

Dissertation Abstract

The discussion on environmental sustainability has occupied the centre stage for managers and policy makers. Decades of research in this domain has shown that production processes are one of the major drivers of greenhouse gas emission. However, with value chain dispersed globally, managing supply chain to achieve true environmental sustainability remains a distant dream for most managers and policy makers. While there are multiple studies that has looked into this aspect, most studies conceptualize buyer-supplier relationship as simple linear relationship without recognizing the interdependencies in the chain. Consequently, the existing literature has failed to appreciate the nuances associated with multi-tier network structure and firm's GHG emission. Probably because of this reason, despite decades of research on sustainability, there is lack of consensus among managers and academics to deal with the issues of environmental sustainability. The conventional doctrine of sustainability is also challenged by the fact that there is growing realization among policy makes that firm's own emission is just the tip of the iceberg. To achieve true sustainability a firm must go beyond its direct emission and must be able to curtail the emission of the entire network. However, lack of availability of data has presented significant challenge for academic researchers to carry out empirical study and provide practitioners with any credible solutions. This work is aimed at overcoming such limitations by delving into role of multi-tier buyer-supplier network in reducing both firm's own emission and emission of the network. We overcome the challenge of construction of a multi-tier network by collecting data from secondary sources. The multi-tier nature of our network not only looks at firm's direct suppliers but also incorporates suppliers' suppliers and customers. Therefore, we not only look at firms contractual relationships but also focus on non-contractual relationships as well. This makes our study more meaningful as it captures the intricacies of the supply chain. Our primary thrust is on GHG emission. In Essay I we focus on role of three important network characteristics- density, betweenness centralization and average clustering co-efficient and its relationship with focal

firm's GHG emission. The objective of this essay is to develop a more robust understanding of multi-tier network structure and GHG emission. We also focus on moderating role of average path length in our study. We find that for some network characteristics there is a linear relationship between network structure and GHG emission whereas for others there is curvilinear relationship. Again, direction of relationships is also different. While, density has an U shaped relationship, betweenness centralization has positive average clustering co-efficient has negative relationship with GHG emission. We collected data from 330 firms and from 28 different countries and tested our proposed model. Hence, for the first time in literature, we are able to unearth the role of buyer-supplier network structure in reducing GHG emission.

Essay II extends the findings of Essay I and focuses on emission of the entire network. While conversation in academia as well as industry has revolved around going beyond firm's own emission, no empirical work exist in this domain. We overcome this shortcoming of existing research by focusing on the relationship between cohesiveness, centralization and modularity and GHG emission of the entire network. We find that while centralization and modularity have positive effect on GHG emission, cohesiveness has a negative relationship with network emission. Therefore, this essay for the first time focuses on network structure environmental performance at a network level.

While doing so, for the first time in literature, we are able to show empirically the relationship between buyer-supplier network structure and environmental performance of both focal firm as well as entire buyer supplier network. This research not only helps us to resolve multiple paradoxes but also helps us to provide a generalizable framework which is valuable for both academic research and practice.

Keywords: *Buyer-supplier Network Structure, Environmental Sustainability, Sustainable Supply Networks, Network Density, Network Centralization, Average Clustering Coefficient, Modularity*

1.1 Introduction

Concern for environmental sustainability concerns are not new to managers and policy makers. Despite relentless efforts to minimize carbon emission, most environmentalist believe that in a growing world economy achieving environmental sustainability may require much higher effort than estimated¹. While multiple organization has claimed that they are becoming more and more environmentally sustainable, many environmentalist has claimed that firms spend more towards marketing and communicating about green practices rather than adopting them in their day to day operations (Greenwashing)². Amidst these contrary viewpoints, Governments such as those in United States have decided to withdraw from Climate Change agreements³ which created a new challenges for environmental sustainability. While United Nations outline sustainable production and consumption as one of its major sustainability goals⁴, with these recent developments achieving these goals look like a distant dream. The agony of sustainable production is not only due to the external factors. In many cases firm's global supply chain has been deemed responsible for lack of success in controlling emission. Multiple companies' despite being focused environmentally has not been able to achieve its sustainability goals because visibility beyond direct suppliers (tier-1) drops significantly (O'Rourke 2014). While firms have adopted third party mechanisms such as environmental audits, but in most cases supply chains audits have failed to detect the anomalies in the chain⁵. Even if firm may have detected certain violations, in many cases power of the suppliers may act as a barrier to sustainable supply chain practices. Moncler group, a globally renowned apparel manufacturer has

¹ <https://www.theguardian.com/environment/2016/apr/14/is-it-possible-to-reduce-co2-emissions-and-grow-the-global-economy>

² <https://www.theguardian.com/sustainable-business/2016/aug/20/greenwashing-environmentalism-lies-companies>

³ <https://www.theguardian.com/environment/2017/jun/01/donald-trump-confirms-us-will-quit-paris-climate-deal>

⁴ <http://www.un.org/sustainabledevelopment/sustainable-development-goals/>

⁵ <https://www.theguardian.com/sustainable-business/2016/jan/14/supply-chain-audits-failing-detect-abuses-report>

faced significant challenge while trying to impose stringent regulations to its suppliers. The suppliers have opposed any change in regulations which has led to suspension of the global initiative towards environmental sustainability. The failure of environmental audits and top down approach to create a sustainable supply chain implies that firm must rely on informal mechanisms to achieve a truly sustainable supply chain.

Despite the importance of this issue, academic literature has adopted an understanding which fail to capture the complexities of a global value chain. For holistic understanding of this environmental sustainability, one must understand that firm's greenhouse gas (GHG) emissions are associated with the portfolio of products and journey of these products from "Cradle to Grave" (Dooley 2014). Again, all these elements don't operate in isolation. As Kim et al. (2011) have pointed out that traditional linear conceptualization of supply chain may not be adequate to understand the complexities of the supply chain and one must move towards a network based approach to understand any complex phenomenon such as environmental sustainability. The network approach to study supply chain takes into consideration not only firms direct suppliers and customers but also looks beyond tier-1 suppliers. "*A firm's "supply network" consists of ties to its immediate suppliers and customers, and ties between them and their immediate suppliers and customers, and so on*" (Kim et al. 2011; p.194). However, lack of availability of data has created a major challenge that has hindered the development of a comprehensive understanding of global value chain. This becomes problematic specially in the context of sustainability as structure of the buyer-supplier network impacts not only the flow of material but also the flow of information (Kim et al. 2011). Defined as hard ties (those suppliers who are involved in material flow) and soft ties (those involved in information flow) scholars have pointed out that these multiplicity of ties are essential for achieving environmental sustainability goals (Tachizawa and Wong 2015). Network structure facilitates both flow as well as monitoring of material (Kim et al. 2011) as well as information (Bellamy et al. 2014), which outlines the importance of network structure

in facilitating environmental sustainability. While there is some level of conceptual development around this issue, to the best of our knowledge no research till now has empirically examined the relationship between buyer-supplier network structure and its relationship with environmental sustainability.

The central thrust of this dissertation is to fill this important gap in literature. Contrary to earlier literature, we managed to collect data from more than 200 global corporations expanding across 28 different countries. To achieve generalizability of our findings, we also incorporated data from multiple industries and adopted a robust methodology accounting for all potential biases such as endogeneity and unobserved heterogeneity we try to throw light in this area. We take a broad view of sustainability, where we not only look at firm's own emission but emission of the supply chain as well. Specifically, we focus on two broad research questions in two essays. In Essay 1, we look at my attention on the role of network structure in firms own emission whereas in Essay 2, we try to unveil at the role of network structure on the emission of the network. Both these issues are critical not only from the perspective of managers but also from the perspective of policy makers. Prior research has shown that focal firm's environmental sustainability positively effects firm value (Yadav et al. 2016), stock market returns (Luo and Bhattacharya 2006) and has a positive effect on firm's innovation output (Dangelico and Pujari 2010). Again, there is ever increasing pressure from both regulators and customers to become environmentally sustainable (Lee et al. 2012). All these aspects highlight the importance of environmental sustainability for a firm. Hence, focus of essay 1 focuses on the relationship between buyer-supplier network structure and firm's own emission. While, essay 1 addresses a vital issue, simply looking at firm's emission may not be adequate to understand such a complex phenomenon such as sustainability. Firm's globally has realized that a major source of carbon emission actually generates from the supply chain. In most sectors emissions in the supply chain is a major cause that organizations are constantly battling. For example, 40% of the carbon emission of

Glaxo Smith Kline (GSK) comes from its supply chain⁶. Similarly, 31% of European Union's total emission is being contributed by food supply chains (Tidy et al., 2016). The supply chain emissions for companies like Tesco and Asda ranges from 85-90% of the total carbon footprint (Blanco et al., 2016). Some scholars have gone to the extent to predict that "a company is no more sustainable than its supply chain" (Krause et al. 2009; pg. 18). The issue becomes even more complicated as the supply network members face much less stakeholder pressure as compared to the focal firm (Lee et al. 2012). Hence, to develop a holistic understanding of environmental sustainability, we focus also on network emission as well.

Our work makes multiple contribution to theory and practice. First, we provide a generalizable framework which outlines the relationship between network structure and environmental sustainability. While multiple scholars have recognized the importance of network structure on sustainability (Tate et al. 2013; Busse et al. 2017); there is no research that has empirically validated such findings. Lack of research in this domain has created massive confusion in the literature about the effect of a particular network characteristics. For example, prior research has reported both positive as well as negative effects of network density on firm's environmental performance (Tachzawa and Wong 2015). Such paradoxical findings present a major barrier to create a unified theory and also hinders future theory development. Hence, our dissertation helps to resolve such contradictory findings and develop a more comprehensive theory.

Second, our research is the first in this domain that focuses on not only firm's own emission but also the emission caused by the network. This we believe is a major contribution to the literature in sustainability. From the research in sustainability perspective, while multiple scholars have urged

⁶ <https://www.theguardian.com/sustainable-business/2015/apr/30/gsk-begins-to-make-inroads-on-supply-chain-emissions>

scholars to understand how a firm can create an environmentally sustainable supply chain (Seuring and Müller 2008; Brandenburg et al. 2014). Similarly, many have expressed grave concern about lack of theoretical development in this domain (Seuring and Müller 2008). In our work, we mitigate both these concerns. By incorporating a detailed understanding of how buyer-supplier network structure can facilitate environmental sustainability we broaden the domain of environmental sustainability. Our data helped us to incorporate till tier-2 level of the supply chain. Therefore, we go beyond firm's direct connections and incorporate indirect connections as well. Again, our research employs social network theory as a theoretical lens to analyse the phenomenon. Hence, we also bring in a unique theoretical perspective which not only mitigates the concerns raised by earlier scholars but also encourages further theory development in the area.

Finally, we also contribute to the area of buyer-supplier network. While multiple scholars have recognized the importance of multi-tier structure in the context of buyer-supplier relationship (Kim et al. 2011), most studies have failed to empirically capture the multi-tier structure. In our work, we capture the multitier structure and thus provide a new dimension to the literature.

Our work also provides multiple managerial insights. Our research has implications for established firms as well as new ventures as well. For established firms, we posit that firm may wish to reorganize their buyer-supply network. We understand that due to the critical nature of the supply chain, it may not be feasible to completely reorient the supply network. But small changes in the supply network may create a significant difference in firm's effort to become environmentally sustainable. For new ventures, our work may help them to create a buyer-supplier network that help them to become environmentally sustainable. As new ventures may lack critical resources, it is important that they pay attention to the network structure. Therefore, through our research a firm can create a broader sustainability frontier which will help them in long term sustainability commitment.

1.2 Summary of Essay I

The central thrust of essay I is to understand the role of buyer-supplier network structure in facilitating firms environmental sustainability performance. While ample amount of research has indicated that network structure can facilitate sustainability performance, empirical evidence in this regards is rare. Our work overcomes this limitation with a large scale data collection effort. We incorporate multi-tier structure of buyer-supplier network and understand the role of three prominent network characteristics- density, betweenness centralization and average clustering co-efficient. We find that density has a U shaped relationship with GHG emission, betweenness centralization has positive and average clustering co-efficient has negative relationship with GHG emission. We also test the moderating role of average path length and find that average path length significantly moderate our main effects. In doing so, we for the first time able to empirically test the relationship between multi-tier buyer supplier network and firm's environmental performance. We also respond to call for research made by earlier scholars (Tachizawa and Wong 2015) and subsequently make both theoretical and managerial contribution to literature.

1.3 Summary of Essay II

While essay I makes a noble contribution to theory, essay II takes the stream a step forward. Rather than looking at firm's own GHG emission, essay II looks at GHG emission of the entire network. The network perspective is critical because it supports the "cradle to grave" journey of a product. It also contributes to the bulk portion of emission for most companies. There is also a growing realization among organizations that merely concentrating on its own emission, focal firm may not be able to achieve a truly sustainable supply chain. Therefore, in this essay we try to understand how the three most prominent network characteristics – cohesiveness, centralization and modularity may effect

GHG emission of the entire network. We find differential effect of all these characteristics on network emission. Our findings show that while cohesiveness may reduce network emission, centralization and modularity adversely affect network emission. Hence, for the first time in literature, we are able to look at differential of network characteristics on network emission.