IMPACT OF SUPPLIER'S NETWORK CENTRALITY WITH CUSTOMER FIRM'S ON SUPPLIER'S CSR PERFORMANCE

by

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A Thesis Submitted to the Faculty of Graduate Studies of

University of Manitoba

In Partial Fulfillment of the Requirements for the Degree of

MASTER OF SCIENCE

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Abstract

This thesis treats the supplier-customer relationship from a customer network perspective to examine the effect of supplying firm's centrality in its downstream customer network on supplying firm's CSR (Corporate Social Responsibility) performance. Furthermore, this research chooses supplier's firm size as the moderator to examine the interaction effect of supplier's centrality in customer network and supplier's firm size on supplier's CSR performance. Then, this study tests the mediating effect of supplying firm's financial performance by the three-step method and Bootstrap method. I collect a data sample of 196 focal firms and 2520 supplier (focal company) -customer relationships in the computer and electronic product industry in 2019 to test the proposed hypotheses. The results show that (a) supplier's centrality (degree/eigenvector centrality) in customer network positively affect supplier's CSR performance; (b) supplier's firm size will reduce the positive effects of supplier's centrality in customer network on its CSR performance; (c) supplier's financial performance will partially mediate the relationship between supplier's centrality in customer network and its CSR performance. These findings combine the social network theory and resource-based theory and contribute to the understanding of both supply chain network and firms' CSR performance.

Keywords: Centrality, Corporate social responsibility, Customer network, Bloomberg

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Acknowledgments

I would like to begin by expressing my deepest appreciation to my supervisor, Professor Changmin Jiang, for the extraordinary support. Without his guidance and persistent help, the completion my thesis would not have been possible.

I would like to extend my sincere thanks to my thesis committee members, Professor Bruno Silvestre, and Professor Jieying Chen, for their helpful comments and support on my thesis.

I must also thank Professor Kun Wang, for his valuable comments and advice on some of the chapters.

Finally, I am extremely grateful to my family, my friends, and all the people who have supported me along the way. Thank you all for your company, guidance, and support. All the best wishes for you.

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Chapter 1 Introduction

Nowadays, the performance of CSR has received a lot of attention in both professionalism and academia. With growing expectations and requirements from governments, customers, and supply chain partners, firms around the world are attempting to make commitments to improve their CSR performance (Harjoto and Wang, 2020; Sancha et al., 2019), with some already reporting their CSR-related information as a separate column on their websites. For example, Cargill reports how it nourishes the world, protects the planet, and enriches the communities, and Starbucks demonstrates its social responsibility standards in the manufacturing processes. In academia, study on firm's CSR performance has been a rising research field, especially in this decade. Previous research mainly studies from a firm-level perspective, such as the drivers or barriers of CSR (e.g., Goyal and Kumar, 2017; Laudal, 2011; Park and Ghauri, 2015) and the outcomes of CSR (e.g., Brown and Zamora, 2015; Cho et al., 2019; Lin et al., 2015). A few of them took on a supply chain perspective, such as the CSR practice of different firms in the whole supply chain (e.g., Jean et al., 2015), the CSR adoption between suppliers and customers (e.g., Yang et al., 2020).

However, applying the social network theory to the supply chain subject is becoming a new trend due to a growing awareness of the complexity and non-dyadic relationship in supplier-customer relationship. Centrality, as a major concept of social network analysis, has also been started to use in literature to indicate the status of a firm by accounting for its location within the supply chain network. Existent research shows that company's performance can be impacted by its centrality in supply chain network from different facets, such as using different centrality measurements and investigating different aspects of firm performance. Most of the research probe how a firm's centrality would affect its financial performance (e.g., Basole et al., 2018; Kim, 2019; Kim et al., 2020; Kim and Zhu, 2018; Lau et al., 2020; Macaulay et al., 2018; Riccaboni et al., 2019; Shi et al., 2019; Tachizawa and Wong, 2015; Yang and Zhang, 2017; Yu and Chiu, 2013). However, few examine the effect on firm's CSR performance. Furthermore, most literature probes how the supply chain network centrality would affect a firm's performance from the supply network perspective, while very little is investigated from a customer network perspective (e.g.,

Kim et al., 2017; Risselada et al., 2016). Downstream customer firm, as an indispensable node in supply network, is quite important for a supplying firm, and some earlier studies show that supplier's operational practices can be influenced strategically by the downstream customer firms (Chen and Paulraj, 2004; Krause et al., 2007; Sancha et al., 2019; Yang et al., 2020). Thus, the important role of downstream customer firms in supply chain motivates our investigation of this issue. To the best of my knowledge, there has been yet any research that studies how the centrality of firm would affect the CSR performance from the customer network perspective.

To fill these research gaps in current literature, the thesis tries to answer three research questions: 1) Does a supplying firm's degree and eigenvector centrality in its downstream customer network influence its CSR performance? 2) How does the supplier's firm size influence these relationships? 3) Does the supplier's degree and eigenvector centrality in its customer network influence its CSR performance through its financial performance?

This research collects the data of supplier and customer relationship in year 2019 from Bloomberg's SPLC database to test our hypotheses. In addition, this thesis uses degree centrality and eigenvector centrality to measure a supplier's centrality level in its customer network to investigate how supplying firm's centrality in its downstream customer network influences its CSR performance. The CSR ratings from CSRhub was used to measure the supplier's CSR performance. Moreover, I use supplier's employee number to measure the mediator in this thesis - supplying firm's size; Then, I examine the mediating role of supplier's financial performance, indicated by return on asset (ROA), based upon the correlation between supplier's centrality in customer network and its CSR performance. Trough the empirical tests, the analysis outcomes demonstrate that large firm with a high degree centrality/eigenvector centrality level in the downstream customer network negatively correlates with its CSR performance. Also, this research finds the supplier's financial performance will partially mediate between a supplier's customer network centrality and its CSR performance. In short, centrality in customer networks can influence the supplier's CSR performance by influencing its financial performance. Moreover, this thesis examines the endogeneity issue between the firm's centrality in its customer network

and firm's CSR performance, and uses 2SLS regression to solve this issue. The result maintains the main conclusions.

This thesis will contribute to the extant literature from two parts. First, it provides new insights for social network theory's implication in the field of Supply Chain. For the last 20 years, academic research has been probing the importance of network centrality in a firm's outcomes, but most research examines its effect on a firm's financial performance, R&D intensity, or productivity. This thesis makes the first attempt to investigate how centrality in customer network influences the CSR performance of a supplier and to study the function of supplier financial performance in this effect. Moreover, most of the existing studies that introduce social network theory in supply chain field are limited to the supply network, while customer network as a necessary and vital part of the network receives little notice. This thesis tries to exam the correlation between supplying firm's centrality and its CSR performance from the customer network perspective.

Second, this research enriches the research on the factors influencing firm's CSR performance. Most of the existing literature considers the drivers of a firm's CSR performance from a firm level, such as stakeholders, governments, consumers, media (e.g., Park and Ghauri, 2015; Laudal, 2011). A few research that consider centrality perspective examine the role of CEO network centrality (Bouchet et al., 2020; Chahine et al., 2019), moral identity centrality (Afsar et al., 2020). This study expands the current discussion about the influence between the supplier-customer relationship and their CSR performance. In addition, this thesis takes a view of a network analytic instead of the linear and dyadic structure adopted by previous literature, suggesting that the position in the customer network may also have a positive correlation with the firm's CSR performance. It was also found that firm size can reduce the positive impact of centrality on CSR performance since this research assumes a firm may perform adverse behaviors when it has enough power, both the high centrality and large size can help the firm gain more power.

Following this introduction section, Section 2 briefs the existing literature, introduces the social network theory (centrality) as well as resource-dependence theory and brings up hypotheses. Section 3 discusses the use of data sources, measurements, and regression methods for hypothesis testing. Then, Section 4 reports the regression and the robustness

test result. Finally, Section 5 summarizes our findings and contributions while also highlighting the research limitations and suggesting some future research avenues.

Chapter 2 Literature review

2.1 Relationship between firm's centrality and performance

The important role of a firm's centrality in its performance has gained more attention from this decade. On the one hand, previous research on supply chain management discussed how centrality of a firm affects its performance in the following aspects: financial-related performance (e.g., Yu and Chiu, 2013; Yang and Zhang, 2017; Basole et al., 2018; Kim, 2019; Shi et al., 2019; Riccaboni et al., 2019; Lau et al., 2020), R&D intensity (e.g., Kim and Zhu, 2018), international business performance (e.g., Sharma et al., 2019), environmental performance (e.g., Tachizawa and Wong, 2015), the competitive advantage of supply chains (e.g., Swierczek, 2018) and firm's productivity (e.g., Su et al., 2020). Table 1 summarizes the existing literature that investigates the influence of firm centrality in the supply chain network over its performance.

On the other hand, most of the existing literature investigates the role of firm centrality from the supply network. To be more specific, the supply network represents the network that identifies the customer firms as the focal firms and finds all their upstream suppliers; then combined all the focal firms and their suppliers as the supply network (Figure 1). Compared with the supply network, the customer network identifies the supplying firms as the focal firms and finds all their downstream customer companies (Figure 2).

A few of the existing research consider the firm's centrality position from customer network through the literature review. For example, Kim et al. (2020) set manufacturing and service industries as the sample industries to investigate how customer degree centrality will affect supplying firm's financial performance, finding a positive correlation between them. Risselada et al. (2016) set mobile telecom industry as the observation to explore the relationship between degree centrality in customer network and opinion leadership.

To my best knowledge, no existing research considers how a firm's centrality in customer network influences this firm's CSR performance.

Table 1 Literature of network centrality in supply chain research

	Centrality types	*Research focus*	*Industry choice*
Shipilov (2009)	Betweenness centrality	Market share	Investment banks
Yu and Chiu (2013)	Eigenvector centrality	Firm's sales growth Rate	Electricity industry
Basole et al., (2018)	Eigenvector centrality	ROA; Inventory/Sales; COGS/Sales	Electronic industry
Swierczek, (2018)			
Kim and Zhu (2018)	Eigenvector centrality	Firm's R&D intensity	Technology industry
Shi et al., (2018)	Degree Centrality; Eigenvector Centrality	ROA	Manufacturing
Swierczek (2018)	Degree Centrality; Eigenvector Centrality	Firm characteristics; Market returns	(Industry as observation)
Riccaboni et al., (2019)	Harmonic centrality	Sales growth	Italy firm in all the industries
Sharma et al., (2019)	Betweenness Centralization	International business performance	50 industries
Kim et al., (2020)	Degree Centrality	ROA	Technology industry
Lau et al., (2020)	Degree Centrality Closeness Centrality Betweenness centrality	Sales turnover	Manufacturing and manufacturing services industries
Su et al., (2020)	Eigenvector centrality	Firm productivity	5 industries

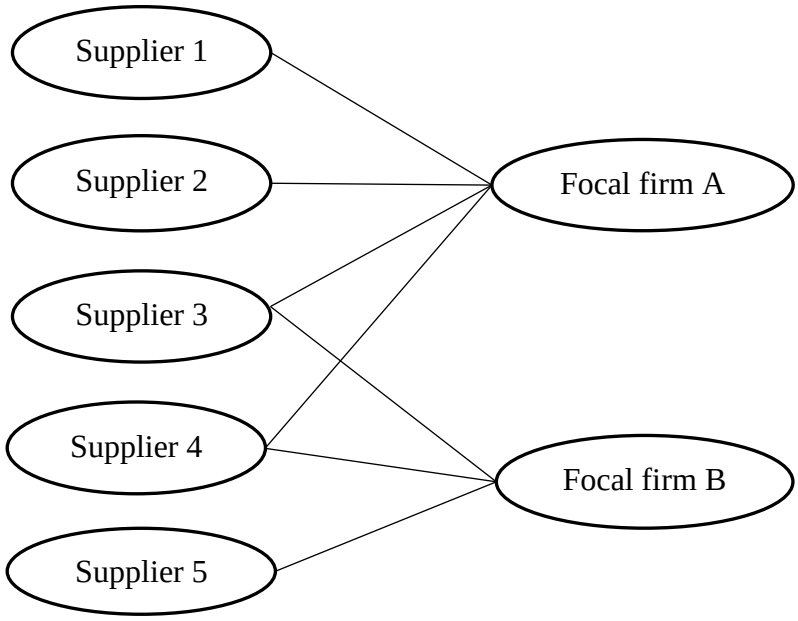

Figure 1 Supply Network

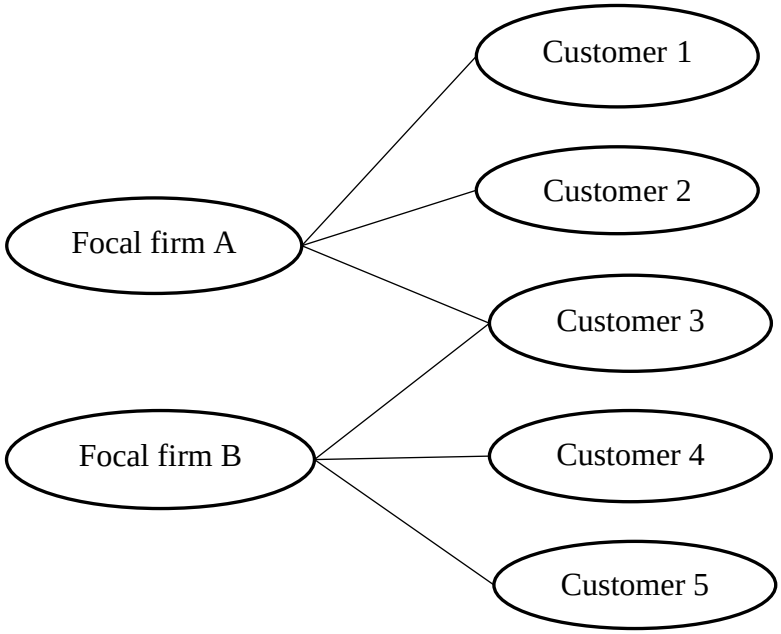

Figure 2 Customer Network

2.2 Firm's CSR performance

The definition of CSR (corporate social responsibility) has experienced a long and diverse discussion from the 1950s, and it is still being added new concepts (Carroll, 1999). Although it keeps updating the concepts, CSR covers the most necessary concerns of the various stakeholders regarding the business model that helps the firm be socially beneficial (Carroll, 1999; Husted, 2020).

Previous research has well discussed the factors or drivers of a firm's CSR practice in the last few decades. However, most of the previous literature investigates from the firm-level perspective, such as the requirement from government, the firm's culture, or the benefit of CSR implementation (Laudal, 2011; Park and Ghauri, 2015). Some of the literature also points out that a firm's stakeholders, such as customers, can affect its operating performance. Sensitivity to the stakeholders is one of the most important drivers of a firm to implement CSR-related practice (Crouch, 2006; Kusyk and Lozano, 2007). For example, Sancha et al. (2019) proposed that supplying firm's reliance on its customer firms can affect suppliers' sustainability performance. Gualandris and Kalchschmidt (2016) concluded that supplier-customer trust could influence the environmental and social performance of supplier firm. Yang et al., (2020) directly point out the CSR adoption of customer firm has a positive impact on its supplier's CSR adoption through empirical research. They believe the suppliers need to meet the CSR standard of their customer firms. The first reason is that the supplying firm will follow its customer firm when the customer firm starts to implement the corporate social-related performance. The other reason is that supplying firm can get some support from its customer firms to implement CSR practice.

However, little research investigates the factors that affect a firm's CSR performance or adoption from the firm's network perspective. The only two research find the CEO network centrality will positively influence the firm's CSR performance (Bouchet et al., 2020; Chahine et al., 2019). According to theses research, when the CEO of the firm who has a high degree of the centrality level in his or her network, the CEO will have better access to get more useful information to support the CSR development of the firm. Moreover, CEOs with a high level of social network centrality will try to maintain or get a more personal

reputation and fulfill their own requirements by making their firm more socially beneficial. To the best of my knowledge, there are no other research investigates how firm's centrality in a different perspective of the network will influence its CSR performance.

In conclusion, through the literature, customer firms do have the possibility and power to affect supplier's performance like CSR practice or performance. However, different from the literature, this thesis explores how customer firms can affect suppliers' CSR performance from a social network view.

Chapter 3 Theory

3.1 Social network theory

In the opinion of social network theory, a system is a group of interconnected nodes. The nodes can be different levels of entities such as individuals, companies, or countries, and the ties among nodes or actors also have different types: friendly relationships or competitive relationships, etc. (Borgatti and Li, 2009). For the supply chain perspective, a network can be described as a tie among groups of companies, directly or indirectly (Borgatti and Li, 2009; Tachizawa and Wong, 2015). The ties can be divided into four classes: "similarities, relations, interactions and flows" (Borgatti and Li, 2009. P8). Specifically, the similarities class represents the condition that the companies are not having to know each other but they will have a great chance to build a relationship; for example, they are in the same location. Concurrently, relations class have consisted of three relations: "continuously ties", "role-based", and "cognitive-affective"; Interactions class refers to infrequently separate or distinct relationship, usually amounted after a while, such as sending an email or having lunch; And flows class refers to the situation that the companies have interacted through information or money. This thesis assumes the supplier and customer have a relationship (tie) when there is a direct financial exchange between them, which can be classified into the flow class.

Centrality of nodes or actors is one of the essential concepts in social network analysis. Borgatti and Li (2009) defined centrality as the important level of the actors/nodes' structural position in its network. Specifically, a higher value of centrality represents the more central position that the node is, which means the node is more important in this network (Yu and Chiu, 2013). Several centrality concepts have been started to discuss and applied in the literature. In the supply chain context, degree centrality and eigenvector centrality are the most common choices to analyze the 1-tier supplier-customer network (e.g., Yu and Chiu, 2013; Yang and Zhang, 2017; Macaulay et al., 2018; Basole et al., 2018; Kim and Zhu, 2018; Shi et al., 2019). According to the literature, the degree centrality counts the direct connection for a company in its network (Yang and Zhang, 2017). The

eigenvector centrality calculates the focal company's centrality considering its partners' influence (Borgatti and Everett, 1997). Basically, in a supplier-customer network, the supplying company's eigenvector centrality is decided by the eigenvector centralities of the customer companies it connected. The supplying company has a higher centrality when its customer companies are more central than others.

Previous studies indicate that a firm with a higher centrality level in its network tends to have a better performance. A company that has a high centrality level in the network means it has more connections or ties, which means it can get more information and resources to support its development (Borgatti and Li, 2009). Also, the high centrality firm will get more control advantage to increase the competitive capability, making it easier to have better financial performance (Shi et al., 2019). These situations can be applied when considering the effect of customer network on the CSR performance of the supplying firm. According to the social network theory, supplying firms with higher customer network centrality means more customer firms. Thus, it needs to consider more requirements from its customer firm (Yang et al., 2020). According to the transmission mechanism, it also can get more resource support to develop CSR performance.

3.2 Resource dependence theory

The resources, controlled by a firm like information, knowledge, asset capabilities, allows the firm to implement its strategies (Barney, 1991). Resource-dependence theory (RDT) is used to explain that an organization must rely on others due to the limited external resources (Pfeffer and Salancik, 1978). An institution is likely to be identified as successful if it can realize the power maximization (Ulrich and Barney, 1984), maximizing the external organization's dependence on itself and minimizing its dependence on external organizations (Pfeffer and Salancik,1978). Especially, imbalance in resources causes an imbalance in power, and organizations with more resources tend to be more powerful. Also, in the imbalanced relationships, the dominant organization may exercise its power or influence over the weaker organization to implement its strategies (Barney, 1991; Touboulic et al., 2014).

Since Pfeffer and Salancik's work, the resource-dependence theory was extensively appealed into supply chain related research to explain the interdependence relationship between supplier and customer (e.g., Lee et al., 2012; Touboulic et al., 2014; Elking et al., 2017; Kumar et al., 2019). Take Elking et al. (2019)'s research as an example, they used this theory to explain the effect of the supplier-customer financial relationship on a firm's performance regarding lean inventory strategy.

As the competitive strength of resource, no matter intangible or tangible, the firm can be more concerned about the requirement from the customer firm if this firm needs to rely on the customer firm to get the resource since the supplier firm's performance will affect the customer's reputation (Kumar et al., 2019). Customer firms may have the reason to require their suppliers to have a good CSR performance.

Chapter 4 Hypothesis and model development

4.1 Hypothesized model

Grounded within insights of social network theory and resource dependence theory, I first examine the impact of supplying firm's centrality in its customer network (also called it "customer network centrality") on its CSR performance as our baseline test. Then, adding supplier's firm size as the moderator, this research tests the interaction effect of supplying firm's customer network centrality and firm size on its CSR performance. Finally, I introduce the supplier's financial performance as the mediator to analyze the supplier's financial performance in the impact that supplier's customer network centrality has on the supplier's CSR performance. To get a deeper understanding of the framework in the thesis, the hypothesized model was presented in Figure 1.

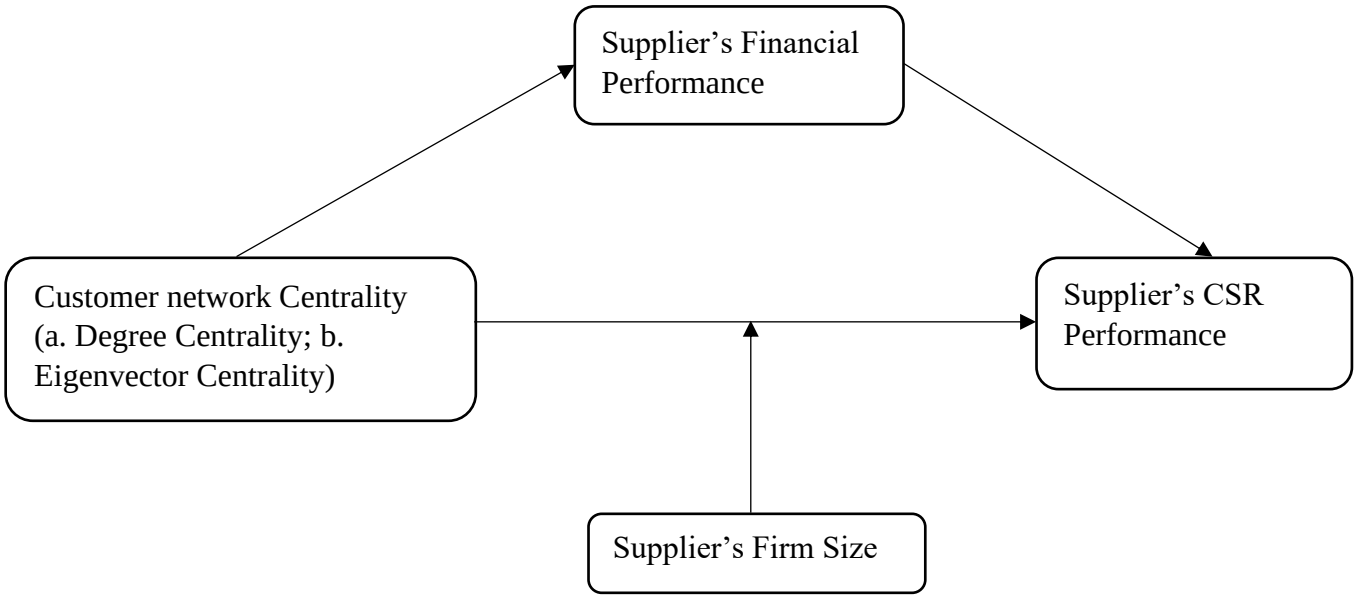

Figure 3 Hypothesized model

4.2 Supplier centrality in customer network centrality and supplier's CSR performance

Existing empirical research finds some conformation that a firm's CSR performance can be impacted by each other. Imbalanced power advances the implementation and monitoring of corporate social responsibility (CSR) between supply chain partners (Boyd and Ellison, 2007; Chen and Paulraj, 2004). Nevertheless, the current CSR research only focuses on the dyadic and linear relationship of suppliers and downstream customers. Unlike previous research, this thesis concentrates on how the supplier-customer relationship affects suppliers' CSR performance from the network point of view. I assume that supplying firms with high customer network centrality are likely to have high CSR performance for the following reasons.

First, the customer firms desire to protect their reputation by requiring suppliers to practice CSR activities. In other words, the supplying company's actions will be subsumed under their customer companies' reputation (Kumar et al., 2019). As an important intangible asset, a firm's reputation can be influenced by other organizations' activities that take part in their network (Kumar and Rahman, 2016). For example, ZARA's sales decreased dramatically after the exposure of Child labor scandal of one of its suppliers. Also, Bridgestone Firestone Corporation's tire quality incident severely damaged Ford Motor Corporation's reputation (Jones, 2001). To reduce and eliminate the risk of scandals, companies not only act independently but also request their partners for more sustainable business practices (Kumar et al., 2019). Improving suppliers' social performance can reduce reputational risks for the downstream customer firms, beneficial for their competitive capability (Yang and Zhang, 2017; Foerstl et al., 2010). The suppliers will be expected to attend to the customers' requests if the supplier relies on the customer companies (Carr et al., 2008). If not, consequences would follow, such as being eliminated as a supplier (Hoehmose et al., 2014; Elking et al., 2017). Because highly dependent suppliers usually aim to form stable partnerships for profit maximization, so they will pay more attention to the customers they are highly dependent upon. According to the social network theory, a supplier has a higher level of centrality if it has more customers (definition of degree centrality) or if its customers are in a central position within the network (definition of eigenvector centrality).

The reason is that a supplying firm with more customer firms needs to consider more requirements on its CSR performance. Similarly, if its customer firms are more central, the supplying firm will pay more attention to their requirements. Therefore, we assume a supplier firm with high customer network centrality (degree/eigenvector) will attempt to improve its CSR performance to improve its competitive advantage in the customer network.

Second, a supplying firm who has a higher level of central position in its customer network can get more resources and support to implement CSR practice. A supplier with a higher customer degree centrality has more direct customers, so maintaining a good collaborative relationship with its customers will help it access more necessary resources to perform CSR activities. When the customer firms are more central, the supplying firm's customer eigenvector centrality will be much higher, meaning the suppliers will gain more support if their customers are more critical and central. Specifically, the resource-dependent theory states that one company cannot get everything it needs by itself due to the limited resources, so it must cooperate with others to achieve its goals. Basole et al. (2018) also concluded that holding a central position in this company's network will give it chances to get more connections, integrate complementary resources, and cooperate with other firms (Shi et al., 2019). Furthermore, researchers find that many customer firms are pleased to assistant their supplying firms to develop and mitigate risks (Galaskiewicz, 2011; Kim et al., 2020; Yang et al., 2017).

Based on the arguments, the first two hypotheses were considered:

H_{1a}: Supplier's degree centrality in customer network is positively related to its CSR performance

H_{1b}: Supplier's eigenvector centrality in customer network is positively related to its CSR performance

4.3 Moderation effect of firm size

Firm size is an essential determinant of a firm's CSR performance. Prior empirical studies find some support on the positive correlation between firm size and its CSR performance (e.g., Buhr and Freedman, 2001; Cormier and Magnan, 2003; Gamerschlag et al., 2011; Patten, 2002). Ali et al. (2017) analyzed existing empirical research articles and got the conclusion that firm size, as the attribute of a firm, is one of CSR disclosure determinants. A large firm usually has the capability to access valuable resources to support its CSR practice. For instance, it will be easier to afford the expenditures of CSR practice. According to the literature, financial support, management commitment, related knowledge, resource, and technology are some of the major barriers to stop a company from improving its CSR development (Ali et al., 2017; Park and Ghauri,2015; Kumar and Rahman, 2015), and the large size helps break through these barriers. Moreover, large firms will get a lot of public and government attention to have more access to the resource for CSR performance development. They also have more specialized staff who design and implement suitable operations to improve CSR performance.

However, this study takes a different angle and argues that the interaction effect on a firm's centrality and firm size is possible to negatively influence its CSR performance since a firm may exhibit adverse behaviors when it has enough power. On the contrary, public opinion, customer groups, competitors, and society are the primary sources of pressure for a company (Kumar and Rahman, 2015). When a company has enough central position in the network with a large size, it will have many ways to obtain resources, and the available resource is enough to support its operation and development. The company in turn does not need to rely on many external organizations to support its development, so it does not need to follow external requests. A company's predictable managerial practice will be reduced if it was given too much freedom (Choi et al., 2001), leading to certain adverse behavior (Kumar et al., 2019).

The benefits of implementing CSR activities include increasing competition and more opportunities in a new market (Kumar and Rahman, 2015; Hess et al., 2002). Smaller firms could gain greater marginal utility to improve firm performance and get a competitive

advantage through better CSR performance and a positive reputation (Hooghiemstra, 2000; Youn et al., 2015). In contrast, the larger companies with a central position in the network already have great competitive power in the industry and capability to enter a new market, so that they may not be concerned with CSR performance.

Based on these arguments, this thesis considers the following hypothesis:

H_{2a}: If supplying firms are large (small), the influence of supplying firms' customer degree centrality on their CSR performance will decrease (increase).

H_{2b}: If supplying firms are large (small), the influence of supplying firms' customer eigenvector centrality on their CSR performance will decrease (increase).

4.4 Mediation effect of supplier financial performance

Social network theory proposes that a firm's performance will be primarily influenced through the social position in the social context that it is embedded (Borgatti and Li, 2009; Burt, 1995). A growing body of studies has demonstrated that a firm's network centrality improves some specific elements of the financial performance (e.g., Basole et al., 2018; Kim, 2019; Kim et al., 2020; Lau et al., 2020; Riccaboni et al., 2019; Shi et al., 2019; Yu and Chiu, 2013; Yang and Zhang, 2017). However, most researchers are just limited on the structural position of the observed firm in its supply network; scant research has examined the impact of firm centrality from the customer perspective. Hence, different from most research in the supply chain network field, I investigate from the customer perspective and assume that supplying firm's centrality in its customer network is positively correlated with its financial performance based on the following reasons.

First, supplying firms with higher customer network centrality can get resources advantage and more support from the customers, enhancing its financial performance. In accordance with the social network theory, a firm who is centered in its network possesses a higher probability of gaining variegated visible and invisible resources so that it can generate higher profits by getting the latest information and knowledge, decreasing inventory levels and cost, improving product quality, etc. (Basole et al., 2018; Lau et al. 2020; Riccaboni et al., 2019). Firms occupying a central position in the network can practice frequent and efficient communication, improve mutual trust with their supply chain partners, develop a closer connection, and better understand the customer's needs (Harjoto and Wang, 2020; Lee, 2009). These close connections along with fast and accurate understanding, facilitate the access of high quality and relevant information, knowledge transfer, and organizational learning, allowing the firm to have better financial performance (Harjoto and Wang, 2020; Inkpen and Tsang, 2005; Kim, 2014; Lau et al., 2020). In summary, the relationship between supplier and customer plays a vital role in getting resources. Keeping a good

interaction and establishing a collaborative relationship with its customers can help the supplier get more support.

Second, focal firms with a higher customer network centrality have a higher power and influence advantage over their supply partners for better financial performance. On the one hand, a firm with a higher centrality will lead to high visibility and a more important role, so it has an opportunity to establish a relationship with other prominent firms and to attract talented employees to increase its business performance (Basole et al., 2018; Kim and Zhu, 2018). On the other hand, in the previous discussion, we know that firms with high levels of customer network centrality have a higher probability of gaining more useful information and resources from their customers and external organizations. This increases its chance to develop new ideas and influence other supply partners' operations by taking such actions as limiting its actions or sharing useful information and knowledge (Lau, 2020; Shi et al., 2018). In summary, higher customer network centrality enables suppliers to access more complimentary and beneficial resources and gain more influence and control over the supply partners.

Previous literature proves that firm's financial performance has a positive relation to its CSR performance. Lack of money is one of the significant barriers of a firm to implement CSR practice (Goyal and Kumar, 2017). Investing in CSR practices is considered an expense and inconsistent with firm's fundamental goal of maximum profit (Chang, 2015; Chen et al., 2015; Goyal et al., 2013). Firms with high financial performance levels may spend more on scarce resources to improve their CSR performance (Waddock & Graves, 1997). In contrast, firms reported with an uncertainty of return or financial problems do not have enough money to achieve a better CSR performance (Wang et al., 2016).

Thus, a supplier's financial performance can increase the likelihood of suppliers' CSR implementation. Supplier's centrality in customer network is likely to influences its CSR

performance through influencing its financial performance, so this thesis presents the following hypothesis:

H_{3a}: Supplier's financial performance partially mediates the relationship between supplier's degree centrality in customer network and supplier's CSR performance.

H_{3b}: Supplier's financial performance partially mediates the relationship between supplier' eigenvector centrality in customer network and supplier's CSR performance

Chapter 5 Data and Methodology

5.1 Sample and Data Collection

The empirical analysis is based on the Computer and Electronic Product Manufacturing industry data in North America from the three-digit level code (334) from the NAICS.

First, this research collects data on the supplier and customer relationship from Bloomberg's SPLC database in 2019 based on the TICKER code. The Bloomberg SPLC database includes the supplier and customer relationship information based on the cost percent, representing what gets incurred by the central company, and the revenue percent, representing what this supplier gets from the central company. According to statistics, the most commonly used databases to collect the data on supplier and customer relationship include Bloomberg (e.g., Lee et al., 2012; Wu and Birge, 2014; Wang et al., 2015; Osadchiy et al., 2016; Kim and Davis, 2016; Elking et al., 2017; Bray et al., 2019; Kumar et al., 2019), Compustat (e.g., Lian, 2017; Cao et al., 2018; Kim and Zhu, 2018; Chen and Ho, 2019; Kim et al., 2020), and Factset Supply Chain (e.g., Cen et al., 2015; Wu, 2015; Upson and Wei, 2019; Piraveenan et al., 2020; Wang et al., 2020). Compared with the other two databases (Compustat and Factset), the Bloomberg SPLC database reports the latest relationships between companies, while Compustat reports the relationship data from 1987 and Factset supply chain from 2003. Nevertheless, the advantage of Bloomberg SPLC is that the supply chain relationship it provides is more complete than the other two. Bloomberg SPLC database contains over 1.5 million supplier and customer relationships of over 26,000 companies from the source documents worldwide with different languages from the supply chain data coverage. Whereas Factset Supply Chain Relationship contains about 25,000 supply chain relationships, including suppliers, customers, and competitors, the Compustat customer segment captures companies' customer information only from companies' 10-K filings, which does not include the supplier-customer information if the sales revenue relation between supplier and customer are under 10%. Taking Apple Inc. as an example (from Table 2), Bloomberg identified 20 customers of Apple Inc. while Compustat and Factset identified 7 and 18, respectively. Bloomberg and Factset have clear

statements for the valid name of customers, but Compustat does not. Moreover, Bloomberg reports the money flows between the company and its customer as revenue percent and Compustat reports as customer sales, but Factset does not provide the financial-related information.

Table 2 An example of the comparison among Bloomberg, Compustat and Factset

	Number of Customers	*Name of customer*	*Relationship Value*
Bloomberg	20	20/20	20/20
Compustat	7	0/7	0/7
Factset	18	18/18	×

In this thesis, I choose the Bloomberg SPLC database to collect the cross-sectional data instead of time-series data from the other two databases to obtain a more comprehensive supplier and customer dataset to make the results more reliable. In the future, we may run time-series data to check the findings. The most relationship years of this sample are 2018 and 2019, but 41 supplier and customer relationship observations were updated in 2016 or 2017. Since Bloomberg SPLC updates the latest supplier and customer relationships annually, it is reasonable to assume that the relationships still exist but do not have an official updated financial relationship if the relationship year is not 2019. Wu and Birge (2014) assumed that the supplier and customer relationship's broad feature will keep stable with 12 months by doing the specific test. Kim and Davis (2016) verified this opinion. This thesis follows Wu and Birge's (2014) and Kim and Davis's (2016) opinions, assuming that the supply chain network will be stable during the relationship year 2018 and 2019. Under this assumption, we delete the observations in the year 2016 and 2017. After that, we identify 253 suppliers as focal companies in the computer and electronic product manufacturing industry, their 567 customers, and 2907 supplier (focal company) and customer relationships.

Then, I match the supplier and customer relationship data with data on CSR score for supplying firm in 2019 from CSRHub, a professional website that collects the CSR performance from CSR rankings and ratings on about 17500 companies from 134 industries from more than 140 countries. It combines more than 660 data resources, including non-government organizations (NGOs), socially responsible investment (SRI) analysis firms, small profitable organizations, and then transforms them into a 0 to 100 scale, making it one of the most credible databases that measure a company's sustainability performance. A stream of literature uses it to measure a firm's CSR performance (e.g., Acharya and Gupta,2014; Hughey and Sulkowski, 2012; Lin et al., 2019; Verma and Kuamr, 2014). Finally, after obtaining the financial performance (ROA) and firm size (employee numbers) data of supplying firms from Compustat database, the final sample of valid observations are 196 supplying firms with 2520 supplier-customer relationships.

5.2 Variables and Measures

5.2.1 Independent variables:

Customer network centrality is calculated using the financial link between supplying and customer firms. In line with the social network analysis, I assume that the relational data set (ties between nodes) has a constricted score (0 or 1). I see the relation value is 1 if company A and company B have supplier-customer relationships and see the relation value is 0 if not. I employ two diverse customer network centrality measures: degree centrality and eigenvector centrality; and calculate them according to the following formulas (Bonacich, 1987; Bonacich, 2007). This research uses UCINET to calculate both degree centrality and eigenvector centrality.

Degree Centrality is defined as following Eq. (1),

$$C_i = \sum_{j=1}^{N} A_{ij} \tag{1}$$

Where C_i represents the customer network degree centrality of supplier i; N is the whole customers in the network; $A_{ij} = 1$ if focal company$i$ and customer company j is connected, $A_{ij} = 0$, otherwise.

Eigenvector Centrality is defined as following Eq. (2),

$$C_i = \frac{1}{\lambda} \sum_{j=1}^{N} A_{ij} C_j \tag{2}$$

Where C_i is the eigenvector centrality of the focal company i; λ represents matrix A's biggest eigenvalue; $A_{ij} = 1$ if focal company i and customer company j is connected, $A_{ij} = 0$, otherwise; C_j represents the eigenvector centrality of focal company i's customer company j.

5.2.2 Dependent Variable:

This thesis collected the company's CSR rating scores in 2019 from the CSRHub database to measure supplying firm's CSR performance. This database measure CSR ratings from give the perceived performance on a 1-100 scale based on the following four categories: community, employees, environment, and governance.

5.2.3 Moderating Variable:

Following the previous literature (e.g., Gualandris and Kalchschmidt, 2016; Touboulic et al., 2014; Sancha et al., 2019), this research uses the employee number of supplier firms in 2019 from the Compustat database to measure the supplier firm size. The first moderating variable, customer network degree centrality × supplier firm size, is calculated by multiplying the employee numbers of supplier firm with customer network degree centrality. Similarly, the second moderating variable, customer network eigenvector centrality × supplier firm size, is calculated by multiplying the employee numbers of supplier firm with customer network eigenvector centrality.

5.2.4 Mediating Variable:

ROA (return on asset) is a common measure represents firm's financial performance (e.g., Basole et al., 2018; Elking et al., 2017; Kim et al., 2020; Kumar et al., 2019; Shi et al., 2018). Following the literature, I collect the data of supplier's ROA in the year 2019 from the Compustat database to test the mediation role of supplier's financial performance on the correlation between 1) firm's degree centrality/2) eigenvector centrality in customer network and its CSR performance.

5.2.5 Control Variables:

This thesis follows the literature and makes some innovations to set the additional variables as control variables to control the extraneous effects on supplier's CSR performance. Specifically, this research controls the customer concentration of supplying firms. Following Kim and Zhu (2018), Kumar et al. (2019), and Kim et al. (2020), this research calculates the customer concentration as the percent of a supplier's total sales to each of its disclosure customer. The formula is defined as following Eq. (3); where $sales_{ij}$ reflects the sales of supplying firm i to its customer firm j in 2019 and sales i reflects the total sales of supplier i in 2019. I draw the data from the Compustat database in the year 2019.

$$Customer\ concentration_i = \sum_{j=1}^{N} (\frac{Sales_{ij}}{Sales_i})^2 \quad (3)$$

Considering customer's CSR adoption may have a positive influence on suppliers' CSR adoption (Yang et al., 2020), the level of all the customer firm's CSR performance is higher, they may have more requirement to their supplier's CSR performance. In other words, the customer firm's CSR performance may positively correlate with the supplier's CSR performance. Therefore, I also control for customer's CSR ratings according to the following Eq. (4), where CSR score j represents customer j's CSR score in year 2019 and Rev% ij represents the revenue percent that supplier i gets from the customer j in year 2019, and the sum of Rev% ij represents the revenue percent of the exposed customer of supplier i's whole revenue. All the data is obtained from the Bloomberg SPLC database.

$$Customer\ combined\ CSR\ Ratings_i = \frac{\sum CSR\ Ratings_j \times Rev\%_{ij}}{\sum Rev\%_{ij}} \quad (4)$$

I further control the intangible asset ratio, which is based on the intangible asset divided by the supplier companies' total assets. Both intangible assets and total assets were collected from Compustat databased in the year 2019. Then, considering every single industry has its requirements so that their ability to perform CSR practice is also different, I control the industry effect using the six-digit NAICS code for each firm were calculated as a dummy variable.

5.3 Method design

To test the hypotheses in this research, I use OLS method with the robust estimator in this thesis to avoid the possible heteroscedasticity issue. First, I conduct the baseline regression on supplier's CSR, where the centrality variables are included as the explanatory variables (5.1; 5.2). Then, I test the main relationship between supplier's centrality in customer network and its CSR performance. In this main effect model, this research first sees supplier's degree centrality in customer network as the independent variable to test the a) part in our hypothesis 1 (call it H1a in the following context); and then use supplier's eigenvector centrality in customer network as the independent variable to test H1b. Furthermore, the moderating effect of supplier's firm size on these relationships (H2) is tested by including the interaction terms into the main regression models: supplier's firm size × customer network degree centrality (H2a), which is showed in 5.3; and supplier firm size × customer network eigenvector centrality (H2b), which is showed in 5.4.

$$CSR\ Performance_i = \alpha_0 + \beta_1 CDegCen_i + \beta_2 CC_i + \beta_3 CCSR_i + \beta_4 IAR_i + \beta_{5\_dummy} In_i + \varepsilon_i \quad (5.1)$$

$$CSR\ Performance_i = \alpha_0 + \beta_1 CEigenCen_i + \beta_2 CC_i + \beta_3 CCSR_i + \beta_4 IAR_i + \beta_{5\_dummy} In_i + \varepsilon_i \quad (5.2)$$

$$CSR\ Performance_i = \alpha_0 + \beta_1 CDegCen_i + \beta_2 SSIZE_i + \beta_3 CDegCen_i \times SSIZE_i + \beta_4 CC_i + \beta_5 CCSR_i + \beta_6 IAR_i + \beta_{7\_dummy} In_i + \varepsilon_i \quad (5.3)$$

$$CSR\ Performance_i = \alpha_0 + \beta_1 CEigenCen_i + \beta_2 SSIZE_i + \beta_3 CEigenCen_i \times SSIZE_i + \beta_4 CC_i + \beta_5 CCSR_i + \beta_6 IAR_i + \beta_{7\_dummy} In_i + \varepsilon_i \quad (5.4)$$

Where $CSR\ Performance_i$ is the dependent variables measured by the CSR ratings of $supplier\ firm_i$; $CDegCen_i$ and $CEigenCen_i$ is the independent variables measured by customer network degree centrality and eigenvector centrality, separately; $SSIZE_i$ is the moderating variable, measured by the employee number of $supplier\ firm_i$; CC_i , $CCSR_i$ and IAR_i are the control variables in this research; while In_i is the dummy variable, represents the specific industry by the 6-digit NAICS code for $supplier\ firm_i$.

Then, this research tests how a supplier's financial performance mediates customer network degree centrality (H3a)/eigenvector centrality (H3b) and supplier CSR performance in two ways. First, following Baron and Kenny (1986), three basic steps should be taken: 1) Significant relationships are established between the variable dependent (supplier's CSR) and independent (customer network centrality degree) 2) the mediator (supplier financial performance) and independent variables is significantly related 3) both independent variable and mediator are added to the regression equation and a comparison

of coefficient value between step 1and step 3. If the mediator reduces the coefficient value of independent variables on the dependent variables, the partial mediation occurs. Second, we use Bootstrap for further mediation testing since it provides the confidence intervals for the indirect effect which the traditional three-steps method does not.

Furthermore, I conducted a robust check of our findings. According to the literature, endogeneity may be considered as an issue when testing the relationship between supply chain network and company performance (e.g., Basole et al., 2018; Kim et al., 2020; Shi et al., 2019). As for this research, there may be exist a reverse causality between firm's customer network centrality and its CSR performance. The reason is that it is possible that customers prefer to choose a supplying firm with high CSR performance level to avoid the potential risk. To test the existence of such endogeneity, Durbin-Wu-Hausman test was used, considering there exist endogeneity when the p values is less than 0.1. According to the literature and related test, this research chooses ego network density and partner's centrality diversity as the instrumental variables after the validity examination through the overidentification test and significant test. The instrumental variables were considered not overidentified if the p-value is larger than 0.1 and significant if the F-value is higher than 10. After that, I adopt 2SLS regression to find the possible endogeneity issue. The first stage regression tests the correlation between instrumental variables and independent variable while the second stage regression tests the correlation between firm's customer network (independent variable) and its CSR performance (dependent variable) after considering the instrumental variables.

Chapter 6 Analysis Results

6.1 Results of the hypotheses tests

The statistical description of all variables in the thesis was showed in Table 3, including independent, dependent, moderating, mediating, and control variables in this thesis. According to Table 4, most variables in this thesis were significantly correlated. Specifically, customer network degree/eigenvector centrality significantly correlates with supplier CSR ratings, which supports H_{1a}/H_{1b} ($p<0.01$). Moreover, supplier ROA has a significant correlation with both customer network degree/eigenvector centrality ($p<0.05$) and supplier CSR ratings ($p<0.01$), which provides support for the essential precondition of H_{3a}/H_{3b}. Also, to avoid the risk of multicollinearity of the models, we check the variance inflation factor (VIF) values, the results show that the maximum VIF value obtained was 4.5 (Model 3a), and all the other VIFs are less than 3, less than the general rule-of-thumb threshold value for collinearity 10 (Neter et al., 1996). It means multicollinearity issue should not be concerned in our models.

The results from the robust regression are presented from Table 5 to Table 7. Table 5 shows the regression results about how supplier's degree and eigenvector centrality in the customer network affect suppliers' CSR performance (H_{1a}/H_{1b}) and how supplying firm size moderates the relationships between them (H_{2a}/H_{2b}); while Table 6 and Table 7 show how a supplier's financial performance mediates supplier's centrality in customer network and its CSR performance, respectively (H_{3a}/H_{3b}). Model 1 of Table 5, a base model, only reports the control variables. Model 2a and model 2b include the degree centrality and eigenvector centrality as the independent variables separately. Using supplying firm's CSR ratings as the dependent variable, I find support for H_{1a} in model 2a ($p<0.01$) and H_{1b} in model 2b ($p<0.1$), which means the supplying firm's degree/eigenvector centrality in its customer network has a positive correlation with its CSR performance. Thus, a high-level centrality of customer network positively increases a supplier firm's CSR performance.

In model 3a and model 3b, I investigate the interaction effect of supplier's firm size and its customer network centrality on its CSR performance. Specifically, model 3a shows the

interaction effect between the supplying firm's degree centrality in its customer network and employee numbers on its CSR performance (H2a), while model 3b shows the interaction effect between the supplying firm's eigenvector centrality in its customer network and employee numbers on its CSR performance (H2b). From the model 3a, either supplier's degree centrality or firm size has a positive correlation with its CSR performance, separately. Same results are indicated in model 3b when considering the effect of firm size and eigenvector centrality on firm's CSR performance. However, as hypothesized in H2a and H2b, the coefficient of the interaction effect of customer network centrality×firm size is negative and significant in both model 3a ($p<0.05$) and model 3b ($p<0.01$). Hence, the hypothesis that higher levels of a supplier firm size will reduce the positive effects of customer degree centrality (H2a)/eigenvector centrality (H2b) on the supplying firm's CSR performance is supported.

To exam the mediating effect of supplier's financial performance on the correlation between supplier's centrality in customer network and its CSR performance, this research first follows Baron and Kenny (1986)'s three-step methods. The results are established in the Table 6a and Table 6b as the comparative tables. Model 4 in Table 6a shows the positive and significant relationship between the mediator (financial performance) and dependent variable (CSR performance) ($p<0.01$), providing one of the mediating effect's preconditions. Table 6a presents the comparative table for H3a, which predicts how supplying firm's financial performance can partially mediate the relationship between supplying firm's degree centrality in customer network and its CSR performance. Following the first step in three-step method, the result should provide a significant correlation between independent variable and dependent variable, which are supplier's degree centrality and supplier's CSR performance in this model. The results from model 2a in Table 5 posits that the significant level between supplying firm's degree centrality and its CSR ratings is $p<0.01$, which satisfying the requirement. At the second step, the results should establish a significant correlation between independent variable and Mediator, which is supplier's degree centrality and supplier's financial performance. Model 5a in Table 6a implies that the supplier's degree centrality is positive related to its financial performance at the level of 5%, which also satisfying the requirement. The last step was to

run a regression of both degree centrality, and supplier's financial performance (measured as ROA) in relation to supplier's CSR rating, and the results were reported in Model 6a. The result highlights that the correlation between degree centrality and CSR performance was still significant ($c'=0.183$, $p<0.01$). However, after implementing the above analysis, the findings exhibit that the positive coefficient of the relationship between the supplying firm's degree centrality in the customer network (independent variable) and its CSR ratings (dependent variable) reduced from 0.201 to 0.183 when adding the supplier ROA (mediator). Thus, supplier's financial performance partially mediates the relationship between supplying firm's degree centrality and its CSR performance, supported H3a. The situation is similar for H3b. Model 5b in Table 6b shows a significant correlation between eigenvector centrality and supplier's financial performance (step 1). The regression in step two at this model is the same as the last model. Then, compared to model 2b in Table 6b ($c=25.52$, $p<0.05$), the coefficient of Model 6b was reduced but significant ($c'=19.36$, $p<0.05$), which follows step 3. Hence, supplier's financial performance also partially mediates the relationship between supplier's customer network eigenvector centrality and its CSR performance; H3b was supported.

Furthermore, Bootstrap with 500 samples was adopted to test the mediating effect of supplier's financial performance on the relationship between customer network centrality and CSR performance (H3). The results were showed in Table 7a/7b. Table 7a presents the bootstrap results when consider degree centrality as the independent variable, showing that the amount of indirect effect is 0.03 at the significant $p<0.1$; the amount of direct effect is 0.17 at the significant level of $p<0.01$; percentile confidence interval does not include 0; so, H3a is supported. According to Table 7b, which considered the eigenvector centrality as the independent variables. The result indicates coefficients are significant at the level of 5% for both indirect and direct effect, and the percentile confidence interval does not include 0. Results confirm the partial mediation effect of supplier's financial performance on the relationship between eigenvector centrality and CSR performance. In summary, it was confirmed that customer network centrality can influence the supplier's CSR performance through influence supplier's financial performance to some extent; H3 was supported.

In order to give a clear understanding of the main hypotheses and related test results, the summary of the test results was showed in Table 8.

Table 3 Descriptive statistics

	Count	Mean	Std. Dev.	Minimum	Maximum
Supplier's CSR ratings	196	49.64	5.95	38.00	64.00
Customer network degree centrality	253	11.49	8.14	1.00	20.00
Customer network eigenvector centrality	241	0.05	0.05	-2.29899E-10	0.18
Supplier employee numbers	249	14.81	29.92	0.02	200.00
Supplier ROA	252	-0.04	0.41	-5.84	0.37
Supplier's intangible Asset Ratio	228	0.24	0.22	.0001571	0.85
Customer Concentration	253	0.07	0.13	7.39e-08	0.96
Integrated customer CSR ratings	237	53.99	5.91	33.00	66.00

Table 4 Correlation coefficient matrix

	1	2	3	4	5	6	7	8
Supplier CSR ratings	1.000							
Degree centrality	0.263***	1.000						
	(0.000)							
Eigenvector centrality	0.194***	0.725***	1.000					
	(0.008)	(0.000)						
Supplier employee number	0.587***	0.247***	0.214***	1.000				
	(0.000)	(0.000)	(0.001)					
Supplier ROA	0.300***	0.154**	0.131**	0.186***	1.000			
	(0.000)	(0.014)	(0.042)	(0.003)				
Supplier's intangible Asset	0.053	0.043	0.140**	0.154**	0.085	1.000		
	(0.476)	(0.514)	(0.040)	(0.020)	(0.202)			
Customer Concentration	-0.090	-0.040	0.010	-0.070	-0.043	-0.058	1.000	
	(0.212)	(0.529)	(0.876)	(0.269)	(0.499)	(0.382)		
Integrated customer CSR	0.077	0.286***	0.298***	0.069	0.116*	-0.115*	-0.368***	1.000
	(0.304)	(0.000)	(0.000)	(0.292)	(0.075)	(0.094)	(0.000)	

p-values in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5 Supploer's CSR performance and the moderation role of firm size

	Model 1	Model 2a	Model 2b	Model 3a	Model 3b
Degree centrality		0.201***		0.168***	
		(0.0614)		(0.0570)	
Eigenvector centrality			25.52**		31.63***
			(9.932)		(9.807)
Supplier’s employee numbers				0.172***	0.153***
				(0.0358)	(0.0220)
Degree centrality × supplier’s employee numbers				-0.00417**	
				(0.00200)	
Eigenvector centrality × supplier’s employee numbers					-0.743***
					(0.283)
Supplier’s intangible Asset Ratio	0.542	0.389	-0.392	-1.603	-2.362
	(2.073)	(2.017)	(2.080)	(1.700)	(1.717)
Customer Concentration	-2.452	-4.456	-4.205	-4.320	-4.796
	(4.325)	(4.252)	(4.321)	(3.507)	(3.516)
Integrated customer CSR ratings	0.0530	-0.0411	-0.0376	-0.0518	-0.0642
	(0.0842)	(0.0868)	(0.0905)	(0.0708)	(0.0726)
Industry Dummies	Yes	Yes	Yes	Yes	Yes
_cons	46.96***	49.46***	50.82***	48.96***	50.46***
	(4.818)	(4.748)	(4.995)	(3.872)	(4.003)
N	174	174	173	173	172
R^2	0.007	0.066	0.044	0.382	0.389

p-values in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6a Mediation role of supplier financial performance (degree centrality - CSR performance)

	Model 2a Supplier CSR	Model 4 Supplier CSR	Model 5a Supplier ROA	Model 6a Supplier CSR
Degree centrality	0.201***		0.00624**	0.183***
	(0.0561)		(0.00313)	(0.0550)
Supplier ROA		12.38***		11.48***
		(3.164)		(3.047)
Supplier's intangible Asset	0.389	0.344	0.175	0.219
	(1.769)	(1.809)	(0.122)	(1.772)
Customer Concentration	-4.456	-2.488	0.248	-4.309
	(4.657)	(4.408)	(0.357)	(4.379)
Integrated customer CSR	-0.0411	0.0501	0.0101	-0.0353
	(0.0783)	(0.0735)	(0.00943)	(0.0751)
_cons	49.46***	46.94***	-0.713	49.22***
	(4.138)	(4.100)	(0.618)	(3.999)
N	174	174	214	174
R^2	0.066	0.079	0.044	0.127

Standard errors in parentheses * p < 0.1, ** p < 0.05, *** p < 0.01

Table 6b Mediation role of supplier financial performance (eigenvector centrality-CSR performance) (robust regression)

	Model 2b Supplier CSR	Model 5b Supplier ROA	Model 6b Supplier CSR
Eigenvector centrality	25.52**	0.735***	19.36**
	(9.857)	(0.209)	(9.750)
Supplier ROA			11.05***
			(3.002)
Supplier's intangible Asset	-0.392	0.162	-0.340
	(1.924)	(0.134)	(1.901)
Customer Concentration	-4.205	0.266	-3.815
	(4.772)	(0.392)	(4.508)
Integrated customer CSR	-0.0376	0.0108	-0.0182
	(0.0829)	(0.0110)	(0.0781)
_cons	50.82***	-0.702	49.87***
	(4.498)	(0.680)	(4.242)
N	173	212	173
R^2	0.044	0.036	0.099

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 7a Bootstrap mediation test of H3a

	Coef.	Std. Error	z	p > |z|	[95% Conf. Interval]	
Indirect effect	0.029	0.016	1.85	0.064	0.0001	0.061
Direct effect	0.165	0.047	3.52	0.000	0.077	0.262

Table 7b Bootstrap mediation test of H_{3b}

	Coef.	Std. Error	z	p > |z|	[95% Conf. Interval]	
Indirect effect	5.831	2.467	2.36	0.018	1.782	11.027
Direct effect	17.728	8.980	1.97	0.048	0.154	35.982

Table 8 Summary of the test results

Path	Hypothesis	Method	Results
Degree centrality ⟶ Supplier CSR performance	H_{1a}	Robust regression	Supported
Eigenvector centrality ⟶ Supplier CSR performance	H_{1b}	Robust regression	Supported
Degree centrality × Firm size ⟶ Supplier CSR performance	H_{2a}	Robust regression	Supported
Eigenvector centrality × Firm size ⟶ Supplier CSR performance	H_{2b}	Robust regression	Supported
Degree centrality + Supplier financial performance ⟶ Supplier CSR performance	H_{3a}	Three-steps method	Supported
		Bootstrap	Supported
Eigenvector centrality + Supplier financial performance ⟶ Supplier CSR performance	H_{3b}	Three-steps method	Supported
		Bootstrap	Supported

6.2 Robustness tests via 2SLS

Considering the possible reverse situation that supplying firm with high CSR levels will attract more customer firm so that increasing its customer network centrality, this research performs 2SLS regression with instrumental variables and Durbin-Wu-Hausman post-estimation to address this potential endogeneity problem. In the first step, I go through the prior studies to find potential instrumental variables, and ego network density and partner's centrality diversity are selected as the instrument variables. Ego network density is the average degree divided by the number of alters minus one (unless reflexive ties are included). This represents the average edge value, calculating by UCINET 6. The partner's centrality is computed by $1 - \sum_i^N (P_i)^2$, where P_i is the percentage of all customers with centrality level i, and N is the total number of different centrality levels (Jiang et al., 2020). Then, this research regresses the customer network centrality and eigenvector centrality on the two instruments and all the control variables in this research; the results reveal the significant relationships. As for the overidentification and significance of instruments tests, we cannot reject the null for overidentification (p=0.47 when degree centrality is the independent variable; p=0.65 when eigenvector centrality is the independent variable). After the significance test of the instrumental variables, the results shows that the F-values of 73.39 and 62.16, respectively, respectively, which are larger than 10, suggesting that ego density and partner's centrality are not weak instruments.

In the second step, the Durbin-Wu-Hausman test was used to address the endogeneity tests. As reported by the results, the endogeneity test statistics of customer degree centrality is not significant (p=0.19), so that the degree centrality is exogenous cannot be rejected. Basically, model 2 is not influenced by endogeneity. However, the endogeneity test of the customer eigenvector is significant (p<0.1). To solve this issue, 2SLS regression was adopted. Results in Table 9 show that customer network eigenvector centrality is positively correlated with supplier CSR performance at a 1% significance level, supporting the one that obtained with previous robust regression.

Table 9 Results of 2SLS regression analysis

	Stage 1 Eigenvector	Stage 2 Supplier CSR
Customer network Eigenvector		49.045***
		(3.08)
Ego network density	-0.025***	
	(-5.96)	
Partner's centrality diversity	0.131***	
	(8.19)	
Supplier's intangible Asset Ratio	0.017	-1.719
	(1.50)	(-0.75)
Customer Concentration	0.050**	-5.621
	(2.12)	(-1.23)
Integrated customer CSR ratings	0.004***	-0.171
	(7.08)	(-1.45)
_cons	-0.207***	57.135***
	(-7.21)	(9.07)
N	194.000	159.000
r2_a	0.518	-0.010

t statistics in parentheses

*** 1% ** 5% * 10%

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Chapter 7 Discussion

7.1 Practical implications

Based on the finding, essential insights can be implied from the analysis results. First, the results shows that customer network degree/eigenvector centrality has a positive influence on supplier's CSR performance, strongly suggesting that the important role of the customer on supplying firm's CSR performance. Therefore, the findings should encourage the managers to respond to customer firms' pressure proactively; and ask for support from customer firms to gain the knowledge, information, and technology that maybe necessary for their CSR development.

Second, this thesis supports the positive relationship between firm size or customer network centrality and firm's CSR performance; and the negative relationship between the interaction effect of firm size and customer network centrality on firm's CSR performance. Hence, the findings remind the external stakeholders should be aware of the powerful company's potential adverse behavior and try to keep a balance between companies.

7.2 Limitations and future research

It is also unavoidable to consider the limitations that can be improved in future research. The first limitation worth mentioning here is related to the database. The data used in this thesis are cross-sectional data. SPLC database in Bloomberg has the most detailed supplier-customer relationship data than other databases, but it only reports the latest relationship, so this thesis only tests the relationship in the year 2019. In the future, I will collect more latest supply chain relationship data and combine them as time-series data to test the result again. Moreover, although Bloomberg's SPLC database contains the most explicit supply chain relationship, it still did not capture all the supplier-buyer information. This database covers the listed companies, but the unlisted companies may not be considered in the database. Then, most supply chain information is disclosed due to the firm's voluntary. Many firms do not report all their customers or suppliers considering the competition. These situations may cause the inaccuracy of the results. However, since there is no ask for companies to report all their supply chain information, it is hard to capture all the needed data. Future research can try to obtain the supplier-customer relationship data from the unlisted companies through interviews or surveys to probe network centrality’s impact. Another limitation in this thesis is that we only obtain data from a specific industry. It would be expedient to extend the study to other industries to validate the generalized applying of the findings in this thesis in the future.

Chapter 8 Conclusion

This thesis uses resource-based theory and social network theory to study whether the firm's centrality in the customer network can positively influence its CSR performance, as reflected by CSR ratings. Centrality, calculated by eigenvector centrality and degree centrality in this research, indicates the central level of firm within the network. If a firm is located in a more central position within its customer network, the firm would be able to get more access to valuable resources, such as financial support, materials, talent staff, or invisible resources like information and technology, to develop a sustainable system to get a good CSR performance. Moreover, supplying firm with a high centrality needs to have a good CSR performance due to their buying firm's requirements. What is more, higher centrality represents more attention. When a firm is more central in the network, it will get more attention from the public, media, and government. The firm has the pressure to perform well to get a positive reputation. Using a sample of 196 supplying firms with 2520 supplier-customer relationships, this thesis finds that customer network centrality positively influences supplier firm's CSR performance, supporting Hypothesis 1a/1b. In doing so, this thesis increases the understating of the supply chain network and firm's CSR performance.

Firm size, measured by firm's employee numbers, was used to test the combinative effect with customer network centrality on firm's CSR performance. This thesis finds that the interaction effect of supplier centrality in customer network and firm size negatively affects supplier firm's CSR performance, providing support for Hypothesis 2a/ab. The results show that a firm may have adverse behaviors when it gets enough power. To provide more insights, we find customer network centrality can affect supplying firm's CSR performance through its financial performance. The results extant the understanding of the role supply chain network centrality on firm's performance and the indicator of firm's CSR performance.

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