cause incorrect calculations. In this study, the sample is composed of public companies; additionally, we made crosschecked with the other databases and completed the missing data from the Hoover industry reports and Mergent Online database.

The Fan and Lang's method measures the relationship between the primary and the other segments of the company. The primary segment is defined as the segment which has the highest sales; the relationship between the primary segment and others is weighted according to the sales of other segments. Acemoglu, Johnson, and Mitton (2009) modified Fan and Lang's method, used equal weights for each segment, and examined the relationship between all segments. As explained in the data section,

Compustat data is limited with 10 segments and this causes inaccurate vertical integration calculation for the companies which are operating in more than 10 different segments.

Other concerns about the Compustat database are related to the definition of segment itself. Because of the ambiguity in definition, some firms may disclose the segments as an aggregation of a couple of unrelated segments (Davis and Duhaime, 1992). Furthermore, they may change the segments and number of segments in their disclosed reports even if there is no change in their operations (Denis, Denis and Sarin, 1997). This may cause incorrect allocation of industries to firms. The Compustat database compiles the segment information on public companies traded on NYSE, ASE, NASDAQ, and OTC. Therefore, we can say that Compustat limits the sample to publicly traded companies.

3.8. Conclusion

This study compared the vertical integration level of sustainable and non-sustainable companies. Literature of natural-resource-based view (e.g. Hart (1995) and Russo and Fouts (1997)) and natural-transaction-cost-economics theory (e.g. Carter and Carter (1998) and Finon and Perez (2007)) propose increasing the vertical integration level for sustainable companies. Carter and Carter (1998) measured the vertical coordination through the supply chain with a survey and concluded that vertical integration increase the environmental performance of the companies. In the literature, the linkage between environmental strategies and vertical integration has not been examined with an economy-based vertical integration index. This study attempts to fill this gap by measuring the vertical integration with Fan and Lang's method and trying to understand if the sustainable companies tend to be more vertically integrated than their non-sustainable counterparts. The results demonstrate that sustainability-focused companies

in the Health Care and Industrials industries tend to have more vertically integrated organizational structures than their industry non-sustainable competitors. There was no significant difference in the vertical integration level of sustainability-focused versus non-sustainability-focused companies for the other seven industries studied.

Higher vertical integration may not be possible under some industry, product, market, and economic conditions. Under these circumstances, sustainable companies may prefer to increase the social capital with its suppliers to eliminate the effect of disintegration. Future research direction should be defining the social ties between sustainability-focused companies and their first and second tier suppliers to understand if they have an organizational structure that is a substitute (or at least complementary) to a pure vertically-integrated organizational structure.

CHAPTER 4:

EVOLUTION OF SUPPLY CHAIN STRUCTURE AS FIRMS BECOME MORE SOCIALLY AND ENVIRONMENTALLY AWARE: A CONTENT ANALYSIS APPROACH

4.1. Abstract

The objective of this research was to understand how the organizational structure of sustainability-focused companies changes over time as the companies become more environmentally, economically, and socially sustainable. We applied trend analysis to the sustainability and vertical integration level of the companies. Our sample consisted of 10 sustainability-focused companies from the industrials industry. We used the content analysis of annual reports to calculate sustainability development scores, and applied the Fan and Lang's method to determine the vertical integration level of the companies. The study results demonstrated an increasing trend in both vertical integration and sustainability development of industrial industry companies over a 15-year of period. Furthermore, the companies became more vertically integrated as their environmental, economical, and social sustainability increased.

Keywords: Content analysis, Sustainable development, Vertical integration, Trend analysis

4.2. Introduction

Developing environmental management strategies affects the whole community as well as the earth's ecology. Employees, environmental activists, communities, and non-governmental organizations are increasingly applying pressure to companies to consider sustainability principles as they manage the material and information flows along their supply chains. As discussed in the previous part of the study, the natural resource-based view and natural transaction cost economics literatures state that sustainability-focused companies (SFCs) tend to be more vertically integrated. Additionally, the results of the previous parts of the study illustrate that, especially in production related industries, SFCs have more vertically integrated organizational structure than their non-sustainable counterparts.

After the report of the World Commission on Economic Development (WCED, 1987), the term sustainability became very popular since the report defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs (p. 43)." The commitment of companies to sustainable management increasingly changes over time. Even consumers are making sustainability-focused decisions when they purchase vehicles, decline plastic bags at supermarkets. According to a recent Deloitte survey of more than 1,000 business travelers in April 2008, 95 percent of respondents thought that lodging companies should be undertaking green initiatives. Institutional theory states that, in modern societies, many programs and policies are enforced by public opinion, knowledge, social prestige, and laws (Meyer and Rowan, 1977).

As stated in natural resource based theory, environmental management is a strategic resource that can produce a competitive advantage and progress towards more sustainable production (Hart, 1995, Menguc and Ozanne, 2005). The natural resources

that contribute to the competitive advantage are assumed to be difficult to replicate because they are rare and/or specific to a given firm (Barney, 1991, Reed and Defillippi, 1990), tacit (causally ambiguous), or socially complex (Teece, 1982, Winter, 1987).

Additionally, according to the literature, superior environmental performance leads to better industry performance (Porter and Van der Linde, 1995, Rosen, 2001, Russo and Fouts, 1997). Analyzing Fortune Magazine's ratings of corporate reputations, McGuire, Alison, and Schneeweis (1988) stated that social responsibility positively affects financial performance. According to Klassen and McLaughlin (1996), environmental management is an important dimension of firm management and operations strategy, and strong environmental performance increases the value of companies. The results of Feldman, Soyka, and Ameer (1996) showed that firms increase their financial market value if they make environmental investments that go beyond strict regulatory compliance.

There are limited numbers of studies that examine the evolution of sustainability-focused strategies. Different from previous studies in the literature, we examined the evolution of sustainability-focused strategies and compared this evolution with the vertical integration of companies over the same period of time. Content analysis (Weber, 1985) was used to evaluate the annual reports of the firms. Institutional theory examines how social choices are shaped, mediated, and channeled by the institutional environment. This study offers contributions to institutional theory and the relationship between organizations and environmental strategies. Moreover, our research seeks to make a contribution by building a framework for understanding how organizational structure and corporate environmental strategies co-evolve. Longitudinal analysis empirically measured changes in the organizational structure of a firm in correlation with the evolution of its corporate environmental strategy.

The rest of this study is organized as follows: Section 2 provides literature review of vertical integration, environmental-management strategy evolution, and sustainable development types. In Section 3, after documenting the sample and data sources, we employ our vertical integration measurement and content analysis. Section 4 presents the results of the analysis. Section 5 discusses possible explanations for the results and, finally, Section 6 concludes the study results.

4.3. Literature on Vertical and Environmental Evolution

There are several studies in the literature that examine trends in the vertical integration level of companies. Adelman (1955), Laffer (1969, (1963), and Tucker and Wilder (1977) found that the vertical integration level of companies remained about the same or indicated little variation over the decades. On the other hand, Maddigan (1981) concluded an upward trend in the index that is contrary to results of value added over sales method and its variations. Fan and Lang (2000) examined the relatedness patterns of U.S. firms between 1979 and 1997 and report an increasing trend in the vertical integration level of firms over time. Hutzschenreuter and Gröne (2009) assessed the influence of foreign competition on vertical integration strategies of U.S. and German companies using a longitudinal study.

Additionally, the environmental management literature presents studies that examine the evolution of sustainability-focused strategies of companies using longitudinal analysis. For example, Hoffman (1999) empirically analyzed the changes in the constituency of an organizational field and correlated those changes with the traditions adopted by the U.S. chemical industry from 1960 through 1993. Bansal (2005) examined the impact of resource-based and institutional factors on corporate sustainable development in Canadian firms that operate in the oil and gas, mining, and forestry industries from 1986 to 1995. Bansal (2005) used time series cross-sectional data techniques to analyze

company annual reports and interview industry members. Lee and Rhee (2007) explored the change in sustainability-focused strategies based on the resource-based view and institutional theory utilizing a longitudinal empirical analysis and conducting mail surveys in South Korea in 2001 and 2004.

Ingram and Frazier (1980) examined if a high degree of correlation should exist between these indices and the content of their disclosures when firms' environmental disclosures are reflective of their environmental activities. According to the content analysis of Carlson, Grove, and Kangun (1993), environmental advertising claims, which present the environmental benefits of products and the environmental image of an organization, may cause confusion and inconsistencies. Jose and Lee (2007) investigated the environmental management policies and practices of the Fortune's Global 200 largest corporations using a content analysis of the environmental reports. Jose and Lee (2007) stated that 52 companies lacked the needed information on their websites. On the other hand, seven companies did not have information in English. Moreover, voluntary dissemination of corporate environmental information is more common in Western European countries and Japan than in the United States. In a similar study; Gill, Dickinson, and Scharl (2008) conducted web content analysis to examine the economic, social, and environmental disclosures in Europe, North America, and Asia oil and gas firms. They found that firms should completely disclose their information to effectively manage their relationships with their key stakeholders. In their case study research, Cruz and Boehe (2008) conducted interviews with the members of a global value chain and analyzed these interviews with content analysis. They concluded that managers need to be aware of corporate social responsibility strategies, and awareness building may influence the competitiveness of their sustainable value chain.

The report of the World Commission on Economic Development (WCED, 1987) stated that sustainable development required the simultaneous adoption of social, economic, and environmental principles. According to the triple bottom line approach (Elkington, 2002, Foran et al., 2005), if any one of the principles is not supported, development cannot be accepted as a sustainable development. Although eco-efficiency is a very important part of corporate strategies, it is not sufficient (Welford, 1997). Dyllick and Hockerts (2002) have framed the three dimensions and defined sustainability as

> "…meeting the needs of a firm's direct and indirect stakeholders (such as shareholders, employees, clients, pressure groups, communities etc), without compromising its ability to meet the needs of future stakeholders as well. Towards this goal, firms have to maintain and grow their economic, social and environmental capital base while actively contributing to sustainability in the political domain. From this definition, three key elements of corporate sustainability can be identified: Integrating the economic, ecological and social aspects in a 'triple-bottom line' (p. 131)"

In our study, we accepted economic, social, and environmental sustainability as three dimensions together. Therefore, we will accept a company as a sustainable company, when it matches the societal expectations, does not engage in an activity that degrades the eco-system, and ensures liquidity while producing a persistent above average return to their shareholders (Dyllick and Hockerts, 2002, Seuring and Muller, 2008, WCED, 1987).

4.4. Research Methodology

4.4.1. Sample

In previous chapters, we showed that in production oriented industries, especially in medical devices and industrials industries, sustainability-focused companies (SFCs) have more vertically integrated organization structure than their non-sustainable competitors in the same industries. In this part of the research, we will focus on only one industry because industry type is one of the main effects that impact the vertical integration level of the companies (Fan and Goyal, 2006, Lindstrom and Rozell, 1993). We selected companies that are specifically focused in one industry to avoid the problems associated with measuring firms that are operating in vastly different industries in accordance with the methodology of Lindstrom and Rozell (1993).

The companies that operate in the industrials industry were drawn from the union of three sets. These companies integrate long-term economic, environmental, and social aspects into their business strategies. The first set is the “Dow Jones Sustainability United States Index” and consists of 14 U.S. industrials industry firms. This index is reviewed with a questionnaire annually to ensure that it represents the leading sustainable companies. This index also utilizes information from the company’s documents, such as sustainability, environmental, social, financial, and health-safety reports. Appendix A presents the set of criteria and weightings that used to assess the economic, environmental, and social aspects of the companies. The second set is “The Global 100 Most Sustainable Corporations” list which has been compiled by the *Corporate Knights* magazine since 2005. After eliminating overlaps, we obtained 7 industrials industry companies by combining the 2005-2009 lists. The annual list of Global 100 is announced each year during the World Economic Forum in Davos. The performance indicators that are developed by Corporate Knights Research Group are

given in Appendix B. The third set, “SB20: The World's Top Sustainable Business Stocks,” has been created by Progressive Investor for 6 years. We eliminated the overlapping companies and obtained 7 sustainable industrials businesses in the combined list. The newsletter works with a group of judges, who are stock analysts, to select, nominate, and discuss companies. The criteria for the list are not announced in detail; however, they are accumulated under two main categories: environmental and financial criteria. Companies should make announcements and progress in meeting objectives, have advanced green technologies, and lead society to a sustainable future. Financial criteria evaluate the profitability of the companies and expect strong management skills and balance sheet.

We compiled our sample from U.S. companies. There are two main reasons: first, we eliminated the country effect (Acemoglu, 2009) on vertical integration; second, we used only the input-output tables for the U.S.. Since all three lists have similar criteria, we combined these lists and finally got 15 companies. However, information for some companies is not available in our databases (see Appendix C for the list of the sustainable firms). We assume that the companies that are listed in these sets are successful in pursuing and/or monitoring sustainability activities.

Similar to the studies of Tolbert and Zucker (1983) and Bansal (2005), we used 4 years of data to evaluate the changes in corporate social development. Since we use the I-O Tables of Bureau Economic Analysis to measure the vertical integration level, we examined the corresponding annual reports of sustainable industrials industry companies in the years of 1987, 1992, 1997, and 2002. Benchmark I-O tables are prepared at 5-year intervals which provide an extensive accounting of the production of goods and services by industry and commodity, the income earned in each industry, and the distribution of sales for each good and service to industries and final users such as

consumers, businesses, governments, and foreigners. We started from the year 1987 as the sustainability being started popularized after the report of WCED (1987). The latest available I-O table was published in 2002 and 2007 tables will be available at the end of 2011.

Since we used the annual reports as the source of content analysis, publicly traded companies were selected for our sample. The final sample includes 10 industrials industry SFCs that have annual reports in 1987, 1992, 1997, and 2002. The average firm age in 2011 was 90 years; the oldest company is 112 years old. The average firm size in 2011 was $35.5 billion dollar in assets, and the largest one has $68.5 billion in assets. The average employee size is 97,000, and the largest one has 208,000 employees. The procedures described in the next section provide a systematic method for quantifying the content of firms' annual reports.

4.4.2. Data Analysis

The vertical integration level of SFCs was measured at intervals over the 15 years to observe any historical changes using the Fan and Lang (2000) method. We selected 10 SFCs and observed their organizational structure change as their environmental, economical, and social performance improved. For examining the evolution of sustainability of companies, we performed a content analysis of company annual reports. The annual reports are available through the company websites, and Mergent Online and Lexis Nexis databases. The sustainability reports will be used for the cross control of sustainability practices which were obtained from the companies' websites and databases.

The use of annual reports was criticized by some scholars. For example, the content analysis study of Ingram and Frazier (1980) revealed that annual reports may be

inconsistent. Their study found that annual reports of the poorer environmental performers contained more environmental disclosures than the better performers. Bowman and Haire (1975) noted that the annual report is addressed to stockholders, and this fact may cause inconsistent disclosures. As a further example, although Bowman and Haire (1975) found a positive relation between emphasis on corporate social responsibility in annual reports and the Moskowitz ratings (Moskowitz, 1972), Preston (1978) could not find an association.

To avoid this inconsistency, in addition to annual reports, we analyzed the content of 2005 sustainability reports to make sure that the SFCs accomplished what they previously mentioned in their annual reports. We searched for each code in the 2005 sustainability reports of the companies. If they did not have related performance metrics or disclosure, we did not include these codes for these companies. Moreover, according to another critic, annual reports may provide incomplete information (McGuire, Alison and Schneeweis, 1988). Using the annual reports of the public companies, we assume that the SEC regulations discourage companies from disclosing incomplete information.

In spite of these critiques about annual reports, several scholars used them to obtain longitudinal data (Miller and Friesen, 1984, Pettus, 2001). As stated in Gingsberg (1988) and Huff (1982), annual reports and other corporate documents are useful sources to study strategic change. As stated in Barr, Stimpert, and Huff (1992) "while statements in annual reports may not precisely mirror the time period of a change, over long periods the exact timing of change is less important than overall patterns of change". Miller and Friesen (1980) asserted that "the only way to perform longitudinal research on many organizations is through detailed, published reports containing continuous history. Finally, Bansal (2005) pointed out, “annual reports are unobtrusive, so that firms cannot

engage in research-specific posturing as they can with interviews or surveys". Therefore, I used annual reports as a source of data for measuring the change in variables.

The content analysis method was conducted on annual reports to scrutinize content and characterize the environmental strategies. In my research, I mainly utilized the coding list of the study of Bansal (2005). The items of the analysis are grounded in theory and relevant to the firms in the sample. Bansal used a three-step approach to generate this list. In the first step, she defined sustainable development using the academic and practitioner oriented literature. In the second step, Bansal interviewed practitioners and reviewed the annual reports to generate a comprehensive list of items that define sustainability from a social, economics, and environmental perspective. Finally, the reliability of items, representing all three dimensions of sustainable development, was tested by a group of researchers. In addition to Bansal's codes, we utilized the criteria of Dow Jones Sustainability and Global 100 Most Sustainable Corporations indices since we compiled our sample from these indices. We discussed the final set of codes with industry and academic experts, who are specialized in sustainable development. The final set of codes that was used in content analysis was given in Table 9.

Table 9. Codes Used as the Source of Content Analysis

Environmental Sustainability

1. Manufactured products that have a less environmentally harmful impact than in previous years or than its competitors
2. Manufactured products with less environmentally damaging or replenished inputs than in previous years or than its competitors
3. Reduced environmental impacts of production processes or eliminated environmentally damaging processes
4. Eliminated or reduced operations in environmentally sensitive locations
5. Attempted to reduce likelihood of environmental accidents through process improvements
6. Reduced waste by streamlining processes
7. Used waste as inputs for own processes
8. Disposed waste responsibly
9. Handled or stored toxic (hazard) waste responsibly

Economical Sustainability

1. Worked with government officials to protect the company's interests
2. Reduced costs of inputs for same level of outputs
3. Reduced costs for waste management for same level of outputs
4. Differentiated the process or product based on the marketing efforts of the process/product's environmental performance
5. Sold waste product for revenue
6. Created spin-off technologies that could be profitably applied to other areas of the business
7. Have risk and crisis management strategies*

Social Sustainability

1. Considered interests of stakeholders in investment decisions by creating a formal dialogue
2. Communicated the firm's environmental impacts and risks to the general public
3. Improved employee or community health and safety
4. Protected claims and rights of local community
5. Showed concern for the visual aspects of the firm's facilities and operations
6. Recognized and acted on the need to fund local community initiatives
7. Existence of women on the Board of Directors**
8. Transparency at disclosing a specific data point (total employee compensation, total CO2e, total waste, total water, or total energy)**

Note: These codes of content analysis were adopted from Bansal (2005)
*Dow Jones Sustainability Index
** Global 100 Most Sustainable Corporations Index

As a result of the content analysis of annual reports, the coder calculated a final "sustainable development score" for each company for the years 1987, 1992, 1997, and 2002. Following the method of Bansal (2005), each item was coded as "0" or "1," where "0" represents no observance of the item and "1" represents the observance the item. Two main criteria were taken into consideration. The first criterion was set to avoid the criticism of inconsistency and unreliability in annual reports. For a company to have a score greater than zero for an item, this item must be mentioned in the sustainability report of 2005. Second, since the accomplishment of sustainable development requires the integration of its social, economic, and environmental components, a firm must have at least one item reported in each category.

While determining the final "sustainable development score" for each company, the number of observed items in each component was divided by the total number of possible items in this category. For example, if the coder observed 6 items out of 9 "environmental sustainability" category items, 3 items out of 7 "economical sustainability" category items, and 4 items out of 8 "social sustainability" category items, then the company's sustainable development score (SDS) would be (6/9+3/7+4/8). Therefore, a company's SDS score can be between 0 and 3.

Manual content analysis was conducted; however, manual coding to assess the presence of an issue has been criticized. Potter and Levine-Donnerstein (1999) pointed out that coder fatigue and the misapplication of coding rules are the primary threats to reliability. If coders have very different schema, there can be very little consistency in coding (Folger et al., 1984). To prevent low consistency, keeping coders free of fatigue, providing them with excellent training on a detailed and extensive set of coding rules, and using the same schema is suggested (Potter and Levine-Donnerstein, 1999). Analyzing the same subset of the sample with a pair of coders is a typical inter-coder

reliability test in content analysis methodology (for example, see King (1995) and Bansal (2005)).

The typical inter-coder reliability in content analysis methodology is to have a pair of coders analyze the same subset of the sample (Potter and Levine-Donnerstein, 1999). Inter-coder reliability tests whether two raters looking at the same occurrence give consistent ratings. In order to test the degree of consistency in decision making of coders, the second coder made judgments on 18 randomly selected annual reports. The first and second coders used in the study are PhD students who are specialized in sustainable supply chains. Cohen's kappa was used as a statistical measure of inter-coder reliability. The result of Cohen's Kappa test ranges from –1.0 to 1.0, where values close to 1 mean good reliability, values near zero indicate poor agreement, and values less than zero signify that agreement is even less than that which could be attributed to chance.

4.5. Results

Data were extracted from the annual reports in target years for each company by a single rater. The example phrases, which were observed in the reports, can be found in Table 10. Additionally, the 18 annual reports were coded by a second rater who is also specialized in sustainable supply chains. The codes were compared, and inter-rater reliability was measured with Cohen's Kappa as 0.81, which satisfies the investigators. In order to preserve consistency, only the codes from the primary coder were used.

Table 10. The Example Phrases Obtained from the Reports that Illustrate the Existence of Category Items

Environmental Sustainability

- "The Company is subject to federal and state requirements for protection of the environment, including those for discharge of hazardous materials and remediation of contaminated sites."
- "60 percent of our forests in Canada were certified as meeting the Canadian Standards Association's (CSA) Sustainable Forest Management Standard."
- "Capital expenditures for environmental purposes have included pollution control devices—such as wastewater treatment plants, ground- water monitoring devices, air strippers or separators, and incinerators—at new and existing facilities constructed or upgraded in the normal course of business."

Economical Sustainability

- "The Company has an agreement with the U.S. Government with respect to certain of the Company pension plans."
- "We participate in source reduction and waste management through storage and collection of recyclables."
- "Our company sells the waste paper and plastics for the revenue."

Social Sustainability

- "Our company is working to improve water quality and its efficient use while preventing corrosion and helping customers meet environmental goals."
- "We are building local relationships, coordinating local business activities and developing strategies that create greater value and opportunities for the enterprise."
- "We are striving to incorporate safety concerns into the design of every manufacturing process and the organization of every workplace."

Additionally, we examined the trend in sustainability development and vertical integration using ANOVA trend analysis. Table 11 shows the descriptive statistics and ANOVA F value for sustainable development scores for each of the sustainable development principles and vertical integration levels from 1987 to 2002. According to trend analysis,

we observed that, the total sustainability scores of the companies are significantly different in each panel year and increasing trend over the time period ($F = 47.47$; $p < 0.001$).

Table 11. Trend Analysis of Vertical Integration and Sustainable Development

	Pooled	1987	1992	1997	2002	ANOVA F Value
(n)	40	10	10	10	10	-
Vertical Integration						
Mean	0.0137	0.0025	0.0039	0.0134	0.0352	7.13*
Stand. Dev.	0.03	0.00	0.01	0.01	0.05	
Range	0-0.1781	0-0.0148	0-0.0291	0-0.0401	0-0.1781	
Sustainable Development						
Pooled						47.47*
Mean	1.81	0.98	1.70	2.15	2.39	
Stand. Dev.	0.72	0.75	0.38	0.22	0.41	
Range	0-3.00	0-2.01	1.23-2.51	1.89-2.51	1.86-3.00	
Environmental Sustainability						7.62*
Mean	0.65	0.38	0.60	0.77	0.84	
Stand. Dev.	0.23	0.18	0.15	0.12	0.14	
Range	0-1.00	0-0.67	0.44-0.89	0.56-0.89	0.56-1.00	
Economical Sustainability						15.43*
Mean	0.59	0.44	0.51	0.70	0.69	
Stand. Dev.	0.19	0.17	0.17	0.11	0.20	
Range	0.29-1.00	0.29-0.71	0.29-0.86	0.57-0.86	0.43-1.00	
Social Sustainability						35.07*
Mean	0.63	0.39	0.59	0.69	0.86	
Stand. Dev.	0.25	0.26	0.16	0.15	0.14	
Range	0-1.00	0-0.75	0.38-0.86	0.38-0.88	0.63-1.00	

* $p < 0.001$

Table 11 also shows with an increasing trend in each principle of sustainability; environmental ($F = 7.62$; $p < 0.001$), economical ($F = 15.43$; $p < 0.001$), and social ($F = 35.07$; $p < 0.001$) sustainability. Moreover, we determined a significant difference in each panel year and increasing trend in the vertical integration level of the companies ($F = 15.43$; $p < 0.001$).

Spearman's rank correlation coefficient was used to identify the strength of correlation between the data set of vertical integration and sustainability development score of each company whether the correlation is positive or negative. Spearman's correlation test can be used for very small samples, in other words, when the normality assumptions for that measure cannot be assumed. In his seminal paper (Spearman, 1904), he examined the hearing and seeing ability of 5 individuals. The measure of correlation as given by Spearman (1904) is usually designated by R_S. This part of our research examined how the organization structure of SFCs changes over time as the companies become more socially and environmentally aware.

In a previous part of the research, we observed that the companies in industrials industry tend to be more vertically integrated compared to their non-sustainable competitors. Since we selected our sample from sustainable company lists and the sustainability concept has been popularized starting from 1987, we were expecting an increasing trend in the sustainable development of these companies from 1987 to 1992. Therefore, we would like to know if there is a tendency for high vertical integration level (VIL) to be associated with high sustainability development scores (SDS).

Then the null hypothesis is

H_0= There is no monotonic relationship between VILs and SDS scores

and the alternative hypothesis of interest is

H_1= There is a monotonic relationship between VILs and SDS scores

Table 12 provides the increases and decreases in vertical integration (VI) and sustainability development score (SDS), means, standard deviations, Spearman correlation coefficient (R_S), and p values.

Table 12. The Change in Vertical Integration and Sustainable Development

	1987	1992 VI/SDS	1997 VI/SDS	2002 VI/SDS	R_S	p value
Company 1	First year	+/-	+/+	+/+	0.80	0.015
Company 2		+/+	+/+	+/-	0.80	0.02
Company 3		+/-	+/+	-/+	0.60	0.40
Company 4		+/-	+/+	-/+	0.60	0.194
Company 5		+/0	+/0	+/+	0.78	0.02
Company 6		+/+	+/+	+/-	0.40	0.60
Company 7		+/-	+/0	+/+	0.32	0.68
Company 8		+/+	+/+	+/+	1	<0.0001
Company 9		+/+	-/+	+/+	0.80	0.02
Company 10		+/-	+/+	-/-	0.60	0.40
Mean		+/+	+/+	+/+	1	<0.0001

The result of spearman correlation test illustrates that the correlation coefficient is equal to or more than 0.6 for eight companies. As for General Electric, it is observed that both the vertical integration and SDS scores are high for every year even though they have different ranking. Only an unexpected decrease in vertical integration score of Cummins was observed between 1987 and 1997. A two tailed P value <0.05 was considered to be statistically significant for all companies that have correlation coefficient equal or greater than 0.80. Although p values are not less than 0.05, the companies that have 0.6 correlation coefficient can still be acceptable because we have only four years. The mean values of SDS and VIL scores illustrate perfect correlation and significant p value.

As for the second analysis of co-evolution, we applied regression analysis. Since we are examining the change in vertical integration as companies become more environmentally aware, we determined SDS scores as an independent variable and VIL scores as a dependent variable. If we consider time as an effect, we obtained p value as 0.0388. On the other hand, if we do not consider time as an effect, then we obtained p value as 0.0221. We will discuss the time effect in detail in the next section. As a result, both of the analyses illustrates that vertical integration level of companies increase as the companies becomes more economically, sustainable, and environmentally, sustainable.

4.6. Conclusion and Discussion

In our previous study, we showed that sustainability focused companies (SFCs) tend to be more vertically integrated than their competitors. In this part of our research, we compared the vertical integration level of companies and any changes in their environmental strategies over the period time to understand how SFCs change their organizational structure as they become more environmentally, economically, and socially sustainable. To avoid the industry effect, we selected companies only from a single industry. We used three indices to determine the SFCs; with the combination of these indices and limitation of the databases we observed 10 SFCs in the industrials industry.

We analyzed the annual reports of SFCs for the years 1987, 1992, 1997, and 2002. The result of our content analyses assigned a sustainability development score for each SFC based on the three aspects of sustainable development: environmental, economical, and social sustainability. Moreover, we measured the vertical integration level of companies using the Fan and Lang (2000) method for these four years panel. After collecting our data, conducting content analysis and vertical integration calculations, we analyzed the

trend in both vertical integration and sustainability development of the companies. Furthermore, using the spearman correlation test, we observed how organizational structure coevolved with sustainable development over the period of time.

The results of our analyses indicated that there is an increasing trend in both sustainable development and vertical integration level for the companies in the industrials industry. In addition to the increasing trend, the vertical integration level increased parallel to the sustainability developments of companies. To produce environmentally friendly products and processes, SFCs would like to increase their control of their suppliers. As stated by natural-transaction cost economics, to decrease the contracting costs, and to avoid uncertainty and asset specificity, companies increase their vertical integration level. Parallel to this theory, as stated by natural- resource based view, companies increase their vertical integration level since their resources (i.e. inputs), which affect their sustainability, are valuable, rare, inimitable, and non-substitutable. These results contribute to our previous study, and to the natural-transaction cost economics and natural resource based view theories.

Nevertheless, there are certain limitations to this study which must be considered. First, restricting the sample to only industrials industry may limit the generalization of the findings. However, since the industry type impacts the vertical integration level and each industry has its own unique dynamics, we should focus only one industry in vertical integration comparisons. Second, although we had more than ten companies in our indices, we had to restrict our sample to ten because of the limitations in databases. The limitations about databases that we used in vertical integration calculations were discussed in Chapter 2. Additionally, there were also limitations in databases that provide annual reports. Company websites provide annual reports to the certain time. The most famous database for annual reports is the Edgar database of The Securities

and Exchange Commission; however, the Edgar database started collection from 1996. The annual reports before this year obtained from commercial databases that provide in a limited manner. Finally, although we mentioned the inconsistencies in the annual reports and tried to avoid these with sustainability reports cross control, some scholars still would like to consider as a limitation.

Other future research directions are suggested by the limitations of our study. Our results are based on relatively small sample, and on an unusual sampling strategy. Therefore, future studies may consider additional indices or methods for determining sustainability focused companies. As the time we prepared this study only 2002 data were available; therefore, the future studies may use 2007 data after December 2011.

In our study, to examine the co-evolution of VIL and SDS scores, we wanted to limit external factor that affect this relationship. For instance, we selected companies from the same country to avoid the country and macro effects, from the same industry to avoid the industry effects, and from the same economical or financial level to avoid some micro effects. Although these are the main factors, there may be other small factors. Even though we consider time effect, future studies may consider additional micro level factors.

CHAPTER 5:

THE IMPACT OF ENVIRONMENTAL SUSTAINABILITY STRATEGIES ON FIRM STRUCTURE

5.1. Abstract

In this study we developed and empirically tested a theoretical model that examines the supplier relationships of sustainability-focused companies (SFCs) to understand if these relationships are a substitute for a vertically integrated organizational structure. Furthermore, we tested if SFCs are more socially connected to their suppliers compared to non-sustainable companies (non-SFCs). An online survey instrument was utilized for data collection. The empirical findings resulting from path analysis demonstrated that SFCs establish long term relationships, collaborate, transfer know-how and experience, and create strong-ties with their first- and second-tier suppliers to have an organizational structure, which is a substitute for pure vertical integration. Findings further revealed that SFCs are connected to their first- and second-tier suppliers with stronger social ties than those formed between non-SFCs and their suppliers. Results support the natural transaction cost economics and natural resource based perspectives.

Keywords*:* Environmental purchasing, Sustainable supply chains, Supplier relationships, Resource based view, Transaction cost economics

5.2. Introduction

Environmental management practices are becoming important in the academic field. The extensive literature research of Seuring and Muller (2008) showed that the number of academic publications dramatically increased in the sustainability field. At the same time, the market for environmentally friendly products is one of the fastest growing, most dynamic markets of the US economy. According to a study of Marketresearch.com, twelve percent of US consumers purchase environmentally friendly products and spend $230 billion a year on sustainable products and services.

One of the primary ways that firms have responded to this new market trend is to integrate sustainable development practices into their supply chain processes. After companies develop sustainable supply chain processes, they can easily distribute environmentally friendly products throughout their complex industrial networks. The purchasing function creates value and significantly affects the environmental actions of the firm and their supply chain (Carter et al., 2000). The results of Carter et al. (2000) demonstrate that environmental purchasing activities positively affect firm performance and suggest that purchasing and supply managers focus on such sustainability principles. This study was conducted on a large sample of supply chain coordinators and purchasing managers who are directly related with the buying and selling activities.

In previous parts of this study, we empirically proved that in production oriented industries, such as medical devices and industrials, sustainability-focused companies (SFCs) are more vertically integrated than their non-sustainable competitors. Additionally, in these industries, companies tend to increase their vertical integration level as they become more environmentally, economically, and socially sustainable. Furthermore, according to natural transaction-cost economics (TCE) perspective, companies increase their vertical integration level to decrease the contracting costs and

to avoid uncertainty and asset specificity. Parallel to this theory, the natural resource-based view (RBV) states that, companies increase their vertical integration level since their resources (i.e. inputs), which affect their environmental sustainability, are valuable, rare, inimitable, and non-substitutable.

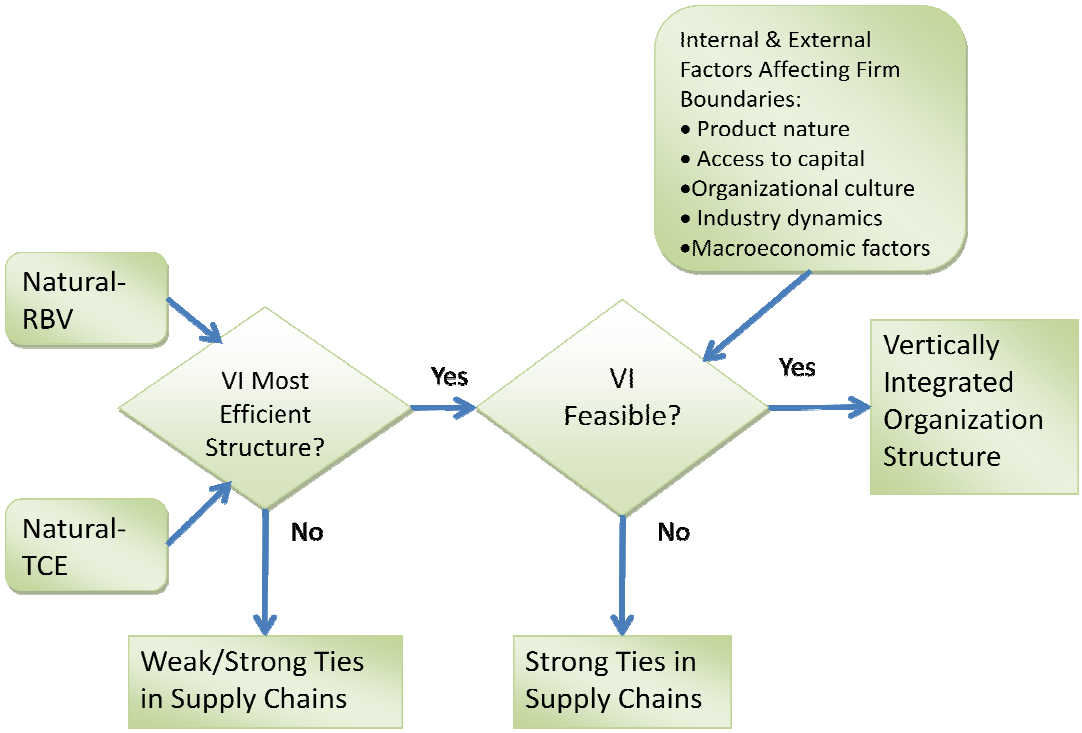

Figure 4. Sourcing Decisions of Sustainability-Focused Company

As illustrated in Figure 4, the natural-resource-based view (Hart, 1995) and natural transaction cost economics (Rosen, Bercovitz and Beckman, 2000) theories indicate that an increased level of integration across the supply chain is necessary to successfully pursue a sustainability-focused strategy. However, it is not always possible for companies to be vertically integrated due to factors that we mentioned in Chapter 4. When vertical integration is not feasible, companies may compensate by accruing

competitive advantage by other means. Several researchers have investigated the efficiency and inadequacy of vertical integration compared with contractual relations since the 1970s. Buzzell (1983) and Harrigan (1983) summarize the advantages of vertical integration as:

- reduced transaction costs (e.g. price shopping, communicating design details, negotiating contracts)
- power to guarantee supplies
- improved coordination of activities
- irreplicable products (e.g. superior service levels, customized development of special products)
- advanced technological capability (because of increased innovation)
- higher entry barriers to the market (i.e. improved marketing intelligence, product differentiation advantages, cost or demand forecast capability)

This part of the study will define the relationship between SFCs and their first- and second-tier suppliers and help us to understand if SFCs have an organizational structure that is a substitute for a vertically integrated organizational structure. For example, a firm may reduce transaction costs by fostering trust (Dyer and Chu, 2003) and building a good reputation. Similarly, firms may guarantee supplies by establishing long-term relationships (Paulraj and Chen, 2007) and strengthening inter-firm collaboration (Carson, Madhok, Varman and John, 2003, Sharma and Kearins, 2010). Firms may also move to improve coordination of activities through means other than direct ownership (Vachon and Klassen, 2008) and manufacture irreplicable products by transferring tacit knowledge (Lee, 2001). The results of this study will contribute to practitioners' effective environmental management strategies.

The rest of this paper is organized as follows: Section 3 provides background information on theory and hypothesis development, research objectives, and proposed hypotheses. After documenting the research design, sample, and data sources in Section 4, we analyze the data and present the results in Section 5. Finally, Section 6 concludes with a discussion of the study results, the limitations of the study, and thoughts regarding future research.

5.3. Theoretical Foundation and Hypotheses

A firm is classified as vertically integrated if one of its subsidiaries can, rather than outsourcing, use another of its subsidiary's products or services as input for its own production (Fan and Lang, 2000). The literature indicates that an increased level of integration across the supply chain is necessary in order to pursue a sustainability-focused strategy (Hart, 1995, Russo and Fouts, 1997). However, under some industry (Fine and Whitney, 1996), product (Christensen, 1994), and market conditions (Arya, Mittendorf and Sappington, 2008), having a vertically-integrated organizational structure is not feasible. Thus, there appears to be the potential for theoretical tension within some companies that set out to pursue a sustainability-focused strategy. That is, while firm capabilities, firm culture, and industry dynamics may make outsourcing the preferred solution, there is an added pressure to vertically integrate simply as a result of the pursuit of a sustainability-focused strategy.

In addition to our research results presented earlier, several other studies demonstrated that transaction cost economics and resource based view theories (i.e. vertical integration) positively affect environmental performance. Different from these studies, our research examines the impact of inter-organizational relationships, when vertical integration is not feasible. Our study makes three main contributions. First, it develops the theoretical foundation for linking sustainability strategies to inter-organizational g116

relationships. Second, it empirically examines the relationships of sustainability-focused and non-sustainable companies with their suppliers in their network. Finally, it compares these relationships to understand the differences that arise from different environmental strategies.

5.3.1. Research Objectives

The relationship between companies and their suppliers was measured using an online survey instrument to measure the strength of relationships between companies and their first- and second-tier suppliers and to understand:

1. if they have a relationship with suppliers that is a substitute for vertically integrated organizational structure,
2. if they are more socially connected to their suppliers compared to non-sustainable companies.

When vertical integration is not feasible, ensuring trust (Dyer and Chu, 2003) and collaboration (Carson, Madhok, Varman and John, 2003), guaranteeing supplies by establishing long-term relationships (Paulraj and Chen, 2007), improving coordination of activities (Vachon and Klassen, 2008), and manufacturing irreplicable products by transferring tacit knowledge (Lee, 2001) are necessary to preserve the effect of integration. Defining the relationship between SFCs and their first- and second-tier suppliers, to understand if they have an organizational structure that is a substitute for vertically integrated organizational structure, has the ability to inform the development of effective environmental management strategies.

5.3.2. The Development of Hypotheses

A set of hypotheses are developed based upon the Buzzell (1983) and Harrigan (1983) studies explained above; as well as the environmental management, transaction cost economics, resource based view literatures; and related frameworks from organizational theory. Through open discussions, I confirmed these hypotheses through five interviews and a focus group meeting with purchasing managers and executives. The details of literature are interviews elaborated upon below.

5.3.2.1. The Impact of Transaction Cost on Environmental Performance – Trust and Reputation

A transaction is defined by Commons (1934) as “a legal transfer of ownership.”.This transfer can be the transfer of goods or services (Williamson, 1985) or “the alienation and acquisition, between individuals, of the rights of future ownership of physical things, as determined by the working rules of society” (Commons, 1934). According to the transaction cost economics (TCE) theory, firms increase their transaction costs as the asset specificity increases because the management must develop safeguards to protect the firm from various hazards (Klein et al., 1978, Williamson, 1985).

Transaction costs can be decomposed into four separate costs related to transacting (Dahlman, 1979, Hennart, 1993, Holloway et al., 2000, North, 1990, Randall, 1972, Williamson, 1975, Williamson, 1985):

1. search cost occurs for exploring sustainable, efficient, and equitable ways of managing with obtaining information,
2. contracting costs, which are a response to the risk of exposure to opportunistic behavior (defined by Williamson (1985) as “self-interest seeking with guile”), is combined with incomplete contracts

3. monitoring costs refers to the costs associated with monitoring the contracts to ensure that each party fulfills the predetermined set of requirements

4. enforcing costs include “establishing one's bargaining position, bargaining and arriving at a group decision, and enforcing the decision made” (Randall, 1972).

To maintain the relationships in a consistent manner and overcome the hazards of opportunism, the focal company must adopt governance safeguards when they make transaction-specific investments (Klein, Crawford and Alchian, 1978, Williamson, 1985). Among the hazards with which transaction cost economics is concerned are the following:

1. *bilateral dependency:*

Since environmentally active suppliers implement specialized technologies and it is hard to transfer the uses of these technologies to other customers, SFCs may demand lower prices to continue buying. On the other hand, if the SFCs are dependent on the specialized environmentally friendly product and find it hard to find a supplier willing to implement necessary technologies in the market, suppliers may demand higher payments.

2. *hazards that accrue due to weak property rights:*

Both SFCs and suppliers may attempt to give information acquired from a particular transaction (e.g. proprietary information) to third parties to gain advantage in the transaction. This is also called involuntary knowledge and technology leakage or appropriability hazard (Hagedoorn et al., 2005, Oxley, 1997, Teece, 1986).

3. *measurement hazards* or *shirking hazard* stem from the risk that a supplier will take advantage of contractual responsibilities which is especially seen in developing countries (Rosen, Bercovitz and Beckman, 2000).

4. "*intertemporal* hazards, which can take the form of disequilibrium contracting, real-time responsiveness, long latency, and strategic abuse" (Williamson, 1996).

5. *hazards* that *result from weaknesses in the political, legal, and social rules* (i.e. institutional environment or rules of the game). The case study of Levy and Spiller (1994, Levy and Spiller, 1996) examined the performance of privatized telecommunications in different political and social circumstances. Weingast (1995) studied the economic role of political institutions especially the role of federalism for protecting markets in both England and the US.

The managers of the firms may utilize various safeguards to protect themselves against diverse hazards. Safeguard (or alternatively 'governance structure') is the term used to describe "a control mechanism which has the objective of bringing about the perception of fairness or equity" (Dyer, 1997). The key purpose of safeguards is to prevent opportunism, provide control and trust (Williamson, 1985) and to specify the transactional relationship with multiple clauses and conditions that are necessary for transactions. Although the most noticeable safeguard employed in developed countries' economies is the legal contract, alternative self-enforcing safeguards have been proposed from other disciplines like trust and reputation.

Rosen et al. (2000) investigate the contracting mechanisms of firms in the computer industry which encourage suppliers to implement environmental management systems in their production operations. Their study found that the firms that pursue environmental management strategies are more concerned about potential expropriation and shirking hazards compared to their competitors in the same industry. Additionally, sustainability-

focused computer firms prefer relational and neo-classical, rather than classical arm's-length, contracting when they are organizing their relationships with other companies.

The strategic management literature argues that relational norms, such as trust, reduce transaction costs (Doney and Cannon, 1997, Dyer and Chu, 2003), in other words, function as self-enforcing safeguards (Dyer, 1997). Trust and its underlying normative behaviors are more effective and less costly substitutes for both contracts and vertical integration (Adler, 2001, Granovetter, 1985, Uzzi, 1997). In addition to this substitution position, contracts and relational governance (i.e. trust, communication, and cooperation) operate as complements (Poppo and Zenger, 2002).

Furthermore, some scholars argue that development of strong ties is necessary only when significant hazards are present because dense social ties may restrict firms from new information and new opportunities (Gargiulo and Benassi, 2000, Uzzi, 1997), and require significant time and resource allocation (Larson, 1992). Empirical work generally shows that relational governance is associated with trust and that trust improves the performance (Chow, 2008) of inter-organizational exchanges such as information (Chu and Fang, 2006, Ghosh and Fedorowicz, 2008, Klein, 2007) and technology (Kwon and Suh, 2005). Finally, Sharfman (2009) argued that developing inter-firm trust is a critical element of cooperative ways to solve environmental challenges.

A firm that is unsuccessful at fulfilling its obligations sacrifices its reputation with current customers, revokes any possibility of successive business relationships, and loses other potential customers (Boulding and Kirmani, 1993). The loss of current and potential businesses, due to lack of reputation, causes extra searching, contracting, and enforcing costs (Kwon and Suh, 2004, Suh and Houston, 2010).

Aalbers and Van der Laan (2006) examined how reputation impacts the inter-firm relationships in the Dutch biotech industry. They found that, especially in high dynamic markets, reputation is used as a self-enforcing coordination mechanism. Since it reduces the uncertainty between partners and leads to more trust, reputation decreases the overall transaction costs of alliances. As for the impact of reputation on supply chain performance, the study of Eltantawy et al. (2009), which was conducted on 161 purchasing managers, found that perceived reputation has a positive influence on the ability to contribute to the accomplishment of goals, effectiveness, and efficiency of the supply chain members. Thus, we argue that developing inter-firm trust and reputation along the supply chain improves the company's environmental performance.

Hypothesis 1: As a company establishes trust and reputation in supplier relationships, its environmental performance improves.

5.3.2.2. Impact of Power to Guarantee Supplies on Environmental Performance (Supply Assurance - Long-Term Relationship)

The supply uncertainty among suppliers; which is related to the unpredictable nature of the quantity, quality, and timing of supply; causes inefficiency and results in higher long-term costs for buyers (Dowlatshahi, 1999, Paulraj and Chen, 2007). Supply uncertainty could occur as a result of lack of strong buyer-supplier relationships (Dowlatshahi, 1999) and can be solved with long-term collaborative relationships with primary suppliers (Manoocheri, 1984). The expectation of a long-term relationship has a positive effect on the level of cooperation between two interacting firms (Carson, Madhok, Varman and John, 2003, Heide and Miner, 1992). A recent body of academic research demonstrates that SFCs are likely to explore long-term buyer-supplier relationship to solve

environmental challenges since this type of relationship makes solving challenging environmental problems easier or more effective (Sharfman, Shaft and Anex, 2009). Simpson et al. (2007), who looked at green supply chains from the relationship perspective, found that suppliers' environmental performance improved when increasing levels of relationship-specific investment occurred. Thus, we argue that establishing long-term relationships along the supply chain improves the company's environmental performance.

Hypothesis 2: As a company develops long-term relationships with suppliers, its environmental performance improves.

5.3.2.3. Impact of Improved Coordination of Activities on Environmental Performance - Collaboration

We evaluated supplier coordination activities in four main areas.

The first area is "supplier assessment." Lamming's (1996) interviews revealed that SFCs make three types of assessments to coordinate their suppliers' activities. First, they use a series of questionnaires that measure their attitude towards customer concerns, supplier seminars, and environmental policies. Second is the complete audit of supplier's raw materials and compliance against regulated pollution levels. Third is about carrying out lifecycle analysis (Hindle et al., 1993) based on customers' concerns.

The second area is "detailed purchasing policies and procedures." SFCs design supplier assessment systems (Handfield et al., 2002, Lu et al., 2007, Noci, 1997) to evaluate suppliers' environmental performance with respect to integrating environmental criteria into their purchasing policies and procedures (Green et al., 1996)). Handfield et al.

(2002) found that adopting a well-developed supplier assessment system helps SFCs to have clear guidance on selecting suppliers that have “greener” products and processes.

Existing and comprehensive purchasing policies and procedures allow companies to facilitate the integration of environmental sustainability into corporate strategies (Bowen, Cousins, Lamming and Farukt, 2001). Some small and medium-sized companies find it difficult to implement environmental strategies because of their limitations in budgets and human resources (Aragón-Correa et al., 2008, Williamson and Lynch-Wood, 2001). Using the analytical hierarchy process, Lu et al. (2007) developed a method to help managers evaluate different green supply chain projects.

The third area is “Environmental Collaboration.” SFCs plan environmental strategies and set relevant goals together with their suppliers to reduce the environmental impact on production processes and products (Green, Morton and New, 1996, Lamming and Hampson, 1996, Piluso and Huang, 2009). Joint environmental planning and goal setting (Vachon and Klassen, 2008) with suppliers develop organizational capabilities (Lorenzoni and Lipparini, 1999) which help companies to improve environmental performance (Hart, 1995).

Various examples and studies are presented in the sustainable supply chain literature to link environmental collaboration to manufacturing performance. The results of Geffen and Rothenberg (2000) point to the improvements in environmental performance when innovative technology and flexible management approaches are combined with supplier collaboration. While examining the furniture industry, Handfield et al. (1997) found that supplier collaboration can significantly affect environmental results achieved within a company. Klassen and Vachon (2003) found that collaborative activities between a plant

and its suppliers have a considerable effect on the level and form of investment in environmental technologies that generates a range of positive environmental outcomes.

The final area is "Quality Management Systems." The relationship between pursuing proactive environmental management strategy and adopting quality management systems has been examined in the literature (Chen, 2001, Stanislav and Walter, 1998). As stated in the literature, they have numerous similarities (e.g. cost reduction, performance improvement, and creating competitive advantage), which facilitates the development of integrated systems (Tarí and Molina-Azorín, 2010). According to Klassen et al. (1993) integrating both environmental and quality management systems facilitates the training and education of the workforce and continuous improvement over the long term. Thus, we argue that improved coordination of activities and collaboration along the supply chain improves the company's environmental performance.

Hypothesis 3: As a company improves the coordination of supplier's operations, its environmental performance improves.

5.3.2.4. Impact of Creating Inimitable Products on Environmental Performance-Tacit Knowledge Sharing

The RBV theory asserts that sustained competitive advantage originates from the acquirement, development, and effective management of a firm's resources such as brand names, skilled personnel, trade contacts, machinery etc. (Peteraf, 1993, Wernerfelt, 1984). According to the literature in strategic management, valuable and rare firm resources may have potential to generate competitive advantage if they are costly to imitate (Barney, 1986, Lippman and Rumelt, 1982, Teece et al., 1997). The creation and

transfer of knowledge have been argued to be a potential source for competitive advantage in firms (Argote and Ingram, 2000, Kearns and Lederer, 2003).

Knowledge is classified into two types: tacit and explicit (Polanyi, 1966). While tacit knowledge is difficult to express, formalize, or communicate to others; explicit knowledge can be easily codified and abstracted as instructions, explanations, and procedures (Collins and Hitt, 2006, Lubit, 2001). Organization culture, intuitions, and wisdom derived from experience are examples of tacit knowledge. On the other hand, examples of explicit knowledge include concrete facts, documentation, standard routines within a firm, and supplier contact information (Collins and Hitt, 2006, Polanyi, 1966).

Leonard and Sensiper (1998) found that the tacit knowledge and expertise of employees form a resource that is difficult for competitors to imitate. The result of Haruyama (2009) revealed that research and development (R&D) creates tacit knowledge as joint products and stronger patent protection can encourage R&D depending on the size of an economy. In order to plan and set goals for environmental improvement collaboratively, the exchange of technical information is necessary and requires a common eagerness to learn about each other's operations (Vachon and Klassen, 2008). Through technical knowledge and experience sharing, collaborative activities influence the focal companies' environmental investments and technology adoption (Ashford, 1993) to reduce uncertainty and resistance to sources resistance associated with sustainable development (Kemp, 1993). Firms must promote a climate of recognition and sharing of employees' experiences for the identification of pollution sources, the management of emergency situations, and the development of preventive solutions (Boiral, 2002). Thus, we argue that recognition and sharing of tacit knowledge along the supply chain improves a company's environmental performance.

Hypothesis 4: As a company effectively shares tacit knowledge, its environmental performance improves.

5.3.2.5. Impact of Establishing Higher Entry Barriers to the Market on Environmental Performance

One of the advantages of vertical integration is creating high entry barriers to the market (Buzzell, 1983, Harrigan, 1983). When vertical integration is not possible, companies will search for opportunities to create other barriers to enter their markets. In their extensive literature review, Karakaya and Stahl (1989) established a broad list of barriers to entry in the industrial market and Karakaya (2002) determined the importance of each dimension with an empirical study. According to the results of this study, absolute cost advantage (Bain, 1956, Harrigan, 1981, Yip, 1982), having high market share (Urban et al., 1986), holding customer loyalty advantage (Bass, 1978; Porter, 1980), owning proprietary technologies (Harrigan, 1981, Schmalensee, 1981), and strengthening brand power (Krouse, 1984) are very important barriers necessary for entering an industrial market. Thus we argue that establishing higher entry barriers to market positively affects environmental performance.

Hypothesis 5: As a company creates higher entry barriers to the market, its environmental performance improves.

5.3.2.6. Impact of Second-Tier-Supplier Relationships on Environmental Performance

The collaboration with suppliers is not limited to the first-tier suppliers for environmental management. Companies must coordinate with second-tier suppliers to ensure that first-tier suppliers purchase socially responsible inputs and have a diverse supply base (Carter and Jennings, 2004).

Very big companies have been blamed in recent years for inhumane working conditions or contamination of the environment and protested by activists and non-governmental organizations. For example, Danish government fined IKEA, a Swedish furniture retailer, because of using formaldehyde in their building products at levels greater than allowable in the late 1980's. IKEA's sales dropped significantly following the public announcement. Although, IKEA quickly limited the suppliers' usage, a German newspaper and television station found formaldehyde emissions in one of the best selling products higher than the legislated requirement in 1992. Later, IKEA realized that this problem originated from the glue companies that sell the binding agent to their suppliers. After coordinating the second-tier suppliers, IKEA's current formaldehyde emissions became significantly below EU requirements (Ivarsson and Alvstam, 2010, Nattrass and Altomare, 1999).

IKEA was blamed for social issues after a Swedish television showed a documentary film about children workers in IKEA's supply chain in 1994. A rug company, which is the supplier to one of IKEA's first-tier exporter supplier, employed child workers. Because of the problems in controlling the second tiers in developing countries, IKEA faced criticism about child labor from various international organizations. Subsequently, IKEA hired experts to keep track of the problem and to execute investigation at its first- and second-tier supplier levels (Lévy et al., 2007).

At the beginning of 2010, Nestlé fought a battle with Greenpeace because of allegations that Nestlé bought palm oils from an Indonesian company that caused illegal deforestation. Greenpeace claimed that illegal deforestation, which was caused by Nestlé's suppliers, endangered orangutans by destroying their habitats. Although, the palm refiner was the third or fourth supplier following the local traders and international trader, Greenpeace released a report about Nestle's palm oil use, staged a protest outside its company headquarters, and posted a negative video on the Internet. Nestlé announced that it had broken ties with the Indonesian company and would complete an examination of its supply chain with a commitment to using only certified sustainable palm oil (Langheinrich and Karjoth, 2010, Tabacek, 2010). It can be inferred from the literature and real life examples that developing relationships with second-tier suppliers is very important for environmental management.

Hypothesis 6: As a company develops strong relationships with second-tier suppliers, its environmental performance improves.

As we stated earlier, when vertical integration is not feasible, companies compensate for the benefits of vertical integration by establishing strong-ties. A nomological network of hypotheses H1 through H6, relating the benefits of vertical integration with environmental performance is presented in Figure 5. The standardized path loadings and associated t-values, which will be discussed in later sections, are displayed in Figure 6 beside numbered hypotheses.

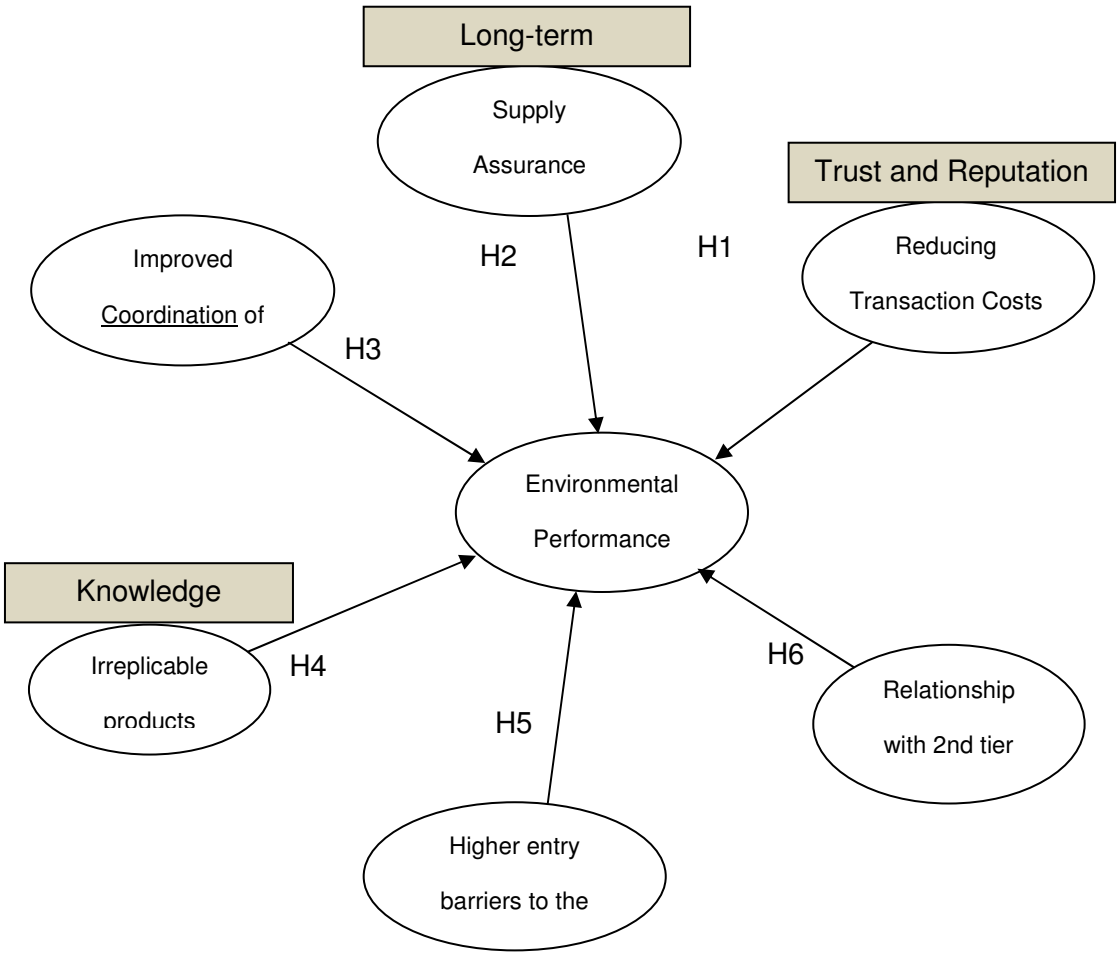

Figure 5. The Impact of Establishing Strong-Ties on Environmental and Financial Performance

5.4. Research Design

A cross-sectional email survey (i.e. a survey completed by a single respondent at a single point in time) was conducted with manufacturing companies in the United States. The survey instrument was distributed by five chapters of the Institute for Supply Management (ISM) that agreed to participate in our study. ISM chapters sent the survey instrument to selected members, who are the middle and top managers of purchasing or supply chain operations at large companies (i.e. have more than 1000 employees). Purchasing and supply chain departments are involved in the design of products for

disassembly, recycling, or reuse (Paton, 1993) through their interaction with manufacturing, marketing, and engineering departments (O'Neal, 1993); therefore, these departments contribute to firm's environmental initiatives (Carter, Kale and Grimm, 2000). Representative titles of selected survey participants are president, vice president, coordinator, manager of purchasing, materials management and supply chain management.

Survey items were measured on a 7-point Likert scale, where 1 denotes ''strongly disagree'' and 7 denotes ''strongly agree.'' The survey instrument was developed based on the literature reviewed. A total of six semi-structured interviews with industry experts were conducted to review the survey. The survey items were revised based on feedback received from three plant visits and three phone interviews with purchasing managers and supply chain coordinators. The literature source of each item can be found in Appendix E.

We utilized a modified version of Dillman's (1978) Total Design Method to maximize the response rate. Dillman's Total Design Method consists of a series of precisely defined strategies. In order to positively influence the response rate, researchers developed strategies during survey development and data collection. Such strategies include financial incentives, repeated emails, and an appealing survey design. The online survey was designed to minimize the respondents' cost (i.e. time, physical or mental effort, revealing personal information). Furthermore, 100 respondents, who were determined by a raffle, were awarded with a book. ISM chapters sent the link of online survey - including a cover explanation- via email to their six hundred and forty members who are working in separate companies. Two weeks after the initial email, a reminder email was sent to ISM members. The second reminder email was sent 30 days after the first reminder. A total of 187 questionnaires were collected, resulting in a 29% response rate.

After deleting 9 incomplete surveys, we obtained the effective response rate of 27%. The final sample of respondents included 24 purchasing presidents/vice presidents, 33 purchasing managers, 11 supply chain coordinators, 74 supply chain managers, and 36 others.

In our sample, we defined the companies as sustainability-focused companies (SFCs) if they are indexed in the following indices: Dow Jones Sustainability United States Index, The Global 100 Most Sustainable Corporations, and SB20: The World's Top Sustainable Business Stocks. Appendix A and Appendix B present the set of criteria and weightings of indices that are used to assess the economic, environmental, and social aspects of the companies. We assume that the companies that are listed in these sets are successful in pursuing and/or monitoring sustainability activities. The list of non-sustainable companies is not available; hence, we assume that the companies that are not listed in these sets are not pursuing and/or monitoring sustainability activities as successfully as listed companies.

From the final sample of 178 respondents, 71 companies are accepted as SFCs and remaining 107 companies are accepted as non-SFCs. The mean annual sales of respondent SFCs were $4.6 billion and non-SFCs were $2.4 billion. The mean employee number of respondent SFCs was 88,000 and non-SFCs was 45,000. A broad range of manufacturers was represented in the sample, including medical devices, pharmaceutical, electronics, heavy work machines, food and beverages, textile, recreational and sporting goods, and apparel.

Non-response bias, which is a potential limitation of survey research, occurs when respondents and non-respondents differ in outcome variables (Armstrong and Overton, 1977, Lambert and Harrington, 1990). A widely used approach is to estimate the non-

response bias by comparing early and late respondents; a late respondent is then used as a proxy for a non-respondent (Lahaut et al., 2003). Depending on the receiving dates, the final sample was separated into two parts. The early respondents group consisted of 108 responses while the late respondents group consisted of 70 responses. We used The Hotelling Trace coefficient (also called Lawley-Hotelling or Hotelling-Lawley Trace) for a multivariate test of mean differences between the two groups. The test results indicated that early respondents did not display significant differences from late respondents (p = .5436).

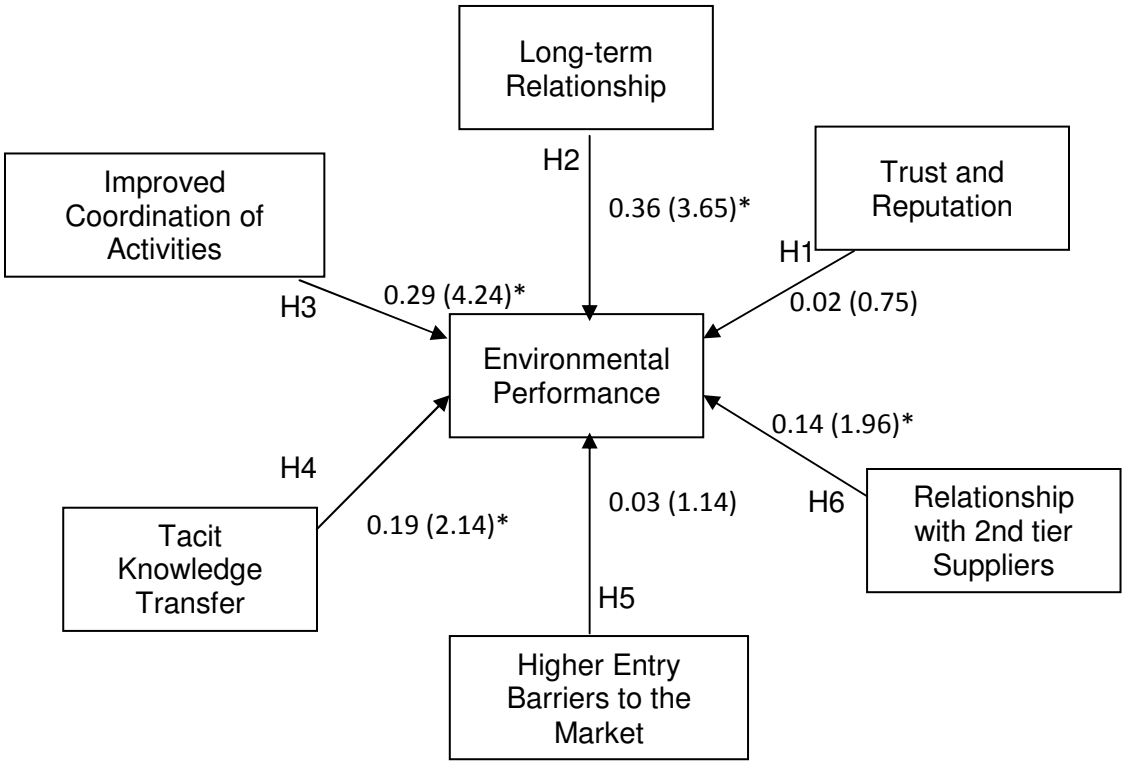

Figure 6. Standardized Parameter Estimation of Model

Model Fit: GFI=0.91; AGFI=0.95; NFI=0.92; *NNFI=0.65*; CFI=0.91; RMSR=0.05; *RMSEA=0.17,* Standardized path coefficients appear on arrows; t values are given in parentheses, *p < 0.05

5.5. Data Analysis and Results

Descriptive statistics, reliability measures, and inter-correlations for all study variables are presented in Table 13. The most common measure of reliability, Cronbach's coefficient alpha (Cronbach, 1951), was used to measure the reliability (Peter, 1979) of scale items. The coefficient alpha values, which are above the 0.70 recommended minimum, provides evidence of scale reliability (Nunnally, 1978).

5.5.1. Hypothesis Testing

In the first part of our analysis, we tested if SFCs have an organizational structure that is a substitute for pure vertical integration. Using structural equation modeling, we would like to test if each benefit of vertical integration predicts the environmental management performance of sustainability-focused companies. Structural equation modeling is a widely employed method since it provides a mechanism for explicitly taking into account measurement in the observed variables. However, our survey instrument has 30 usable items; therefore, testing such a model requires around 200 respondent surveys (Marsh et al., 1988). Since our sample size is only 71, full latent variable structural equation modeling was not applied. However, since Cronbach's alpha of all the scale items is above the conventional reliability criterion of 0.7, combining all scale items as observed values rather than using individual item scores is permissible. The combination reduces the number of model parameters to a reasonable number that can be used with small sample sizes as is seen in the study of Bowen, et al. (2001).

Figure 6 presents the results of our model, which is based on the covariance matrix and the use of maximum likelihood estimation, using LISREL 8.53 (Joreskog and Sorbom, 1993). The parameter estimates and significance levels of hypotheses are given in Figure 6. Four of the six hypothesized relationships were found to be significant. The

calculated fit indices given in Figure 6 provide an adequate fit to the data given the relatively small sample size. Although the RMSEA > 0.1 and NNFI < 0.9, our model can be acceptable since NFI > 0.9 and GFI> 0.9. Similar results was obtained in the study of Bowen et al. (2001). The definitions of fit indices we used here can be obtained from Raykov and Marcoulides(2006).

The hypothesized relationships were tested using their associated t-statistics. H1 proposed that as sustainability-focused companies (SFCs) establish trust and reputation, its environmental performance improves. A significant relationship was not found between establishing trust and environmental performance, based on the path loading in Figure 6 ($b = 0.02$, $t = 0.75$, $p > 0.05$). Environmental performance was not predicted by trust and reputation; thus, H1 is rejected.

H2 posited that as SFCs establish their long term relationships, their environmental performance improves. The path loading was positive and significant ($b = 0.36$, $t = 3.65$, $p < 0.05$). Environmental performance was predicted by establish long term relationships; thus, H2 is supported.

H3 stated that as SFCs increase the coordination of suppliers, their environmental performance improves. A significant relationship was found between improving coordination of suppliers and environmental performance, based on the path loading in Figure 6 ($b = 0.29$, $t = 4.24$, $p < 0.05$). Environmental performance was predicted by improved coordination; thus, H3 is supported.

H4 posited that as SFCs transfer their tacit knowledge (i.e. know-how, experience), their environmental performance improves. The path loading was positive and significant ($b = 0.19$, $t = 2.14$, $p < 0.05$). Environmental performance was predicted by tacit knowledge transfer; thus, H4 is supported.

H5 proposed a positive relationship between establishing higher entry barriers to market and environmental performance. An examination test statistics led to a rejection of this hypothesis ($b = 0.03$, $t = 1.14$, $p > 0.05$). Environmental performance was not predicted by establishing higher barriers to the market; thus, this finding led to a rejection of H5.

Finally, H6 proposed that the establishing relationships with second-tier suppliers would lead to increased levels of environmental performance. A significant relationship was found between establishing relationships with second-tier suppliers and environmental performance, based on the path loading in Figure 6 ($b = 0.14$, $t = 1.96$, $p < 0.05$). Environmental performance was predicted by second-tier supplier relationships; thus, H6 is supported.

5.5.2. Comparing Relationships of SFCs with Non-SFCs

The second objective of our research was to evaluate the supplier relationships of SFCs and non-SFCs to understand if SFCs are more socially connected to their suppliers compared to non-sustainable companies. The One-Way Analysis of Variance was used to compare the means of vertical integration benefits and second–tier supplier relationships. The Table 14 presents the results of analysis. The results illustrated that there is a significant difference between SFCs and non-SFCs for each benefit of vertical integration and second-tier supplier relationships (i.e. model constructs). As we can see from the table, the mean values of SFCs are higher than non-SFCs. Therefore we can say that SFCs have stronger ties with their first- and second-tier suppliers than non-SFCs.

Table 13. Descriptive Statistics and Inter-Correlations of the Model Constructs

Construct	(α) ***	Mean	Std. Dev	1	2	3	4	5	6	7
Sustainability Focused Companies										
1. Trust and Reputation	0.82	5.38	0.854	1						
2. Long Term Relationships	0.75	5.68	0.874	.543**	1					
3. Improved Coordination	0.76	5.66	0.871	.664**	.801**	1				
4. Tacit Knowledge Transfer	0.72	5.13	0.958	.584**	.628**	.778**	1			
5. Higher Entry Barriers to Market	0.76	5.27	0.835	.648**	.685**	.740**	.767**	1		
6. 2nd tier Suppliers Relationship	0.84	5.12	1.318	.426**	.519**	.623**	.621**	.557**	1	
7. Environmental Performance	0.74	5.55	0.831	.409**	.509**	.545**	.558**	.451**	.411**	1
Non-Sustainability Focused Companies										
Construct	(α) ***	Mean	Std. Dev	1	2	3	4	5	6	7
1. Trust and Reputation	0.82	4.95	0.831							
2. Long Term Relationships	0.75	5.09	0.885	.405**	1					
3. Improved Coordination	0.76	5.10	1.001	.443**	.576**	1				
4. Tacit Knowledge Transfer	0.72	4.68	0.834	.259*	.607**	.437**	1			
5. Higher Entry Barriers to Market	0.76	4.94	1.013	.287**	.495**	.594**	.426**	1		
6. 2nd tier Suppliers Relationship	0.84	4.92	1.074	.113	.189	.355**	.180	.140	1	
7. Environmental Performance	0.74	.113	.189	.264*	.570**	.368**	.449**	.273*	.215*	1

* Correlation is significant at the 0.05 level;

** Correlation is significant at the 0.01 level;

*** Cronbach's alpha values were calculated for the complete set of surveys and 0.70 and higher indicate acceptable construct reliability.

Table 14. Descriptive Statistics and Mean Comparison for Each Construct

		N	Mean	Std. Dev.	F	p-value
Trust	Sustainable	71	5.38	.860	13.328	.000**
	Non-Sustainable	107	4.95	.835		
Long-Term Relationships	Sustainable	71	5.68	.881	9.201	.003**
	Non-Sustainable	107	5.09	.889		
Improved Coordination	Sustainable	71	5.66	.878	15.629	.000**
	Non-Sustainable	107	5.10	1.006		
Knowledge Transfer	Sustainable	71	5.15	.965	12.315	.001**
	Non-Sustainable	107	4.70	.841		
Higher Barriers to Market	Sustainable	71	5.27	.841	9.129	.003**
	Non-Sustainable	107	4.94	1.018		
2nd-tier Supplier Relationships	Sustainable	71	5.13	1.331	4.246	.041*
	Non-Sustainable	107	4.28	1.403		
Environmental Management	Sustainable	71	5.55	.838	14.575	.000**
	Non-Sustainable	107	4.91	1.080		

* Significant at $p \leq 0.05$;

** Significant at $p \leq 0.01$

5.6. Discussion

The first objective of our study was to understand if sustainability-focused companies (SFCs) develop strong relationships with their suppliers to increase their environmental performance when producing subcomponents in their own facilities is not profitable. Four of our hypotheses were supported by the data. Analysis of our online survey results demonstrated that environmental performance of companies was predicted by established long-term and second-tier supplier relationships, improved collaboration, and transferred tacit knowledge. According to these supported hypotheses, companies

establish long-term relationships, effectively transfer know-how and experience (i.e. tacit knowledge), increase collaboration, and create strong connections with their second-tier suppliers to improve their environmental performances when vertical integration is not feasible.

The second objective of our study was to understand if SFCs have stronger ties with their first- and second-tier suppliers compared to non-sustainable companies. The result of our ANOVA analysis showed that there is a significant difference between SFCs and non-SFCs regarding their social connectedness to first- and second-tier suppliers. The descriptive statistics illustrate that SFCs establish stronger trust, more long-term relationships, increased collaboration, efficient knowledge transfer, and stronger 2nd-tier supplier relationships when compared to non-SFCs.

The study results should be useful to researchers who are specialized in natural resource based view, natural transaction cost economics, and environmental management. Moreover, the study results showed practitioners the importance of establishing strong ties with suppliers while pursuing corporate sustainability strategies. Our study offers relatively strong support for the natural resource-based view advanced by Hart (1995). He argued that companies increase their vertical integration level since their resources (i.e. inputs), which affect their environmental performance, are valuable, rare, inimitable, and non-substitutable. The tacit resource (e.g. knowledge) transfer increases the value of products; therefore, they become rare, inimitable, and non-substitutable (Leonard and Sensiper, 1998, Teece, 1982, Winter, 1987).

Previously I showed that SFCs tend to be more vertically integrated than their counterparts. Furthermore, in this part of the research, I found that SFCs are more

socially connected, and this connectedness is a substitute for vertical integration. Therefore, the result of the current study is consistent with our previous studies.

Our findings raise an interesting circumstance about establishing trust relationships with suppliers. I observed that SFCs establish stronger trust relationships compared to non-SFCs; however; hypothesis 1 - as a company establishes trust and reputation in supplier relationships, its environmental performance improves - was not supported. The reason may be our limited number of SFCs or the nature of companies in our sample. The future research should investigate the effect of trust with a wider sample of companies. Therefore, our survey results partially support the natural-transaction cost economics theory.

Nevertheless, there are certain limitations to this study which must be considered. First, our survey was sent to one person from each company. In the cover letter that accompanied the survey, I asked participants to respond to the questions based on general company strategies. Although I paid great attention to establishing the reliability and validity of our data, the survey results may still include the personal opinions of participants. A future study may focus on small set of companies and conduct deeper analysis of corporate strategies in the subsidiary and department levels.

Second, our study consists of a company set that is limited to three sustainability indices that are previously mentioned. The future study can use the set of companies that includes the environmental award winner companies as utilized by Klassen and McLaughlin (1996). Because of this limitation in our study, we could not develop a full structural equation modeling. If the future studies utilize a wider set of companies, the sample size will be larger than the number of estimated parameters which allows using constructs as latent variables rather than observed variables.

CHAPTER 6:

CONCLUSION

This dissertation focuses on three main objectives:

1. Test the hypothesis that sustainability-focused companies (SFCs) tend to be more vertically integrated than their non-SFC counterparts.
2. Measure the change in vertical integration level over time as a company becomes more environmentally aware.
3. Apply social network analysis to the study of supply chain network structure to understand if the supply chain relationship characteristics of SFCs are a substitute for pure vertical integration.

The first objective was accomplished in two parts as presented in Chapter 2 and 3. In Chapter 2, I compared the recently developed Davies and Morris's, Fan and Lang's, and Hortacsu and Syverson's indices. The results provide information that there is an inconsistency between the results Hortacsu and Syverson and the other two indices. For that reason, it is not known whether or not these indices accurately measure the vertical integration. Buzzell (1983) examined the impact of vertical integration on profitability with using VA/S and stated that vertically integration has a strong impact on the profitability of the companies. On the other hand, Maddigan and Zaima (1985) could not find a relation between VI and profitability with using VIC method. These inconsistencies among the measurements are no doubt the reason for the contradictory results and lack of a generally accepted VI measurement. The researchers may select one of these methods

by utilizing the discussions about methods and databases. Our analysis suggests adoption of the Fan and Lang's method because of the easiness and accuracy in the application of this method.

In Chapter 3, I compared the vertical integration level of sustainable and non-sustainable companies. Literature of natural-resource-based view (e.g. Hart (1995) and Russo and Fouts (1997)) and natural-transaction-cost-economics theory (e.g. Carter and Carter (1998) and Finon and Perez (2007)) propose increasing the vertical integration level for sustainable companies. Carter and Carter (1998) measured the vertical coordination through the supply chain with a survey and concluded that vertical integration increase the environmental performance of the companies. In the literature, the linkage between environmental strategies and vertical integration has not been examined with an economy-based vertical integration index. This study attempts to fill this gap by measuring the vertical integration with Fan and Lang's method and trying to understand if the sustainable companies tend to be more vertically integrated than their non-sustainable counterparts. The results demonstrate that sustainability-focused companies in the Health Care and Industrials industries tend to have more vertically integrated organizational structures than their industry non-sustainable competitors. There was no significant difference in the vertical integration level of sustainability-focused versus non-sustainability-focused companies for the other seven industries studied.

Higher vertical integration may not be possible under some industry, product, market, and economic conditions. Under these circumstances, sustainable companies may prefer to increase the social capital with its suppliers to eliminate the effect of disintegration. Future research direction should be defining the social ties between sustainability-focused companies and their first and second tier suppliers to understand

if they have an organizational structure that is a substitute (or at least complementary) to a pure vertically-integrated organizational structure.

In Chapter 4, I compared the vertical integration level of companies and any changes in their environmental strategies over the period time to understand how SFCs change their organizational structure as they become more environmentally, economically, and socially sustainable. To avoid the industry effect, I selected companies only from a single industry. I used three indices to determine the SFCs; with the combination of these indices and limitation of the databases I observed 10 SFCs in the industrials industry.

I analyzed the annual reports of SFCs for the years 1987, 1992, 1997, and 2002. The result of our content analyses assigned a sustainability development score for each SFC based on the three aspects of sustainable development: environmental, economical, and social sustainability. Moreover, I measured the vertical integration level of companies using the Fan and Lang (2000) method for these four years panel. After collecting our data, conducting content analysis and vertical integration calculations, I analyzed the trend in both vertical integration and sustainability development of the companies. Furthermore, using the spearman correlation test, I observed how organizational structure coevolved with sustainable development over the period of time.

The results of our analyses indicated that there is an increasing trend in both sustainable development and vertical integration level for the companies in the industrials industry. In addition to the increasing trend, the vertical integration level increased parallel to the sustainability developments of companies. To produce environmentally friendly products and processes, SFCs would like to increase their control of their suppliers. As stated by natural-transaction cost economics, to decrease the contracting costs, and to avoid uncertainty and asset specificity, companies increase their vertical integration level.

Parallel to this theory, as stated by natural- resource based view, companies increase their vertical integration level since their resources (i.e. inputs), which affect their sustainability, are valuable, rare, inimitable, and non-substitutable. These results contribute to our previous study, and to the natural-transaction cost economics and natural resource based view theories.

Other future research directions are suggested by the limitations of our study. Our results are based on relatively small sample, and on an unusual sampling strategy. Therefore, future studies may consider additional indices or methods for determining sustainability focused companies. As the time I prepared this study only 2002 data were available; therefore, the future studies may use 2007 data after December 2011.

In our study, to examine the co-evolution of VIL and SDS scores, I wanted to limit external factor that affect this relationship. For instance, I selected companies from the same country to avoid the country and macro effects, from the same industry to avoid the industry effects, and from the same economical or financial level to avoid some micro effects. Although these are the main factors, there may be other small factors. Even though I consider time effect, future studies may consider additional micro level factors.

In Chapter 5, the first objective was to understand if sustainability-focused companies (SFCs) develop strong relationships with their suppliers to increase their environmental performance when producing subcomponents in their own facilities is not profitable. Four of our hypotheses were supported by the data. Analysis of our online survey results demonstrated that environmental performance of companies was predicted by established long-term and second-tier supplier relationships, improved collaboration, and transferred tacit knowledge. According to these supported hypotheses, companies

establish long-term relationships, effectively transfer know-how and experience (i.e. tacit knowledge), increase collaboration, and create strong connections with their second-tier suppliers to improve their environmental performances when vertical integration is not feasible.

The second objective of Chapter 5 was to understand if SFCs have stronger ties with their first- and second-tier suppliers compared to non-sustainable companies. The result of our ANOVA analysis showed that there is a significant difference between SFCs and non-SFCs regarding their social connectedness to first- and second-tier suppliers. The descriptive statistics illustrate that SFCs establish stronger trust, more long-term relationships, increased collaboration, efficient knowledge transfer, and stronger 2nd-tier supplier relationships when compared to non-SFCs.

The study results should be useful to researchers who are specialized in natural resource based view, natural transaction cost economics, and environmental management. Moreover, the study results showed practitioners the importance of establishing strong ties with suppliers while pursuing corporate sustainability strategies. Our study offers relatively strong support for the natural resource-based view advanced by Hart (1995). He argued that companies increase their vertical integration level since their resources (i.e. inputs), which affect their environmental performance, are valuable, rare, inimitable, and non-substitutable. The tacit resource (e.g. knowledge) transfer increases the value of products; therefore, they become rare, inimitable, and non-substitutable (Leonard and Sensiper, 1998, Teece, 1982, Winter, 1987).

Previously I showed that SFCs tend to be more vertically integrated than their counterparts. Furthermore, in this part of the research, I found that SFCs are more

socially connected, and this connectedness is a substitute for vertical integration. Therefore, the result of the current study is consistent with our previous studies.

Our findings raise an interesting circumstance about establishing trust relationships with suppliers. I observed that SFCs establish stronger trust relationships compared to non-SFCs; however; hypothesis 1 - as a company establishes trust and reputation in supplier relationships, its environmental performance improves - was not supported. The reason may be our limited number of SFCs or the nature of companies in our sample. The future research should investigate the effect of trust with a wider sample of companies. Therefore, our survey results partially support the natural-transaction cost economics theory.

Nevertheless, there are certain limitations to this study which must be considered. First, our survey was sent to one person from each company. In the cover letter that accompanied the survey, I asked participants to respond to the questions based on general company strategies. Although I paid great attention to establishing the reliability and validity of our data, the survey results may still include the personal opinions of participants. A future study may focus on small set of companies and conduct deeper analysis of corporate strategies in the subsidiary and department levels.

Second, our study consists of a company set that is limited to three sustainability indices that are previously mentioned. The future study can use the set of companies that includes the environmental award winner companies as utilized by Klassen and McLaughlin (1996). Because of this limitation in our study, I could not develop a full structural equation modeling. If the future studies utilize a wider set of companies, the sample size will be larger than the number of estimated parameters which allows using constructs as latent variables rather than observed variables.

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APPENDICES

Appendix A. Criteria and Weightings for Dow Jones Sustainability Index

Table A. Criteria and Weightings for Dow Jones Sustainability Index

Dimension	Criteria	Weighting (%)
Economic	Codes of Conduct / Compliance / Corruption & Bribery	6.0%
	Corporate Governance	6.0%
	Risk & Crisis Management	6.0%
	Industry Specific Criteria	Depends on Industry
Environment	Environmental Reporting*	3.0%
	Industry Specific Criteria	Depends on Industry
Social	Corporate Citizenship/ Philanthropy	3.0%
	Labor Practice Indicators	5.0%
	Human Capital Development	5.5%
	Social Reporting*	3.0%
	Talent Attraction & Retention	5.5%
	Industry Specific Criteria	Depends on Industry

*Criteria assessed based on publicly available information
Source**:** http://www.sustainability-index.com/07_htmle/assessment/criteria.html

Appendix B. Criteria and Weightings for Global 100 Sustainable Company List

Table B. Criteria and Weightings for Global 100 Sustainable Company List

Dimension	Calculation Methodology	Weighting
Energy Productivity*	US$ sales / Gigajoules of total energy consumed	75%
	Increase in resource productivity equal to or exceeding 6% per annum	25%
Water Productivity*	US$ sales / total cubic meters of water consumed	75%
	Increase in resource productivity equal to or exceeding 6% per annum	25%
Carbon Productivity*	US$ sales / Metric tons of total CO2e emitted	75%
	Increase in resource productivity equal to or exceeding 6% per annum	25%
Waste Productivity*	US$ sales / Metric tons of total waste produced	75%
	increase in resource productivity equal to or exceeding 6% per annum	25%
Leadership Diversity	the percentage of women on the Board of Directors	100%
CEO-to-average worker pay*	Highest company compensation package in US$ / Average employee compensation in US$	75%
	Average employee compensation calculated as total company compensation / total employees	25%
Taxes Paid	(US$ Statutory tax obligation – US$ Cash taxes paid) / US$ Statutory tax obligation 1-the result in #1 up to a maximum of 100%	100% of Maximum
Sustainability Leadership**	Binary system with 1 awarded for presence of a sustainability committee within the company and 0 for absence	25%
	Binary system with 1 awarded for presence of at least one Board member on the committee and 0 for absence	75%
Sustainability Pay Link	Binary system with 1 awarded for at least one Director's remuneration being linked to extra-financial performance and 0 for absence of a link	100%
Innovation capacity*	US$ R&D / US$ Sales	100%
Transparency**	Binary system with 1 awarded for disclosure on a specific data point and 0 for absence for of disclosure. (e.g. total workforce; R&D expenditures, etc.)	50%
	Score of 0 to 1 awarded for level of GRI Adherence and Verification	50%

*Final score (0-1) based on a normalized z-score.
**Final score (0-1) based on a weighted average.
Source: www.global100.org

Appendix C. List of Sustainability-Focused Companies in the Sample

Basic Materials
- Alcoa Inc.
- Apogee Enterprises Inc.
- Dow Chemical Co.
- E.I. DuPont de Nem. & Co.
- Newmont Mining Corp.
- Praxair Inc.

Consumer Goods
- Campbell Soup Co.
- Coca-Cola Co.
- Eastman Kodak Co.
- Ford Motor Co.
- General Mills Inc.
- Herman Miller Inc.
- Johnson Controls Inc.
- Kimberly-Clark Corp.
- Kraft Foods Inc.
- Nike Inc.
- PepsiCo Inc.
- Procter & Gamble Co.
- Reynolds American Inc.
- Whirlpool Corp.

Consumer Services
- Chipotle Mexican Grill
- DeVry Inc.
- Dun & Bradstreet Corp.
- Gap Inc.
- H&R Block Inc.
- J.C. Penney Co Inc.
- Kohl's Corp.
- Macy's Inc.
- Marriott Intl Inc.
- McDonald's Corp.
- McKesson Corp.
- Pitney Bowes Inc.
- Safeway Inc.
- Starbucks Corp.
- Target Corp.
- Time Warner Inc.
- Walgreen Co.
- Walt Disney Co.
- Whole Foods Market Inc.

Financials
- Allstate Corp.
- American Int. Group Inc.
- Chubb Corp.
- Citigroup Inc.
- NYSE Euronext
- Goldman Sachs Gr. Inc.
- JPMorgan Chase & Co.
- MasterCard Inc.
- Morgan Stanley
- Plum Creek Timber Co Inc.
- ProLogis
- Travelers Cos Inc.

Health Care
- Abbott Laboratories
- Baxter International Inc.
- Allergan Inc.
- Becton Dickinson & Co.
- Bristol-Myers Squibb Co.
- Genzyme Corp.
- Humana Inc.
- Johnson & Johnson
- Life Technologies Corp.
- Medtronic Inc.
- Merck & Co. Inc.
- Millipore Corp.
- Novartis AG
- Quest Diagnostics Inc.
- UnitedHealth Group Inc.

Industrials
- 3M Co.
- Accenture Ltd.
- Agilent Technologies Inc.
- Boeing Co.
- Caterpillar Inc.
- Cummins Inc.
- Ecolab Inc
- General Electric Co.
- IMS Health Inc.
- Interface Inc.
- Lindsay Corp.
- Manpower Inc.
- Masco Corp.
- MeadWestvaco Corp.
- Rockwell Collins Inc.
- United Parcel Service Inc.
- United Technologies Corp.
- Weyerhaeuser Co.
- Xerox Corp

Oil & Gas
- FMC Technologies Inc.
- Fuel Tech Inc.
- ConocoPhillips Inc.
- Chevron Corp.
- Noble Corp.
- Schlumberger Ltd.
- Occidental Petroleum
- Smith International Inc.

Technology
- Advanced Micro Devices
- Applied Materials Inc.
- Autodesk Inc.
- Cisco Systems Inc.
- Comverge Inc.
- Dell Inc.
- First Solar Inc.
- Google Inc.
- Hewlett-Packard Co.
- IBM Corp.
- Intel Corp.
- Maxwell Technologies
- Microsoft Corp.
- Motorola Inc.
- Symantec Corp.

Utilities
- Consolidated Edison Inc.
- Duke Energy Corp.
- Entergy Corp.
- Exelon Corp.
- FPL Group Inc.
- Ormat Technologies
- PG&E Corp.
- Pinnacle West Capital
- Progress Energy Inc.
- Public Service Enterprise
- Spectra Energy Corp.

Appendix D. Example of Measuring Vertical Integration Level with Fan and Lang Method

Table C. Example of Measuring Vertical Integration Level with Fan and Lang Method

Company	Segment Name	NAICS	Sale in NAICS (M$)	w_j	Total Sales of NAICS	a_{ij}	a_{ji}	v_{ij}	v_{ji}	V_{ij}	V
H&R Block Inc.	Tax Services	541200	1,947		101,089.2						0.0019
	Mortgage Services	522A00	1,150	0.6443	206,138	208	279.9	0.001	0.003	0.00189	
	Business Services	541200	434.1	0.2432	101,089.2	108.5	108.5	0.001	0.001	0.00107	
	Investment Services	523000	200.8	0.1125	323,927.6	394.7	595.9	0.001	0.006	0.00360	

Appendix E. Measurement Scale Items, Standardized Factor Loadings, and Literature Source

Table D. Measurement Scale Items, Standardized Factor Loadings, and Source

Measurement Scales (Cronbach's α, Eigen value)	Factor Loading	Literature Source
Reputation and trust (α = 0.82; Eigen value= 1.96)		
Our firm's long-term strategy depends on maintaining a good reputation and trustworthiness among our major supplier.	0.73	(Dyer, 1997)
Our company and its suppliers have limited policies and procedures that effectively regulate the purchasing activities.(R)	(D)	
Our company and its suppliers find it difficult to solve conflicts fairly that fall outside of our formal agreements. (R)	0.69	(Carson, 2003)
When an unexpected situation arises, the parties come to a mutually beneficial solution, even though it contradicts formal agreements.	0.82	
There are performance goals for the contractor's work that are understood and accepted even though they are not written in formal agreements.	0.70	
Long-term relationship (α = 0.75; Eigen value= 2.49)		
We establish long term contracts in order to assure supply of raw materials for our products.	0.60	(Carson, 2003)
We conduct joint planning with our suppliers to anticipate and resolve supply assurance problems.	0.79	
Our suppliers see our relationship as a long-term alliance.	0.80	(Paulraj, 2007)
Our suppliers involve us in the product design and development stages.	0.73	
Our suppliers inconsistently meet our requirements. (R)	0.65	
Improved coordination of activities (α = 0.76; Eigen value= 2.58)		
Our company selects suppliers based on their congruence with our strategic goals.	0.81	(Vachon, 2007)
Our company performs regular assessments of our suppliers in order to monitor their compliance and to motivate continuous improvement.	0.64	
Our company requires suppliers to implement a quality management system (e.g. ISO 14000, ISO 9000).	0.56	
Our company makes joint decisions with suppliers about their product specifications.	0.75	
Alliances with our suppliers help our company to enhance its existing capabilities/skills.	0.80	(Kale, 2000)

Appendix E. (Continued)

Table D. (Continued)

Measurement Scales (Cronbach's α, Eigen value)	Factor Loading	Literature Source
Knowledge Transfer (α = 0.72; Eigen value= 2.05)		
It is difficult for our company and its suppliers to share know-how from work experience with each other. (R)	0.68	(Lee, 2000)
Both our company and suppliers can easily explain the necessary knowledge to produce services or products that meet our specifications.	0.83	(Kale 2000)
Our company and suppliers apply jointly for patent protection for intellectual property.	0.55	
Both parties learn or acquire new or important information from each other about producing products that meet our specifications.	0.87	
Higher entry barriers to the market (α = 0.76; Eigen value= 1.91)		
The relationships we have with our suppliers have little impact on our company's ability to gain cost advantage in the market. (R)	(D)	(Karakaya, 1989, 2002)
Successful relationships with our suppliers provide sometimes high-market share in the industry than what we expect.	0.79	
Our relationship with suppliers increases the customers' loyalty.	0.72	
Our company owns proprietary technologies that have been jointly developed with our suppliers.	0.84	
Our company strengthens relationships with our suppliers to increase the power of our brand.	0.75	

Appendix E. (Continued)

Table D. (Continued)

Measurement Scales (Cronbach's α, Eigen value)	Factor Loading	Literature Source
2nd-Tier Supplier Relationships (α = 0.84; Eigen value= 2.14)		
Our company interacts directly with some of our suppliers' suppliers	0.92	(Frohlich, 2001)
Our company forms close relationships with some of our suppliers' suppliers.	0.90	
Our company demands from or encourages suppliers to select their suppliers based on specific criteria.	0.75	(Judge, 1988)
Environmental performance (α = 0.74; Eigen value= 2.05)		
Our company management gives a low priority to environmental issues. (R)	0.83	(Bowen 2001)
We always attempt to go beyond basic compliance with laws and regulations on environmental issues.	0.50	
Our company purchases environmentally friendly raw products.	0.61	(Judge 1998)
Our company has implemented a supplier environmental award.	(D)	(Bowen 2001)
We inefficiently manage the environmental risks that affect our business. (R)	0.84	

Note: All measurement scales were measured on a 7-point Likert scale, where 1 = "Strongly Disagree", and 7 = "Strongly Agree".

Some of the measurement scales were modified after the interview with industry experts for clarification.

(R) These measurement scales were reverse coded.

(D) These measurement scales were deleted before data analysis to increase the reliability.

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